Semiconductors *Japan*

Source: Dataquest

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Welcome to Dataquest

Semiconductors *Japan*

You are in the
Source: Dataquest
binder

An annually updated collection of reference documents for the Semiconductors *Japan* service. Japanese market statistics; *Company Backgrounders*; and several guides such as *How to Use Dataquest, Dataquest Research Methodology,* and *Dataquest High-Technology Guide—Segmentation and Glossary* are contained in this binder.

Other Semiconductors *Japan* service binders:

Dataquest Perspective
A series of multitopic publications that provide analysis on the Japanese semiconductor industry, Japanese semiconductor application markets trends and issues, and semiconductor news and views are contained in this binder.

Dataquest

How to Use Dataquest

Source:
Dataquest

Dataquest

How to Use Dataquest

Dataquest

A worldwide network of information-gathering resources

Source: Dataquest

Published by Dataquest Incorporated

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Chapter 1

A Guide to Help You Get the Most Out of Your Dataquest Information Resources

Introduction

As a Dataquest client, we want you to obtain the greatest possible value from your subscription. This guide will acquaint you with the available information resources and will help you establish a "user strategy" that ensures that Dataquest's products and services contribute to your success.

This guide is divided into the following sections:

- Your Industry Service: What's in It for You?
- How to Use Your Industry Service
- Customizing Your Industry Service
- Whom Do You Call at Dataquest?
- About Dataquest
- Subscription Terms
- Appendixes
  - Appendix A: Dataquest Information Resource Center CD-ROMS and Computer Databases
  - Appendix B: Dataquest 1991 Conference Schedule
  - Appendix C: Technology Products

Chapter 2

Your Industry Service: What's in It for You?

Clients can tap into Dataquest's extensive knowledge base to support their decision-making process in the industries and markets that we track. The information and analysis that you receive from Dataquest can help you to better:

- Evaluate markets
- Position new products
- Develop marketing strategies
- Perform competitive analysis
- Understand end-user trends
- Verify critical market assumptions
- Assess emerging technologies
- Implement and execute tactical plans
- Support your ongoing research activities

As a Dataquest client you will receive much of this information automatically through the regular publication of database documents and industry analysis. Your industry service also provides information, available at your initiation, that is specific to your company's needs. You will receive Dataquest information through a variety of forms, including:

- *Source: Dataquest*
- *Dataquest Perspectives*
- Inquiry support
  - Industry Analysts
  - Client Inquiry Centers
- Dataquest Information Resource Center

Source: Dataquest

The *Source: Dataquest* binder is an annually updated collection of reference documents. The binder contains worldwide and regional market statistics, *Company Backgrounders*, and several guides.

Guides

- *How to Use Dataquest*: Describes your industry service subscription, publications, inquiry privileges, phone contacts, library use, and other services.
- *High-Technology Guide—Segmentation and Glossary*: Lists key terms and defines the market segments, products, applications, regions, distribution channels, and environments tracked by Dataquest.
- *Dataquest Research Methodology*: Details the research methodology used by Dataquest to gather data and information and provides the general assumptions used to generate industry forecasts.

Market Statistics

Market Statistics documents provide clients with detailed tables consisting of product shipments, average selling prices, industry revenue, forecasts, and market share data.

Company Backgrounders

Each service provides its clients with a set of *Company Backgrounders by Dataquest*, made up of companies that represent 80 percent of the revenue of that industry. *Company Backgrounders* are produced by the Strategic Company Analysis group in Research Operations. The documents contain useful information on a company's finances, product lines, sales and manufacturing locations, and joint ventures, mergers, and acquisitions.

Dataquest Perspective

This multitopic publication, delivered on average twice a month, contains timely analysis of markets, products, technologies, companies, and industry events, and provides detailed discussions of our market projections and market share statistics. These publications are filed chronologically, and include a quarterly index that cross-references articles by company name and major topic. They may be supplemented as needed by the timely delivery of faxes that provide information and analysis of current significant events.

Please note that all of Dataquest's written material is copyrighted and therefore may not be copied without our permission.

Inquiry Support

Inquiry—via phone, fax or letter—is an integral part of the service Dataquest provides. Through inquiry you can:

- Clarify or interpret information.
- Explore Dataquest information in more depth.
- Discuss the application of this information to a particular situation.
- Access information that is not available in Dataquest publications, but is available in Dataquest's extensive files.

Each Dataquest client has a designated binderholder. In addition to receiving all the Dataquest published materials, the binderholder serves as the liaison between Dataquest and your company.

The binderholder has access to Dataquest's inquiry privilege and may designate up to two people to serve as alternates for inquiry privileges. Dataquest account managers need to be aware of any designated alternates.

If someone calls who is not a binderholder or alternate, Dataquest will refer that person to the account manager for your company. We have a commitment to our clients to provide them with timely, high-value information. In order to do that, services must be restricted to authorized contacts.

Call Your Industry Analyst

Industry analysts have significant industry expertise. Directly or through the assistance of Client Inquiry Center (CIC) personnel, you have access to the industry analysts associated with your service. This access is on an as-required basis relative to those markets, products, and technologies within the scope of your service. Analysts may be called directly when you know exactly what you need and who at Dataquest can provide the information.

Call the Client Inquiry Center

Many of Dataquest's services provide a Client Inquiry Center (Enquiry Desks for European customers). These centers are responsible solely for the quick turnaround of your fact-based questions. CIC personnel have access to industry service publications and database information, and they are trained to help you locate information within your Dataquest service. CIC personnel will also put you in touch with appropriate industry analysts when you require in-depth analysis of issues and trends, or opinion about the implications of recent industry events. The CIC may be called when you need an answer to a fact- or data-related question, when you need a backup to your regular analysts should they not be available, or when you need direction to new areas as your questions develop.

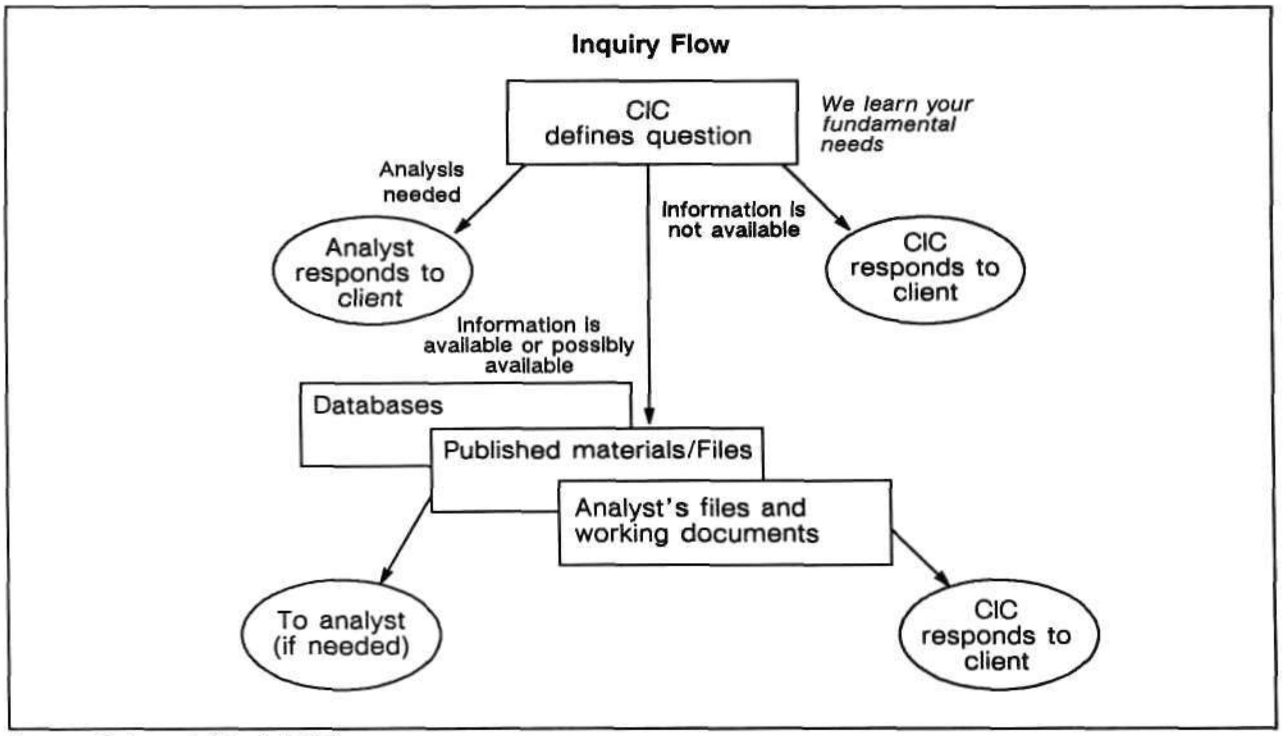
Dataquest is committed to personally handling each of your calls. Figure 2-1 illustrates how inquiries in the CIC are handled. We will ensure that you are put in touch with the right individual, or if you wish, you may choose to leave a voice-mail message when a particular analyst is not immediately available.

The more Dataquest knows about your inquiry, the better we will be able to help you. When you call with a question, the CIC will want to know:

- What information you already have on the subject
- What related information you are gathering
- How you plan to use the information
- What you are trying to demonstrate

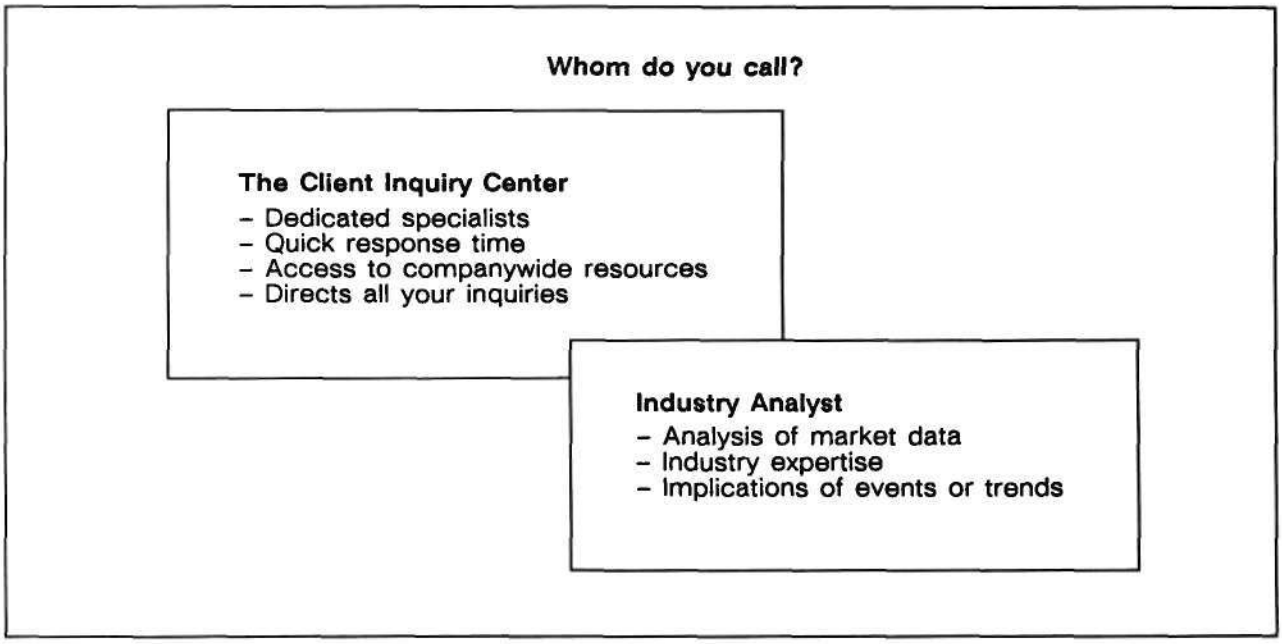
It will also help us to know what stage of the market research process you are in, as well as the depth of information you require. The more we know, the better we will be able to offer additional or related information, or offer insights into different ways to approach the question. Of course, tell us only what you are comfortable with—we don't need or want to know proprietary information. Figure 2-2 shows the mix of people available to respond to your inquiries.

Figure 2-1
Client Inquiry Center Flow



Source: Dataquest (April 1991)

Figure 2-2
Whom to Call for Your Inquiry



Source: Dataquest (April 1991)

Information Resource Center

Dataquest's Information Resource Center (IRC) is a valuable supplement to the information delivered through your industry service. It consists of a 1,200-square-foot corporate library in San Jose, plus two major satellite libraries located in Boston and the United Kingdom. The IRC maintains a wide selection of industry directories, trade press periodicals, financial reports from most of the publicly held companies followed by Dataquest industry services, government reports, and CD-ROM-based and on-line information services.

The European Corporate Library maintains more than 300 titles and reference works concerning the European Community, including approximately 30 files and 100 reference works on the 1992 single European market objective. The U.K. library collection includes basic reference works produced by Her Majesty's Government, the Department of Trade and Industry, and other governmental agencies. Special reports have also been collected from a variety of sources, including the U.K. government, trade associations, the Financial Times, and other research organizations.

Appendix A lists the CD-ROMs and computer databases available to clients at the San Jose IRC. The San Jose IRC is staffed by three degreed professionals (Master of Library Science), as well as assistants who specialize in managing the corporation's secondary research resources.

Clients typically use the IRC in the following ways:

- To obtain financial information on the leading companies within their industry
- To collect recent publications on new areas of the market
- To research a market or topic not covered by a Dataquest industry service

You are encouraged to use the IRC. If it is not convenient to visit an IRC, your Client Inquiry Center staff can often make many of the center's resources available to you through your inquiry privilege.

Policies and Procedures

Because the IRC is a private company library, our collections are limited to the following individuals:

- All permanent Dataquest employees
- Current clients—Binderholders and designated alternates from within the client company
- Consultants/contractors working on specific Dataquest projects (only for duration of contract)
- Prospective clients escorted by a Dataquest salesperson

Non-Dataquest Consultants

It is Dataquest policy to deal directly with Dataquest clients in answering their information needs. The Information Resource Center does not authorize the use of library facilities by consultants working for clients.

Chapter 3

How to Use Your Industry Service

Receiving value from your industry service requires knowing where to find the information you need and how to use that information. The following guidelines will help you get the most out of the many elements of your service.

What Written Materials Will You Receive?

You will receive written material at least twice a month. Some industry services are segmented into key market areas (product or geographic) to allow you to choose the coverage that is most relevant to the markets in which you participate. You will receive written material covering both the broad-based issues of the industry as a whole, as well as the more focused issues of the particular market segment. All written material will be labeled as belonging to one of the following:

- The *Source: Dataquest* binder
- The *Dataquest Perspective* binder
- The segment binder

Source: Dataquest

Source: Dataquest is a regularly updated reference binder in which you'll find the following:

- *How to Use Dataquest:* You are currently in this document.
- *Dataquest High-Technology Guide—Segmentation and Glossary:* This document describes in detail the segmentation and terms used by all Dataquest services to define the markets they track. This guide should be used whenever you are looking for definitions of products, applications, regions, technologies, and environments referred to by your industry service. This document also provides you with standard definitions of research terms that appear in your industry service publications, such as retirements, average selling price, and compound annual growth rate.
- *Dataquest Methodology:* This document will help you understand the research methodology Dataquest uses to gather information on the industries covered by our industry services. It also describes the general assumptions used to generate industry forecasts.
- *Market Statistics:* Each Dataquest industry service provides its clients with documents that contain detailed tables consisting of history, market forecasts, and market share data. We encourage you to use these tables as an opportunity to review your business outlook with Dataquest analysts. Updates and detailed discussions of these data are provided in the *Dataquest Perspective* on an ongoing basis. For segmented services, top-level market statistics are provided in the *Source: Dataquest* binder, and the more detailed statistics for each segment can be found in each segment binder.
- *Company Backgrounders:* You will receive a set of *Company Backgrounders*—profiles on the top players in your industry. These documents are published annually. You should refer to them for corporate overview information, such as financial reports, product line descriptions and analysis, sales and manufacturing locations, and joint ventures, mergers, and acquisitions.

With the exception of the *Company Backgrounders,* these documents will be individually bound and delivered annually or twice yearly, as required. Each *Company Backgrounder* will be updated once a year and will be shipped shortly after the close of the fiscal year for that company. At the time of arrival, the earlier version of the document should be removed from the binder and archived as desired so that the most recent information will be easily accessible to you.

Dataquest Perspectives

Dataquest Perspectives are designed to deliver analysis and Dataquest's view of important issues in your industry. This is a multitopic publication delivered twice a month that contains articles under the following major topic headings:

- Market Analysis: These articles may cover either a product market, regional market, application market, or a distribution channel. Industry service forecast updates are presented and discussed in this section of the *Dataquest Perspective.*
- Product Analysis: These articles analyze the impact of new products on the industry.
- Company Analysis: This section highlights new activities or organizational changes within companies. The articles provide more in-depth analysis of a company's product strategy, financial performance, or marketing performance and strategy than is contained in the *Company Backgrounders*. Articles may also be written about companies for which there is no *Company Backgrounder.*
- Technology Analysis: This section analyzes the impact of key or emerging technologies on your industry. These articles are designed to assist you in strategic and competitive evaluations.
- Conferences and Exhibitions: These articles will identify important industry trends and analyze key events at the conferences and exhibitions attended by Dataquest analysts.
- News and Views: These shorter articles provide Dataquest's perspectives on major industry events.

Dataquest Perspective offers a twice-monthly opportunity to engage your industry service analysts in discussion of the issues and events contained in each publication. For this reason, we provide the name of the author of each article along with a brief synopsis. Clients are encouraged to call the appropriate analyst with questions or a request for more information.

How Do You File Your Written Materials?

Your *Source: Dataquest* binder holds a collection of reference and statistical material. Each document that belongs in this binder will be clearly marked as such and should be filed behind the appropriate tab as indicated in the Table of Contents. Outdated sections should be either discarded or filed separately for archival purposes.

Clients will receive at least 24 *Dataquest Perspectives* each year. These should be filed in the *Dataquest Perspective* binder in chronological order. If you subscribe to a segmented service, at least 4 of your 24 annual *Dataquest Perspectives* will focus on issues specifically related to the markets covered under that industry segment. The industrywide *Dataquest Perspectives* are filed in the core *Dataquest Perspective* binder, and the segment-specific editions are filed in the segment binder.

Each *Dataquest Perspective* will be identified by the name of the service and the name of the segment, if appropriate. It will also have the date, volume, and number on the first page. For example, a subscriber to the Telecommunications—North America service may receive the following two *Dataquest Perspectives:*

- Telecommunications—North America
  Vol. 1, No. 1
- Telecommunications—North America
  Image Communications
  Vol. 1, No. 1

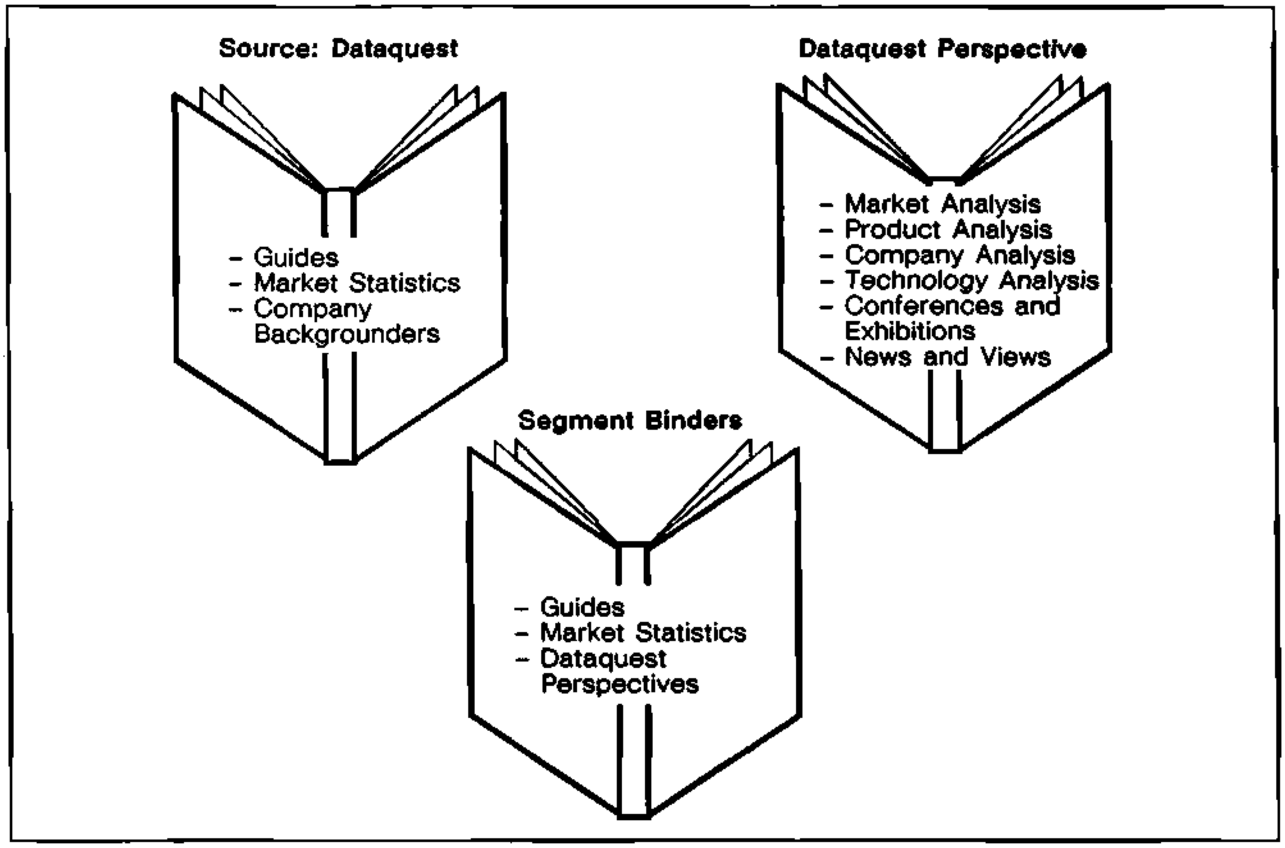
The first document would be filed in the core Telecommunications—North America *Dataquest Perspective* binder. The second would be filed in the Image Communications segment binder.

The contents of your binders are illustrated in Figure 3-1. Subscribers to a standalone European country segment will receive detailed market statistics for that particular country, top-level European statistics, and the pan-European Perspectives. The binder contents are illustrated in Figure 3-2.

How Do You Find the Written Material?

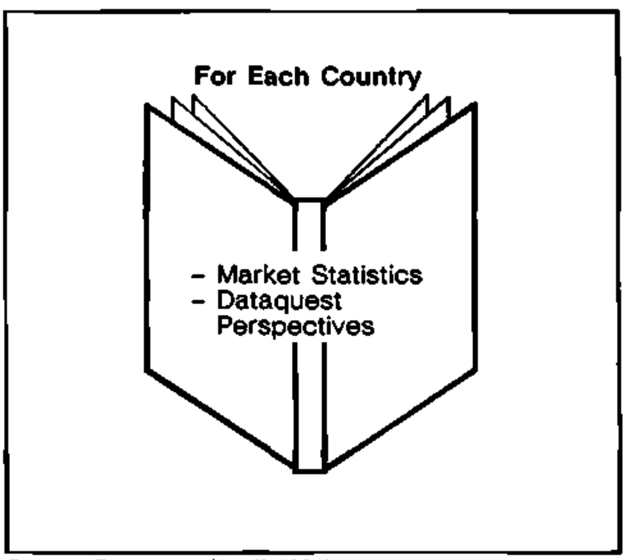
Dataquest is committed to not only providing you with the highest quality research, but also

Figure 3-1
Contents of Your Binder



Source: Dataquest (April 1991)

Figure 3-2
Standalone European Country Binder Contents



Source: Dataquest (April 1991)

making it easy for you to access the information. Clients are provided with the following tools:

- The spines of all binders list the types of information you will find in that binder.
- "What's in This Binder?", appearing immediately following the title page, summarizes the documents in that binder and highlights what can be found in other binders of that service.
- A detailed Table of Contents is contained in the *Source: Dataquest* and segment binders.
- Each bound document in the *Source: Dataquest* and segment binders has its own Table of Contents, including a list of tables where appropriate.
- To help you access the articles you need in a timely manner, Dataquest provides you with a comprehensive index which is delivered quarterly and provides a year-to-date

cross-reference by company name and major topic. The index lists the titles of all articles and of all tables and figures that appear in issues of the publication. Listings include the title, date, and page number for each entry. The first page of each quarterly index provides an explanation of how the index can best be used, along with an example. Segment Perspectives are indexed separately and incorporated into the year-end index provided for the entire service.

Chapter 4

Customizing Your Industry Service

As a subscriber to a Dataquest syndicated market research service, clients receive significant tactical and strategic information. Dataquest also offers a variety of individualized and proprietary programs to clients to help them solve their specialized information and analysis needs. Each project is treated with the strictest confidence.

We carefully review each project with the client prior to beginning the actual research. Dataquest's consulting staff designs a research plan that most effectively meets each client's unique requirements. This includes determining the appropriate information to be gathered, the proper sample size, appropriate collection techniques, and the best analytic methods to be used.

Custom Consulting

Dataquest's custom consulting helps clients in any of the following ways:

- Analyzing specific markets and competitive environments
- Developing strategies for increased market penetration
- Evaluating new business, product, and distribution plans
- Verifying critical market assumptions
- Assessing the impact of emerging technologies on existing products and markets
- Assisting in developing international business strategies, including:
    - Identifying strategic partners, both domestic and international
    - Defining technology "fits"

Custom consulting is structured to provide assistance across all TID services beyond the scope of each service. In areas where new, original work is needed, consulting provides value not only through its own individualized proprietary efforts, but also through its integration of TID information and analysis resources.

Among the elements that consulting can bring to a project are specialized planning assistance, proprietary analyses, in-person interviews, mail surveys, telephone surveys, focus groups, and custom database cuts.

Multiclient Studies

Custom Consulting engages not only in full-custom research projects, but also in the generation of multiclient studies. These studies allow Dataquest to offer clients in-depth information on emerging and/or niche markets at an amortized cost for consulting.

Retainer Consulting

Dataquest also offers its clients retainer consulting. Dataquest analysts and consultants provide consulting advice on an ongoing basis and with quick turnaround to address a variety of client management and marketing needs.

Primary Research

Dataquest's Primary Research services offer a comprehensive range of survey research capabilities that can provide vital information tailored to each client's specific needs. This is important when survey work, but not analysis, is needed. Studies of any type, size, or aspect can be performed as a supplement to existing market research efforts, when nonbiased third-party research is required, or to provide complete primary research capabilities when company resources are not available. Primary Research assumes total responsibility for a project at any stage, from questionnaire development through sample selection, data collection, and final tabulation. The following are examples of the broad range of business applications addressed by Primary Research:

- Market penetration surveys
- Customer needs and satisfaction surveys
- New product research
- Product pricing and positioning surveys
- Annual trend surveys
- Installed base surveys
- Sales trend identification

End-User-Based Services

Score Reports

Customer satisfaction surveys track the level of satisfaction by users of PCs, copiers, electronic printers, PBXs, and public key systems. Key indicators measured include value for price, quality, commitment to customer, features, product delivery, technical documentation, and service. The Score Report is conducted four times a year so that manufacturers can monitor trends in end-user satisfaction levels over an extended period of time.

Score Reports are based on telephone interviews with an annual sample of over 5,000 respondents. A stratified sampling plan is used, with users selected randomly by vendor from a database of U.S. business establishments. No manufacturers' lists are used.

The Score Report survey meets the requirements for measuring customer satisfaction as defined by the Malcolm Baldrige National Quality Award. The Baldrige Award is granted annually by the U.S. Department of Commerce in recognition of U.S. companies that excel in quality achievements and management.

CPE Market Dynamics

This end-user information service provides quarterly data on PBX, Centrex services, and key systems users' purchases by manufacturer, system model, RHC region, state, and vertical market. There are two proprietary custom options, as follows:

- Product-Presence-Hit Rate (PPH) Analysis: Assesses a company's position in the marketplace as a function of product acceptance, distribution, or sales effectiveness.
- Win-Loss Analysis: This option takes PPH analysis one step further, delving into why systems sales are being won or lost by you and your competitors. A customized direct mail, telephone, or personal interview program is established to contact the appropriate end users.

Chapter 5

Whom Do You Call at Dataquest?

Clients who have questions or need assistance in any way are encouraged to call Dataquest at their earliest convenience. Table 5-1 is an overview of who to contact at Dataquest.

Table 5-1

Who to Contact at Dataquest

Question/Concern	Who to Contact
My subscription (e.g., billing, renewal)	My customer service representative
Subscribing to another service	My sales account manager
Data or facts about my industry	Client Inquiry Center
Opinion or analysis about my industry	Analyst in the service
Other services/products offered by Dataquest	My sales account manager
New services/products I would like Dataquest to offer or feedback on current offerings	Product Marketing Components: (408) 437-8624 Systems: (408) 437-8517 Telecommunications: (408) 437-8602 Peripherals: (408) 437-8308 Ledgeway: (617) 862-8500
An upcoming conference	Conference Department U.S.—(408) 437-8245 Europe—(44) 895-835050 Japan/Asia—(81) 3-5566-0416
A possible proprietary consulting project	Consulting Department, sales account manager, or service analyst
Library visits	Client Inquiry Center, service analyst, or corporate librarian in the U.K.
The new Dataquest format for research delivery	(408) 437-8215, or dedicated Voice Mail Hot Line: (408) 437-7878
Reprints of selected articles	Sales Department—Technology Products: (800) 624-3282

Source: Dataquest (April 1991)

Chapter 6

About Dataquest...

Dataquest was formed in 1971 with the sole purpose of delivering timely and accurate information on critical issues in the high-technology arena. Quoting from the Dataquest mission statement:

> "Our goal is to be the acknowledged worldwide leader in market intelligence for the industries we serve by providing indispensable information and analysis to our clients."

As a member of The Dun & Bradstreet family of companies, Dataquest has access to supplemental information from Dun & Bradstreet and its subsidiaries. Together with our own primary and secondary research capabilities and analyst expertise, this relationship offers the most comprehensive information available on topics pertinent to your industry.

Dataquest comprises two basic business units. Dataquest's Technology Information Division (TID) provides data and analysis on the high-technology electronics industry, encompassing semiconductors, systems, peripherals, application markets, software, and service and support. A cross-industry financial program supported by TID analysts and assigned account managers is tailored to the needs of the financial community. The Machinery Information Division (MID) offers a full range of marketing research and consulting services for professionals in all areas of the heavy equipment and material-handling industries.

The Technology Information Division

The information service you have purchased from Dataquest is part of our Technology Information Division (TID) family of products. TID provides information services that are both tactical and strategic in nature, and include syndicated industry services, custom consulting, multiclient studies, primary research, specialized information services for the financial community, product specification directories, and standalone reports on technology markets. These services are described in more detail in the following paragraphs.

There are five research groups within TID. Each provides data and analysis covering the global electronics industry from semiconductors to systems, from hardware to software, and from applications to service.

Semiconductor Group

This group covers the entire semiconductor "food chain," including manufacturing equipment and materials, device technologies and markets, and end-use applications and procurement issues. Its information services are worldwide in scope and include targeted North American, European, Japanese, and Asian services. The Semiconductor Group is divided into the following 9 services:

- Semiconductors—Worldwide
  - Segments:
    - Semiconductor Memories
    - ASICs
    - Analog and Mixed Signal ICs
    - Microcomponents
    - Gallium Arsenide Semiconductors
- Semiconductors—Europe
- Semiconductors—Japan
- Semiconductors—Asia
- Semiconductor Application Markets—Worldwide
- Semiconductor Application Markets—Europe
- Semiconductor Application Markets—Japan
- Semiconductor Procurement
- Semiconductor Equipment, Manufacturing, and Materials

Systems Group

This group covers business and technical computer systems and applications, both hardware and software, ranging from palmtops to PCs to supercomputers.

Computer Systems Services

The computer systems services cover the following six segments:

- Business Computers
- Servers
- Supercomputers
- Technical Computers
- Unix Systems
- Workstations

European Computer Systems

This service covers the same product areas for 14 European regions.

Microcomputer Systems Group

This worldwide service tracks and analyzes PCs by packaging type, microprocessor, operating system, price point, environment, and region of the world. It includes the following segments:

- Personal Computers—North America
- Personal Computers—Europe
- Personal Computers—Asia
- Personal Computers—European Quarterly Statistics
- Personal Computers—European Price Tracking

Business Applications

This service covers electronic equipment environments in the office that are primarily software driven and looks at the ways in which these environments drive their associated hardware markets. Business Applications is divided into two services:

- Office Software
- Personal Computer Software

Technical Applications

The CAD/CAM/CAE service provides information on four key applications: Mechanical, AEC, GIS/Mapping, and Electronic Design Automation. Its geographic coverage extends to North America, Europe, and Asia. The service is segmented as follows:

- Electronic Design Automation
- Mechanical Applications
- Architecture, Engineering, and Construction, and Geographic Information Systems
- Personal CAD
- CAD/CAM—Europe
- CAD/CAM—Asia

In addition, CASE is covered through consulting.

Telecommunications Group

The Telecommunications Group is divided into two services, the Telecommunications North America service and the Telecommunications Europe service.

These worldwide services divide their coverage of the industry into five major product segments, as follows:

- Image Communications
- Networking
- Personal Communications
- Public Network Equipment and Services
- Voice Communications

Regional market options include country-specific coverage of any of the following European countries: France, Germany, Italy, Netherlands, Spain, Sweden, and the United Kingdom.

Peripherals Group

This group covers markets for devices that are typically attached to multiuser host systems or serve an output function.

Computer Storage Service

The Computer Storage service covers the following four segments:

- Rigid Disk Drives
- Tape Drives
- Optical Disk Drives
- Flexible Disk Drives

Graphics and Displays Service

The Graphics and Displays service covers the following four segments:

- Graphics Processors
- Monitors
- Display Terminals
- Network Stations

Document Management Group

The Document Management group is made up of the following four services:

- Copying and Duplicating (including fax coverage)
- Electronic Printers—North America
- Electronic Printers—Europe
- Electronic Publishing

Ledgeway/Dataquest

Ledgeway/Dataquest is the group that provides strategic and tactical information on the fast-growing services industry. Computer systems vendors typically obtain 25 to 30 percent of their revenue from pre- and postsale services. In addition to services provided by manufacturers, there is a very large and fast-growing industry for professional and systems integration services. Ledgeway/Dataquest covers both of these market sectors.

Ledgeway/Dataquest offers 10 different subscription programs. All programs include access to Ledgeway/Dataquest analysts for inquiry support, periodic bulletins on key events in the service industry, and attendance at Ledgeway/Dataquest's annual ServiceTrends conference.

The ServiceTrends Program

The most widely subscribed service, now in its eighth year, is Ledgeway/Dataquest's ServiceTrends program. In addition to the cornerstone of the program, Ledgeway/Dataquest's annual two-volume *Trends and Forecast* report, which provides in-depth market size and forecast information and analysis of market trends, four topical reports are provided. In 1991, these topical reports are:

- *Global Support Strategies*
- *Measuring and Managing Customer Satisfaction*
- *Japan and the Pacific Rim: Customers or Competitors*
- *Self-Service: Opportunity or Threat*

The Professional ServiceTrends program features analysis of customer wants and needs for systems integration and professional services, in addition to a market trends report, which forecasts market size, growth rates, and analyzes trends. In addition, there are six profiles provided on leading participants in the industry.

Sector Market Programs

Sector market programs are focused on narrow segments of the service market and feature an annual market trends and forecast report, user wants and needs analysis, a pricing trends and data study (for all but the European ServiceTrends program), and six profiles of leading service vendors in each sector. Ledgeway/Dataquest's sector market programs are as follows:

- European ServiceTrends
- Independent/Multivendor Services

- Network/Communications Support
- Mini/Mainframe Software Support
- PC/Workstation Software Support
- Technical Workstation Service and Support
- PC/End-User Computing Services
- Channel Support Strategies

In addition to its subscription services, Ledgeway/Dataquest has a very professional and active custom consulting group that conducts custom projects focused on the following areas:

- Customer satisfaction and service quality audits
- Key competitor analysis and positioning
- New service product market analysis and strategy formation

Subscription services and custom consulting are provided covering worldwide markets.

The Executive and Financial Group

Dataquest's Executive and Financial Group (EFG) offers a number of cross-industry services that are designed primarily for clients in the financial and executive communities. These services offer clients the following benefits:

- Access to all Dataquest research professionals
- Access to TID *Dataquest Perspectives*
- Access to TID conferences
- A personal account manager

EFG includes the following services, which are differentiated largely in terms of the type of clients they serve.

Financial Services Program

The Financial Services Program (FSP) is designed to serve the needs of clients who evaluate loans and investments, monitor portfolios, identify markets and prospects, and develop strategies for penetration of new markets. FSP clients include banks, venture capital firms, CPAs, leasing companies, and development agencies. The program benefits these clients by helping them develop financial strategies in high-technology areas, identify financial opportunities, evaluate proposed client investments and relationships, and monitor companies and markets.

Strategic Executive Service

The Strategic Executive Service (SES) is a networking and technology advisory program specifically designed for CEOs or senior executives. The service is open by invitation only to the presidents of technology companies. Dataquest senior staff from all high-technology industry service groups provide decision support to each president. SES also hosts an annual Presidents' Summit Conference, bringing together subscribers to focus on future trends in high technology products and markets. It is a highly customized service for executive decision makers.

Equipment Leasing Service

At the core of Equipment Leasing Service (ELS) is a portfolio of more than 300 individual future value projections for specific products from more than 45 leading computer, peripherals, and telecommunications vendors. These projections are calculated through a proprietary model and are delivered to clients along with relevant research newsletters. Clients also receive inquiry access to specialized leasing analysts. ELS is designed for companies that lease high-technology equipment. The service assists clients in the areas of lease origination sales, vendor sales, equity sales, asset management and remarketing, and new business development and marketing.

Technology Investment Program

The Technology Investment Program (TIP) is designed to serve the needs of clients in the securities industry, investment banking industry, equity research markets, and institutional investment fields. The service provides clients with company evaluations, product and technology assessments, and other forms of information that help identify target companies for merger/acquisition, joint venture, initial public offerings, and equity investment.

Other Dataquest Services

Conferences

Technology Information Division Conferences

Dataquest hosts a number of conferences each year to present industry forecasts and discuss critical issues and trends. Clients obtain a number of benefits from attending these conferences, including:

- Receiving Dataquest updates on key markets
- Meeting with industry leaders and users
- Discussing market events and their significance to your organization with Dataquest analysts

As an industry service client, you may purchase tickets to any Dataquest conference you wish to attend. Each ticket entitles you, or someone you designate, to attend one Dataquest conference. A complete list of conferences is included in Appendix B of this document. To purchase a conference ticket, or to obtain more information about Dataquest's conferences, contact Dataquest's conference department at any of the following locations:

- North America
  (408) 437-8245
- Europe
  (44) 895-835050
- Japan/Asia
  (81) 3-5566-0416

Invitational Computer Conferences

Dataquest's Invitational Computer Conferences (ICCs) bring major computer manufacturers together with buyers in 41 regional markets around the world. The one-day ICC format combines hands-on product displays with technology seminars designed to educate prequalified regional buyers throughout the United States, Europe, and Asia/Pacific. Each SalesEvent ensures a focused conference, whereby the manufacturers have a selectively targeted audience of buyers and the buyers can learn about new technology, receive a hands-on view of products and solutions, and discuss their application needs with exhibiting regional sales and technical managers. Three ICC series are held as follows:

- *OEM Peripherals* (in various U.S. and European locations), serving OEMs, systems integrators, volume end users, and government buyers/integrators who are all looking to buy computer peripherals.
- *Computer Connectivity* (in various U.S. and European locations), serving MIS/DP managers, systems integrators, network managers, and value-added resellers/dealers who are all looking to buy connectivity/networking solutions.
- *Asia Pacific* (in various Asian locations), serving OEMs, systems integrators, volume end users, and government purchasers who are all looking to buy computer peripherals.

Technology Products

Dataquest also provides standalone products, including specification guides in both hard copy and electronic format (disk), reports, and monthly newsletters that are marketed and sold individually to broad customer audiences. These products are designed to be complementary to the TID syndicated market research services and include highly tactical information on product specifications and pricing, as well as in-depth analyses of specific markets and technology trends. See Appendix C for a current list of products.

Chapter 7

Subscription Terms

Basic Terms of Syndicated Industry Services

The service begins on the date of the first billing. At that time, the subscriber receives the *Source: Dataquest* binder with the current documents and a *Dataquest Perspectives* binder complete with documents covering the last six months. Clients also receive the current year-to-date index as well as the previous year's annual index.

Subscribers to a segment of a service receive a segment binder containing recent segment-specific *Dataquest Perspectives* and the current version of the detailed, segment-specific market statistics. For the duration of the subscription, subscribers receive a copy of each *Dataquest Perspective* published and any annual updates to *Source: Dataquest* documents as they are produced. The inquiry privilege may be used to supplement the material in the binders.

Add-On Subscriptions

Subsidiaries, divisions, regional offices, majority-owned affiliates, and parent companies of a subscribing organization within the same region are eligible for add-on subscriptions at a percentage of the base subscription price. Add-on subscriptions include complete copies of all published material, inquiry privileges specific to the markets subscribed to, and conference attendance at discounted prices. Regions are defined as North America, Europe, and Japan.

Payment Terms

Dataquest's terms, including the applicable sales or value-added tax, are net 30 days.

Base Price

Dataquest reserves the right to change its subscription prices to reflect broadened scope or increased costs. Subscribers will be notified in advance of any such price increase.

A Reminder

Your agreement specifies the individuals in your company who have access to Dataquest information. You will need to obtain written consent from Dataquest to disclose data, analysis, and written materials to any other person or entity beyond those specified by the terms of the agreement.

Dataquest also asks that you not use any data obtained through your industry service in any legal proceedings, or as the basis for advertising copy, press releases, collateral material, or any other promotional material. For further information on the conditions pertaining to your industry service, please refer to your industry service agreement, or contact your sales representative.

Your industry service agreement provides you with a license to use your industry service for the length of time designated in the agreement. If you decide not to renew your industry service at the end of this time, it is your obligation to return these materials to your nearest local Dataquest office.

We Thank You for Choosing Dataquest as Your Marketing Research Partner.

We hope this guide has helped you. Please take advantage of the services we have described. Dataquest's goal is total satisfaction. If you have any questions or comments about this guide or the services it describes, please let us know.

Dataquest Information Resource Center CD-ROMS and Computer Databases

PATENTS

Micropatent

This CD-ROM is a basic search and current awareness tool for U.S. patents, containing abstracts and selected front-page information from patents published by the U.S. Patent and Trademark Office. It covers 1975 to date, with limited information 1969 to 1974. Patent number, inventor, title, and assignee are just a few of the ways to search this CD. It is updated monthly. Book version not available.

FINANCIAL INFORMATION

Compact d Sec—USA

This CD-ROM contains financial and management information on 11,000 public companies filing with the SEC. The current and historical financial information is culled from annual reports and 10-Ks. It is updated monthly. Book version not available; however, the library files have annual reports, 10-Ks, quarterly reports, and 10-Qs. Please check the lateral files and the listing on top of the files.

Compact d Sec—Canada

This CD-ROM provides financial information on 6,000 Canadian companies and is updated quarterly. Book version not available; however, the library files have annual reports. Please check the lateral files and the listing on top of the files.

Compact d Sec—Europe

This CD-ROM provides financial and factual information on 2,000 publicly held European companies and is updated quarterly. Book version not available; however, the library files have annual reports. Please check the lateral files and the listing on top of the files.

COMPANY DIRECTORIES

Corptech

This database contains information on developers and manufacturers of high-technology products in the United States. It is searchable by product, location, size, status, and name and is updated quarterly. Book version available.

Thomas Register

This CD-ROM provides product and directory information for manufacturing companies in the United States and Canada. It is updated monthly. Book version available.

ARTICLE SEARCH

Computer Select (formerly Computer Library)

This CD-ROM is a major upgrade to Computer Library. In addition to the ever-growing list of periodicals included in Computer Select, the full contents of Data Sources, the most comprehensive computer industry directory available, have been added. You'll be able to retrieve specifications on over 67,000 hardware, software, and data communications products, as well as profiles of the over 1,000 companies that make them. New searching capabilities include locating articles by choosing lists of publications, article types, date ranges, topics, and other fields. It is updated monthly. Book version of Data Sources available.

COMPUTER DIRECTORIES

ICP Software Information Database

This CD-ROM provides information on micro, mini, and mainframe software products offered by over 4,000 vendors and is updated quarterly. Book version available.

Appendix B

Dataquest 1991 Conference Schedule

North America		
Forecast '91-Technology Briefing	March 5	San Jose
Ledgeway Service & Support	April 8-9	San Francisco
Semicon/West	May 22	Redwood City
Document Management	June 27-28	San Francisco
Personal & Wireless Communications	August 12-13	Monterey
Portable Computing	September 11-12	San Jose
Semiconductor	October 14-16	Monterey
Europe		
Computer Industry	February 14-15	London
	February 19-20	Milano
	February 25-26	Frankfurt
	March 6-7	Paris
Semicon/Europa '91	March 6	Zurich
Semiconductor	May 29-31	Marbella
Printer	June 11-12	Amsterdam
Colour Market	June 12-13	Amsterdam
Copying & Duplicating	June 13-14	Amsterdam
Telecommunications	November 7-8	London
Japan and Asia		
Semiconductor	April 22-23	Tokyo
Computer & Telecommunications	June 25-26	Tokyo
Strategic Industry	September 24-25	Taipei
Peripherals	October 1-3	Tokyo

For reservations or further information call: U.K. 895-835050 San Jose (408) 437-8245 Tokyo 3-5566-0411
January 1991—Subject to revision

Appendix C

Technology Products

SpecCheck Guides

Copier SpecCheck-On-Disk Disk version of the Copier SpecCheck Guide. Allows custom sorts on 500 models and 24 vendors. Six annual updates on either 3.5-inch or 5.25-inch format.

Copier SpecCheck Guide Detailed specifications and pricing information on 500 copier models. Two full books, two updates per year.

Fax SpecCheck-On-Disk Disk version of Fax SpecCheck Guide. Allows custom sorts on 600 models and 47 vendors. Six annual updates on either 3.5-inch or 5.25-inch format.

Fax SpecCheck Guide Detailed specifications and pricing information on 600 fax models. Two full books, two updates per year.

PC SpecCheck-On-Disk Disk version of PC SpecCheck Guide. Allows custom sorts on 400 models and 47 vendors. Six annual updates on either 3.5-inch or 5.25-inch format.

PC SpecCheck Guide Detailed specifications and pricing information on 400 PC models. Four full books per year.

Personal Page Printer SpecCheck-On-Disk Disk version of Personal Page Printer SpecCheck Guide. Allows custom sorts on 400 models and 100 vendors. Four annual updates on either 3.5-inch or 5.25-inch format.

Personal Page and Ink Jet Printers SpecCheck Guide Detailed specifications and pricing information on 275 personal page and ink jet printer models. Two full books per year.

Dot Matrix Printer SpecCheck Guide Detailed specifications and pricing information on 300 dot matrix printers. Two full books per year.

High-Speed Page and Line Printers SpecCheck Guide Detailed specifications and pricing on 300 high-speed page and line printers. Two full books per year.

Reports

Imaging Materials Series

Series of reports on key areas of the imaging materials industry. Reports currently available or planned are:

Toner in the '90s: The Shape of Things to Come Detailed analysis of the liquid and dry toner and developer industry. The report looks at market size, structure and growth, U.S. and foreign producers, and trends in materials manufacturing and distribution. Includes directory of suppliers. Available now.

Specialty Papers and Films: New Technology, Media, and Markets In-depth report on the hard-copy media field for paper and film products. The report looks at imaging processes, imaging hardware, end-use applications for hard-copy output, and market size and forecast. Includes directory of suppliers. Available June 1991.

The Photoreceptor Industry: A Marketing and Technical Analysis Detailed analysis of photoreceptor technology and the industry. Volume I chronicles the evolution of the industry in terms of equipment, manufacturing, and distribution, providing market size and forecasts. Volume II is a complete reproduction of U.S. patent abstracts from 1979-1990. Includes directory of manufacturers. Available Fall 1991.

Other Reports

Fax On Demand—Marketing Tool for the '90s A useful report to help end users evaluate and select voice/fax systems and implement fax-on-demand services for their business. Includes applications, technology, and economic considerations for fax-on-demand, as well as a directory of product vendors and service providers. Available June 1991.

Color Scanner User Survey for U.S. Publishing Markets Extensive survey of key end-user markets in publishing, advertising, printing services, graphic design, PostScript output services, and Fortune 1000 companies to ascertain purchase intentions and installed base of color and monochrome scanners. Available May 1991.

Semiconductor Industry Insights—from Silicon to Systems Analysis of the global semiconductor industry containing market forecasts, key drivers, product demand, semiconductor production, equipment, and materials.

Voice Processing Opportunities in the U.S.—A Market Assessment and End-User Survey Extensive end-user survey providing networking information, applications, satisfaction level, purchase decision making, and selection criteria by key vertical markets. Also includes market shares, technology, standardization, revenue, and pricing forecasts through 1994.

High-Speed Printing Applications in Banking A vertical market study comprising two reports and videotapes/transcripts of three focus sessions. Study focuses on high-speed printing applications in the banking industry and examines the applications that banks print internally and externally, as well as special printing capability needs of the banking industry.

Portable Computing in the 1990s Three-part series on the latest products, features, and options for transportables, laptops, notebooks, palmtops, and electronic daybooks.

PC LAN Markets in Europe 1990 Analysis of all the major PC LAN vendors in 13 European countries. Market shares, forecasts, distribution channels, and shipments segmented by end-user types.

Computer Usage in European Banks 1990 In-depth, two-volume study on the demand for hardware, applications, LANs, and operating systems in European banks, segmented by bank size. A widespread survey of banks in nine European countries was supplemented by personal interviews with key decision makers at the largest banks.

Monthly Newsletters

Copier FAXts A look at new products, distribution, organizational news, and trade show highlights for the copier and fax industries.

IC Europe All the latest local intelligence and analysis of new products, alliances, technology impacts, and forecasts for the European semiconductor industry.

European Monitor Monthly newsletter with all the latest news on vendor, product, and distribution developments in the European personal computer market.

Price Tracking Flash Monthly newsletter on PC product announcements and changes in price, configuration, and distribution for PC products by 16 manufacturers in 14 European countries.

Other Technology Products

Company Backgrounders by Dataquest Detailed vendor profiles on almost 300 leading worldwide high-technology companies highlighting company strategic direction, business direction, detailed product line summaries, information on joint ventures, mergers and acquisitions, and licensing agreements.

DQ Monday On-Line News, analysis, and current prices for 25 leading semiconductor product groups for all the major markets: United States, Europe, Japan, Hong Kong, Taiwan, and Korea.

DQ Test Target Package of ten 8.5 x 11-inch copier/fax test patterns: gray scale, black and white, and color.

International Test Target Package of ten standard European-size test targets.

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Dataquest Research Methodology

Source:
Dataquest

Dataquest

Dataquest Research Methodology

Source: Dataquest

Dataquest

Published by Dataquest Incorporated

Dataquest's Research Philosophy—Methodology for Value

From semiconductors to systems, office to factory automation, Dataquest provides quality research on more than 25 separate high-technology industries and their markets.

Fundamental to the way Dataquest conducts its research is an underlying philosophy that says the best data and analysis come from a well-balanced program. Such a program includes a balance between primary and secondary data collection techniques; between supply-side and demand-side analysis; between focused, industry-specific research and coordinated, "big picture" analysis; and between the informed, insightful perspectives of experienced industry professionals and the rigorous, disciplined techniques of seasoned market researchers. Ultimately, this leads to a balance between data and analysis—the combination of which provides unique insight and ultimate value to our clients.

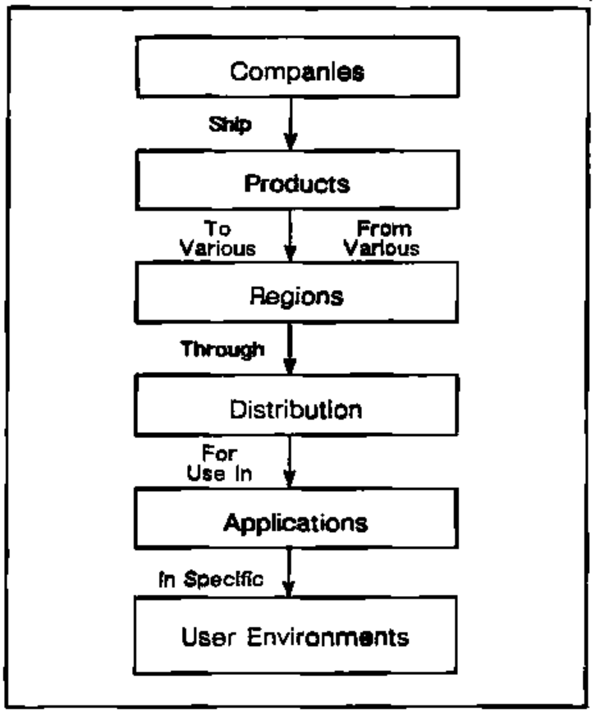
Market Segmentation—Setting the Standards

The design of market segmentation and data standards is a critical issue at Dataquest. Much effort is devoted to choosing and defining the way products, industries, and markets are segmented. Dataquest's objective is to provide data and analysis along lines of segmentation that are logical, appropriate to the industry in question, and immediately useful to clients.

Over the years, Dataquest has consistently established industry-accepted standard segmentations for the way we follow products and their movement. Figure 1 reflects the way we track products. Further, we spend a great deal of time and effort in defining *how* we track these products and determining what *our* definitions are for the market metrics we use—for example, shipments, installed base, retirements, factory revenue versus end-user revenue, market share, and so on.

We follow several dimensions. Sometimes there are one-to-one, or dedicated, relationships between dimensions—for example, between software products and their applications. We believe that all major high-technology industries mirror this scheme. Note that we do not use the term vertical markets. This term is often used to refer to either applications or environments because both terms describe the use of a product. Application describes what the product is used for, and environment describes where the product is used. The term vertical market often is used for either of these terms and thereby can cause confusion.

Figure 1
How Dataquest Tracks High Technology



Source: Dataquest (March 1991)

We have therefore standardized on the following terminology, which distinguishes between application and environment, for each dimension we follow:

- Major product categories:
  - Materials
  - Components
  - Boards and subsystems
  - Equipment
  - Software
  - Consumables
  - Services
  - Others
- Product—A good or service
- Product category—A group of similar products
- Region—Geographic areas of both shipments and consumption
- Distribution—The path by which a product moves from manufacturer to ultimate user
- Application—The use to which a product is put; the function it performs
- Environment—Where a product is ultimately used

The Dataquest Staff

Dataquest believes that in order for an analyst to understand and analyze an industry, the analyst must have competed in it. To that end, our staff is heavily populated with professionals who have extensive experience in the industries they analyze. These analysts have held high-level positions in engineering, marketing, product development, and other related areas.

These industry veterans are complemented by a staff of professional market researchers who understand the principles of market research and who direct Dataquest's programs in primary and secondary research, demographics, economics research, statistical analysis, forecasting, and modeling. Figure 2 illustrates our staffing philosophy. This blend of experience and training is unique in the research industry and allows Dataquest to provide its clients with market research of unequaled value.

To develop industry analysis and data, Dataquest collects a wide spectrum of information from a carefully selected portfolio of sources. Data are collected directly by our researchers in the United States, Europe, Japan, and Asia.

Primary Research

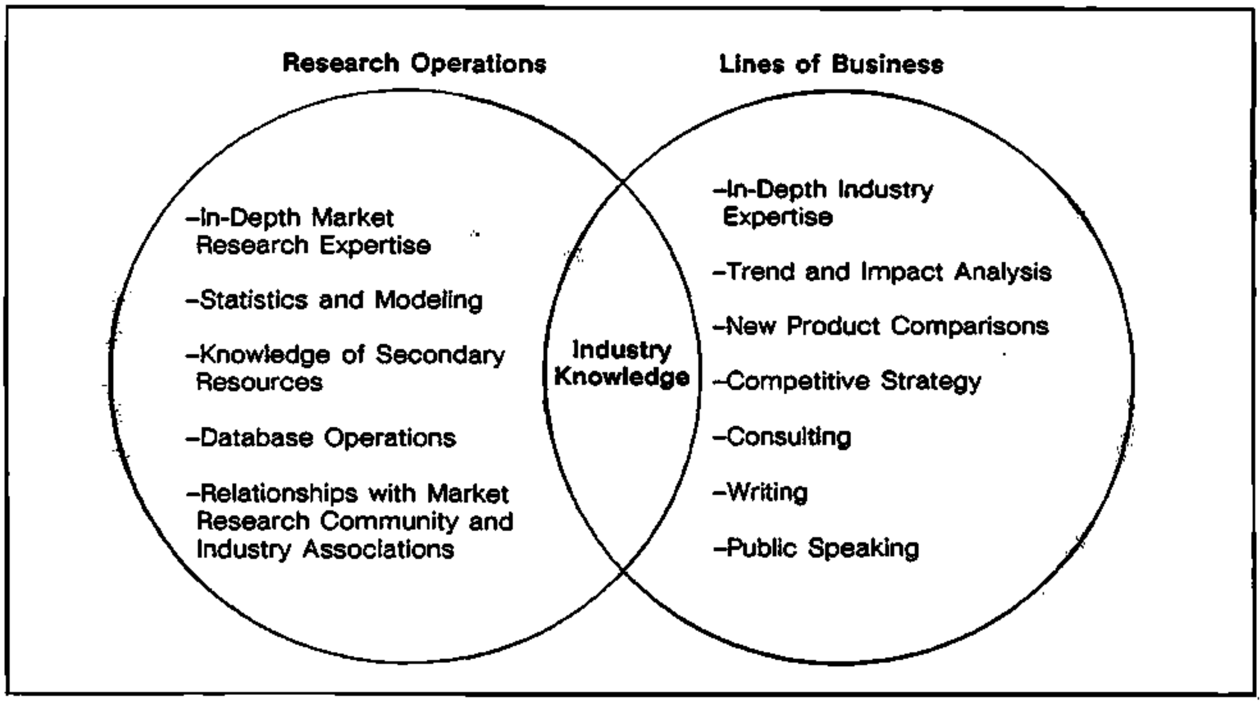
The principal data collection methodology at Dataquest is primary research—firsthand data collection by Dataquest researchers. Primary research is conducted with businesses, households, government, and schools; manufacturers, suppliers, and distributors; and product end users. Dataquest's in-house Primary Research Group (located in San Jose and Paris) processes more than 10,000 interviews each month, through both mail and telephone interviews, as well as using focus groups and personal interviews. Questionnaires are developed by the Primary Research Group in conjunction with Dataquest industry analysts.

All surveys have been designed and demographic samples selected to answer specific inquiries. These samples conform with Dataquest's standard demographic profiles so that results will comply with existing data structures.

The samples are drawn from a variety of sources, frequently from the databases of our parent company, The Dun & Bradstreet Corporation, including the Dun's Market Identifier File of 6 million U.S. businesses. We also draw samples from the databases of Computer Intelligence and Focus Research. The number of interviews conducted is usually specified to produce data with a reliability of ± 5 percent at a 95 percent confidence level.

Following questionnaire development and sample selection, each survey undergoes a rigorous pretesting to make sure the interview captures the desired information. Once adjustments have been made, the telephone surveys are conducted on-line by Dataquest's in-house team of professional interviewers. Call monitoring allows us to provide quality control throughout the process. All data entry and tabulation are done in-house.

Figure 2
Research Organization



Source: Dataquest (March 1991)

Firsthand Observation

On a daily basis, Dataquest watches and measures high technology around the world, using yet another technique of primary research: firsthand observation. Dataquest analysts regularly visit the laboratories, R&D facilities, and manufacturing plants of the companies they follow. They view the technologies and new products; study the manufacturing yields and levels of automation; and meet the people behind the products and companies, from start-up companies to industry leaders.

Secondary Sources

Primary research is supplemented with a review of secondary-source materials. Dataquest's Information Resource Centers throughout the world maintain an extensive collection of information including technical, trade, and general business periodicals; reports; economic data; technical papers; patents; government data; directories; financial literature; product literature; press releases; and many on-line databases. These sources provide specific data points and qualitative input to Dataquest analysis. They cover trends in technology, pricing, manufacturing capacity, competition, product features, demand, buyer behavior, and macroenvironmental forces such as demographics, the economy, and the regulatory arena. The following steps reflect the overall research process at Dataquest:

- Initiate and clarify research request
- Develop methodological approach
- Develop questionnaire
- Select sample
- Load questionnaire (on-line interviewing)
- Prepare estimates (if appropriate)
- Conduct interviewer briefing
- Pretest
- Interview

- Perform quality check and call monitoring
- Merge data
- Perform scrubbing, tabulation, and statistical analysis
- Approve data
- Report on and deliver results
- Maintain database (as required)

The following is a typical cadre of sources:

- Industry contacts
- Industry associations and user groups
- Trade shows and conferences
- Demographics
- D&B economic research
- D&B credit services
- Computer intelligence
- Document management systems
- Focus Research
- Government and regulatory agencies
- Industry and trade publications
- Public databases and libraries
- Annual reports and Forms 10-K
- Product specifications and press releases
- Patent activity

Market Sizing and Market Share

Dataquest conducts surveys of manufacturers and distributors in their respective industries monthly, quarterly, or annually. These surveys collect information on shipment and inventory levels, pricing, and short-term market expectations. Data are checked and cross-checked across data collection points at the supplier, manufacturer, distributor, and end-user levels.

This data collection effort resides at the core of our standard syndicated industry services. We use demand-based surveys for many of our newer products and custom consulting. However, the balance of this discussion focuses on our standard, syndicated industry service product line.

We first develop a company universe for each industry. The sources reflected in Figure 2 are checked to make sure that we have a full census of industry participants.

Next, Dataquest analysts and researchers derive estimates for each product or product category for which we collect shipment and revenue data. The estimates are then provided to vendor representatives for correction or substantiation.

The data collected in our vendor surveys are always considered public information. The data are used to allow bottom-up analysis defining market revenue, market size, and market share. The names of respondents are always kept confidential, and all data are published as Dataquest estimates. All respondents are notified of our policies when our market estimates are initially sent.

Following is a list of steps we go through to derive estimates and reconcile the responses for final approval and reporting:

- We establish product category or model-level detail.
- We establish estimates and check against the following:
  - Aggregate data
  - Industry forecast
  - Historical performance
  - Growth rate of competition
  - Growth rate of related products
- We use the following sources:
  - Vendor verification
  - Quarterly financials
  - Industry associations
  - Distribution channel data
  - Manufacturing capacity
  - Life-cycle analysis
  - Components and peripherals purchases
  - Consumables production
  - Ongoing dialog with industry sources

- Industry analysts' qualitative insight
- Government statistics
- Other secondary sources

- We reconcile responses against Dataquest segmentation standards.

Market Forecasts

We believe that complex interrelationships among the various products, markets, and high-technology industries that we follow should be understood and accounted for in the assumptions underlying each forecast. Forecasts must reconcile the complementary nature of systems, peripherals, and components.

Our forecast methodology begins with the completion of our vendor-based data acquisition, which is used to establish market size for the given year of data collection. These data are used to measure the accuracy of our previous year's projection for the current year. This infrastructure creates a critical foundation that is the starting point for our forecasts.

No single forecast model applies at Dataquest because of the large scope of products and industries that we follow. We have a basic forecasting framework in place that incorporates both quantitative and qualitative data to derive forecasts. Analysts take the following factors into consideration when deriving and cross-checking forecasts and their assumptions:

- Macroeconomics
- Emerging technologies
- Life-cycle analysis
- Retirements
- Environmental trends
- Demographic trends
- Product availability
- Buying intentions
- Captive production
- Historical growth
- Historical pricing
- Installed base
- Saturation
- Obsolescence
- Import and export
- Most likely constraints
- Total available market

Finally, we regularly hold research forums that provide an open exchange of opinions for our analysts.

Throughout Dataquest, each variable must be defined and measured in the same way. Analysts may vary the relationships between variables but not the values themselves. Not all variable relationships hold true for all industries; therefore, analysts may specify which sets of variables to use. Data must be reported according to Dataquest standard segmentation, and all final data must be approved before they are reported. *All* preliminary data are clearly stated as such. All final data are reported as Dataquest estimates. Our information is sourced appropriately with the phrase "Source: Dataquest," and the data are stamped with a date so that users have a clear understanding of what iteration they are using and the assumptions behind those data.

Dataquest Market Research—What's behind the Numbers?

When Dataquest clients receive forecast data with the familiar line "Source: Dataquest," they receive the end result of a rigorous process of primary and secondary data collection; supply-side, demand-side, and macroenvironmental analysis; and the cross-industry perspective afforded by Dataquest's uniquely broad and in-depth worldwide coverage of high technology.

Behind the numbers is a thorough discussion, involving industry professionals and research experts, and testing of the assumptions used to develop Dataquest's forecasts. In this way, clients get more than simply a single point of data for planning and decision making. Behind the numbers is a commitment to quality—a worldwide organization of people committed to supplying the highest-quality *information* and *analysis* to Dataquest's clients.

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Dataquest High-Technology Guide

Segmentation and Glossary

1991

Source: Dataquest

Dataquest

Dataquest High-Technology Guide

Segmentation and Glossary

1991

Source: Dataquest

Dataquest

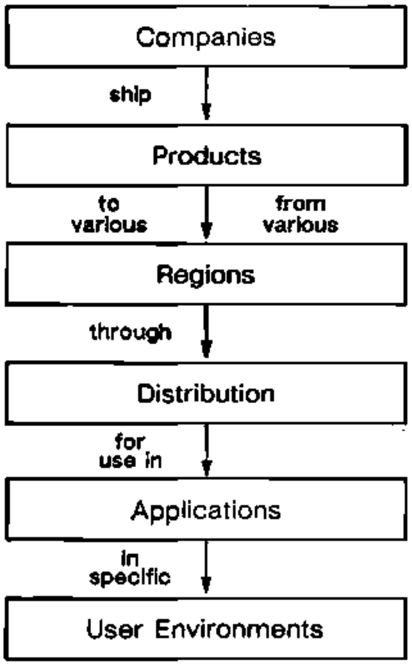
Published by Dataquest Incorporated

High-Technology Guide

The *High-Technology Guide* provides a reference for Dataquest research, analysis, and publications. The segments and terms found in this guide are used consistently in our research and methodology and throughout Dataquest products.

The *High-Technology Guide* is divided into two parts: segmentation and glossary. The segmentation section provides a comprehensive listing of the classifications used in our research. This segmentation is broken into different dimensions including companies, products, regions, distribution, applications, and user environments. These dimensions are illustrated below (see Figure 1). The glossary is an alphabetical list defining the terms found in the segmentation section.

Figure 1
Research Dimensions



Source: Dataquest (January 1991)

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Segmentation

Companies

The companies section contains more than 3,500 companies on which Dataquest conducts research. These companies are studied because of their concentration or emphasis in technology markets and industries. The company segmentation shows the breadth and depth of collective coverage that Dataquest maintains. Because of the extensive nature of the company list, it is not published in this guide but can be provided upon request.

Products

The products section lists high-technology products. This section presents the segmentation of the technology as defined by Dataquest.

The major categories of products are as follows:

- Materials
- Components
- Boards and Subsystems
- Equipment
- Software
- Consumables
- Services
- Other Products

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Products

MATERIALS

- Wafer
  - Silicon Wafer
  - Epitaxial Wafer
- Gas
  - Bulk Gas
    - Nitrogen
    - Oxygen
    - Hydrogen
    - Argon
  - Specialty Gas
    - Silicon Precursor
    - Dopant
    - Plasma Etchant
    - Reactant Gas
    - Atmospheric/Purge Cylinder Gas and Other
  - Plastics

COMPONENTS

- Semiconductor
  - Integrated Circuit
    - Bipolar Digital (by Technology)
      - TTL/Others
      - ECL
    - Bipolar Digital (by Function)
      - Bipolar Digital Memory
        - Bipolar RAM
        - Bipolar Nonvolatile Memory
        - Other Bipolar Memory
      - Bipolar Digital Microcomponents
      - Bipolar Digital Logic
        - Bipolar ASIC
          - Bipolar Gate Array
          - Bipolar PLD
            - Bipolar PLA
            - Bipolar PMD
            - Bipolar FPGA

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

COMPONENTS

Bipolar ASIC (Continued)
Bipolar Cell-Based IC
Bipolar Custom IC
Bipolar Standard Logic
Other Bipolar Logic

MOS Digital (by Technology)
NMOS/PMOS
CMOS
BiCMOS

MOS Digital (by Function)
MOS Memory

DRAM
16K DRAM
32K DRAM
64K DRAM
128K DRAM
256K DRAM
1Mb DRAM
4Mb DRAM
16Mb DRAM

SRAM
Slow SRAM
1K SRAM
4K SRAM
8K SRAM
16K SRAM
64K SRAM
256K SRAM
1Mb SRAM
4Mb SRAM

Fast SRAM
1K SRAM
4K SRAM
8K SRAM
16K SRAM
64K SRAM
256K SRAM
1Mb SRAM
4Mb SRAM

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

COMPONENTS

- Nonvolatile Memory IC
  - ROM
    - 4K ROM
    - 8K ROM
    - 16K ROM
    - 32K ROM
    - 64K ROM
    - 128K ROM
    - 256K ROM
    - 1Mb ROM
    - 2Mb ROM
    - 4Mb ROM
    - 8Mb ROM
    - 16Mb ROM
  - EPROM
    - 16K EPROM
    - 32K EPROM
    - 64K EPROM
    - 128K EPROM
    - 256K EPROM
    - 1Mb EPROM
    - 2Mb EPROM
    - 4Mb EPROM
    - 8Mb EPROM
  - EEPROM
    - 1K EEPROM
    - 2K EEPROM
    - 4K EEPROM
    - 8K EEPROM
    - 16K EEPROM
    - 32K EEPROM
    - 64K EEPROM
    - 128K EEPROM
    - 256K EEPROM
    - 512K EEPROM
    - 1Mb EEPROM
  - Other MOS Memory
- MOS Microcomponents
  - MOS Microprocessor (by Word Length)
    - 8-bit MOS MPU

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

COMPONENTS

- MOS Microprocessor (by Word Length) (Continued)
  - 16-bit MOS MPU
  - 16/32-bit MOS MPU
  - 32-bit MOS MPU
  - 32/64-bit MOS MPU
  - 64-bit MOS MPU
- MOS Microprocessor (by Technology)
  - CISC MOS MPU
  - RISC MOS MPU
- MOS Microcontroller
  - 4-bit MOS MCU
  - 8-bit MOS MCU
  - 16-bit MOS MCU
  - 32-bit MOS MCU
  - Digital Signal Processor
    - DSP Microprocessor (DSMPU)
    - Microprogrammable DSP (MPDSP)
    - Special-Function DSP (SFDSP)
- MOS Microperipheral
  - System Support Peripheral
    - Traditional Peripheral
      - Counter/Timer
      - DMA
      - Interrupt Controller
      - Memory Management
      - Real-Time Clock
      - Others
    - General-Purpose I/O
    - DRAM Controller
    - Cache Controller
    - PC Logic Chip Set
  - Display Peripheral
    - Alphanumeric CRT Controller
    - Graphics Controller
    - Keyboard Controller
    - Printer Controller
    - Others
  - Mass Storage Peripheral
    - Floppy Disk Controller
    - Hard-Disk Controller
    - Optical Disk Controller
    - Others

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

COMPONENTS

- Communications Peripheral
  - LAN
  - ISDN
  - Modem
  - Serial I/O
  - UART/USART
  - Others
- Floating-Point Coprocessor
  - 16-bit
  - 32-bit

MOS Logic
- MOS ASIC
  - MOS Gate Array
  - MOS PLD
    - MOS PLA
    - MOS PMD
    - MOS FPGA
  - MOS Cell-Based IC
- MOS Custom IC
- MOS Standard Logic
- Other MOS Logic

Analog Integrated Circuit
- Monolithic Analog IC
  - Linear IC
    - Amplifier IC
    - Voltage Regulator
    - Voltage Reference IC
    - Comparator IC
    - Special-Function IC
    - Special Consumer IC
    - Special Automotive IC
    - Linear Array/ASIC
  - Mixed Signal IC
    - Data Converter IC
    - Telecommunication IC
    - Interface IC
    - Switch/Multiplexer IC
    - Disk Drive IC
    - Mixed Signal ASIC
- Hybrid Analog IC

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

COMPONENTS

- Discrete Semiconductor
  - Transistor
    - Small Signal Transistor
    - Power Transistor
      - Bipolar Power Transistor
      - MOS Power Transistor
      - Insulated Gate Bipolar Transistor
  - Diode
    - Small Signal Diode
    - Power Diode/Rectifier
  - Thyristor
  - Other Discrete Semiconductor
- Optoelectronic Semiconductor
  - Light-Emitting Diode/Display
  - Optocoupler
  - CCD
  - Laser Diode
  - Photosensor
  - Solar Cell
- III-V Semiconductor
  - GaAs Digital IC
  - GaAs Analog IC
  - III-V Discrete Transistor
  - Optoelectronic IC

Passive Component
- Cable
- Capacitor
- Cathode Ray Tube (CRT)
- Connector
- Inductor
- Potentiometer
- Relay
- Resistor
- Socket
- Splice (Optical)
- Transducer
- Liquid Crystal Display
- Switch

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

BOARDS AND SUBSYSTEMS

- Graphic Board
  - Mac-Type Add-On Graphic Board
  - IBM-Type Add-On Graphic Board
- Imaging Subsystem
  - Add-On Memory Board
  - Controller Board
    - Storage Controller Board
    - Printer Controller Board
  - Magnetic Recording Head
  - Board-Level Computer
- Storage Subsystem

EQUIPMENT

- Data Processing Equipment
  - Computer Systems by Product Segment
    - General-Purpose Computer System
      - Supercomputer
        - Corporate Supercomputer
        - Departmental Supercomputer
        - Research Supercomputer
      - Mainframe Computer
      - Midrange Computer
        - Superminicomputer
        - Minicomputer
        - Microcomputer
      - Workstation Computer
        - Graphic/Project Supercomputer
        - Superworkstation
        - Traditional Workstation
        - Entry-Level Workstation
      - Personal Computer
        - Desktop Personal Computer
        - Desk-Side Personal Computer
        - Transportable Personal Computer
        - Laptop A/C Personal Computer
        - Laptop D/C Personal Computer
        - Notebook D/C Personal Computer
        - Pen-Based Personal Computer

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

Hand-Held Personal Computer

Special-Purpose Computer System

Data Storage Device
- Flexible Disk Drive
  - Fixed Media
    - Sub-3.5-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB
      - 61 to 100MB
      - 101 to 200MB
      - 201 to 500MB
      - 501+MB
    - 3.5-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB
      - 61 to 100MB
      - 101 to 200MB
      - 201 to 500MB
      - 501 to 1,000MB
      - 1,001+MB
    - 5.25-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB
      - 61 to 100MB
      - 101 to 200MB
      - 201 to 500MB
      - 501 to 1,000MB
      - 1,001+MB
    - 8 to 10.5-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB
      - 61 to 100MB
      - 101 to 200MB
      - 201 to 500MB
      - 501 to 1,000MB
      - 1,001+MB
    - 14-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- 14-Inch Disk Drive (Continued)
  - 61 to 100MB
  - 101 to 200MB
  - 201 to 500MB
  - 501 to 1,000MB
  - 1,001+MB
- Rigid Disk Drive
  - Fixed Media
    - Sub-3.5-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB
      - 61 to 100MB
      - 101 to 200MB
      - 201 to 500MB
      - 501+MB
    - 3.5-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB
      - 61 to 100MB
      - 101 to 200MB
      - 201 to 500MB
      - 501 to 1,000MB
      - 1,001+MB
    - 5.25-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB
      - 61 to 100MB
      - 101 to 200MB
      - 201 to 500MB
      - 501 to 1,000MB
      - 1,001+MB
    - 8 to 10.5-Inch Disk Drive
      - 0 to 30MB
      - 31 to 60MB
      - 61 to 100MB
      - 101 to 200MB
      - 201 to 500MB
      - 501 to 1,000MB
      - 1,001+MB

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- 14-Inch Disk Drive
  - 0 to 30MB
  - 31 to 60MB
  - 61 to 100MB
  - 101 to 200MB
  - 201 to 500MB
  - 501 to 1,000MB
  - 1,001+MB

Removable Media

- Sub-3.5-Inch Disk Drive
  - 0 to 30MB
  - 31 to 60MB
  - 61 to 100MB
  - 101 to 200MB
  - 201 to 500MB
  - 501+MB
- 3.5-Inch Disk Drive
  - 0 to 30MB
  - 31 to 60MB
  - 61 to 100MB
  - 101 to 200MB
  - 201 to 500MB
  - 501 to 1,000MB
  - 1,001+MB
- 5.25-Inch Disk Drive
  - 0 to 30MB
  - 31 to 60MB
  - 61 to 100MB
  - 101 to 200MB
  - 201 to 500MB
  - 501 to 1,000MB
  - 1,001+MB
- 8 to 10.5-Inch Disk Drive
  - 0 to 30MB
  - 31 to 60MB
  - 61 to 100MB
  - 101 to 200MB
  - 201 to 500MB
  - 501 to 1,000MB
  - 1,001+MB

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

14-Inch Disk Drive (Continued)
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

Rigid Disk Drive

Fixed Media

Sub-3.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501+MB

3.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

5.25-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

8 to 10.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

14-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

Removable Media

Sub-3.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501+MB

3.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

5.25-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

8 to 10.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

14-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

Dual Media

Sub-3.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501+MB

3.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

5.25-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

8 to 10.5-Inch Disk Drive
- 0 to 30MB
- 31 to 60MB
- 61 to 100MB
- 101 to 200MB
- 201 to 500MB
- 501 to 1,000MB
- 1,001+MB

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- 14-Inch Disk Drive
  - 0 to 30MB
  - 31 to 60MB
  - 61 to 100MB
  - 101 to 200MB
  - 201 to 500MB
  - 501 to 1,000MB
  - 1,001+MB
- Optical Disk Drive
  - CD-ROM
  - WORM Optical Disk Drive
    - 5.25 Inch
    - 8 to 12 Inch
    - 14 Inch
  - Rewritable Optical Disk Drive
    - 2 to 5.25 Inch
    - 8 to 12 Inch
  - Optical Jukebox
- Tape Drive
  - 1/4-Inch Tape Drive
    - Start-Stop
    - Streamer
      - 8 Inch
      - 5.25 Inch
      - 3.5 Inch
  - 1/8-Inch Tape Drive
    - Cassette
    - Cartridge
  - 1/2-Inch Tape Drive
    - 1/2-Inch Vacuum Column
    - 1/2-Inch Tension Arm
    - 1/2-Inch Streaming
    - 1/2-Inch Cartridge
  - Reel-to-Reel Tape Drive Recap
  - Helical Scan Tape Drive
    - VHS
    - DAT
    - 8mm
    - Others
- Input/Output Device
  - Terminal
    - Alphanumeric (CRT) Terminal
      - Minicomputer-Based Terminal

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Alphanumeric (CRT) Terminal (Continued)
  - Non-IBM, Protocol-Specific Terminal
  - IBM 3270 Protocol Terminal
  - Host/Vendor-Independent Terminal
  - Processing Terminal
- Graphics Terminal
- Point-of-Sale Terminal
- Funds Transfer Terminal (ATMs)
- Smart Card
- Other Specialized Terminal

Electronic Printer
- Serial Printer
  - Serial, Impact, Dot Matrix Printer
    - Dot Matrix Printer by Speed
      - 0 to 180 cps
      - 181 to 250 cps
      - 251 to 399 cps
      - 400+ cps
    - Dot Matrix Printer by Size
      - Total < 9 Wire (Pin)
      - Total 9 Wire (Pin)
      - Total 18 Wire (Pin)
      - Total 24 Wire (Pin)
  - Serial, Impact, Fully Formed Printer
    - 0 to 30 cps
    - 31+ cps
  - Serial, Nonimpact, Direct Thermal Printer
  - Serial, Nonimpact, Thermal Transfer Printer
    - Wax-Based
    - Sublimation
    - Dry Silver
  - Serial, Nonimpact, Ink Jet Printer
- Line Printer
  - Line, Impact, Dot Matrix Printer
    - 0 to 450 lpm
    - 451 to 650 lpm
    - 651+ lpm
  - Line, Impact, Fully Formed Printer
    - 0 to 450 lpm
    - 451 to 650 lpm
    - 651 to 1,050 lpm

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

Line, Impact, Fully Formed Printer (Continued)
- 1,051 to 1,250 lpm
- 1,251+ lpm

Line, Nonimpact, Direct Thermal Printer
Line, Nonimpact, Thermal Transfer Printer

Page Printer
- 0 to 6 ppm
- 7 to 10 ppm
- 11 to 15 ppm
- 16 to 20 ppm
- 21 to 30 ppm
- 31 to 50 ppm
- 51 to 80 ppm
- 81 to 150 ppm
- 151+ ppm

Other Input/Output Devices
- Monitor
- Remote Batch, Job-Entry, and Output
- Key Entry Equipment
- Media-to-Media Data Conversion
- Magnetic Ink Character Recognition (MICR)
- Optical Scanning Equipment
- Computer Plotters
  - Small Format Pen Plotter
  - Large Format Pen Plotter
  - Small Format Electrostatic Plotter
  - Large Format Electrostatic Plotter
  - Ink Jet Plotter
  - Thermal Plotter
  - Photosensitive Plotter
  - Laser Plotter
- Voice Recognition Computer Device
- Voice Synthesizer
- Mouse
- Keyboard
- Digitizer

Office Equipment
- Copier and Duplicator
  - Personal Copier (Up to 12 cpm)
  - Segment 1 (Up to 20 cpm)

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

Copier and Duplicator (Continued)
- Segment 2 (21 to 30 cpm)
- Segment 3 (31 to 44 cpm)
- Segment 4 (45 to 69 cpm)
- Segment 5 (70 to 90 cpm)
- Segment 6 (91+ cpm)

Full-Color Copiers
Electronic Calculator (without Alpha Keyboard)
Dictating, Transcribing Machine
Electronic Typewriter
Word Processor
Banking System
- Check-Handling System

Cash Register
Mailing, Letter-Handling, Addressing Equipment
Other Office Equipment

Communications
- Telecommunicatons
  - Image Communications
    - Facsimile
      - Classification by Type
        - Standalone Systems
        - PC Facsimile Cards
        - LAN to Fax Gateways
      - Classification by Technology
        - Group I
        - Group II
        - Group III
        - Group III Bis
        - Group IV
      - Classification by Feature
        - Ultra Low End
        - Low End
        - Midrange
        - High End
      - Classification by Price
        - <$1,000
        - $1,000 to $1,499
        - $1,500 to $1,999
        - $2,000 to $2,499
        - $2,500 to $2,999
        - $3,000 or More

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

Classification by Printing Technology
Thermal
Thermal Transfer
Plain Paper (Laser, LED, etc.)
ISDN Terminals
Servers
Teleconferencing
Audio
Video
Captured Image
Near-Full Motion
Codecs
PX64
Telex
Machines
Black Boxes
Gateways
Message Switches
Videotex
Terminals

Personal Communications

Mobile Radio
Cellular Handsets
Classification by Type
Car-Mounted
Transportable
Portable
Classification by Technology
Analog
C450
NMT450
NMT900
TACS
ETACS
Radiocom 2000
AMPS
RTMS-Italy
Digital
GSM
Others

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Cordless Handsets
  - CT0
  - CT1
  - CT2
  - CT3
  - DECT
  - GSM
  - Base Stations
- Global Positioning Systems
- Mobile Infrastructure
  - Base Stations
- Personal Communications Networks (PCN)
  - Mininetworks
- Public Mobile Radio (PMR)
- Paging Systems

Networking

- Cable (Private)
- Data PBX
- Encryption Units
- Front-End Processors
  - IBM and IBM-Compatible
  - Proprietary
- ISDN
- Local Area Networks (LANs)
  - Terminal Servers
    - Ethernet
    - Token Ring
    - Others
  - PC Network Operating Software
  - PC LANs
  - Classification by Type
    - IBM PC/Compatible
    - Apple Macintosh
  - Classification by Technology
    - 802.3
    - 802.5
    - Arcnet
    - FDDI
    - Others
  - Classification by Media
    - Coaxial
    - Unshielded Twisted Pair (UTP)
    - Fiber-Optic
    - Datagrade

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Local Operating Network Systems (LONs)
- Modems
  - Classification by Standards
    - U.S. Standards
      - 212 A
      - V.22 Bis
      - 201 B/C
      - 208 A/B
      - V.29
      - V.32
      - V.33
      - 16.8 Kbps
      - 19.2 Kbps
      - V.35
      - V.36
        - Proprietary Dial-Up 9.6 Kbps
    - European Standards
      - V.21/23
      - V.21/23 PC
      - V.22
      - V.22 PC
      - V.22 Bis
      - V.22 Bis PC
      - V.26
      - V.27
      - V.29 Basic
      - V.29 Premium
      - V.32
      - V.32 PC
      - Proprietary Dial-Up 9.6 Kbps
      - V.33
      - 16.8 Kbps
      - 19.2 Kbps
      - Proprietary Baseband
      - Proprietary DOVE
- Multiplexers
  - Classification by Technology
    - Time Division (TDM)
      - Low-End Point-to-Point/Dual Trunk
      - Low-End Networking
      - Channels Banks/Primary MUX
      - T1/E1 Point-to-Point/Dual Trunk

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Time Division (TDM) (Continued)
  - T1/E1 Network Access
  - High-End Networking
  - Greater than T1/E1
- Statistical Time Division (STDM)
  - Classification by Size
    - Low End (Up to 16 Channels)
    - Midrange (Up to 48 Channels)
    - High End (More than 48 Channels)

Network Management Systems
- Public
  - Carrier
  - Local
  - Long Distance
- Private
  - LANs
  - T1/E1
  - X.25
  - Modems
  - Voice (Call Accounting)
  - Switch and Patch
  - Matrix
  - Mini/Mainframe-Based
  - Test Equipment
    - Analyzers
  - Operator Support Systems

Network-Terminating Devices

Operator Support Systems

Other Datacom Equipment
- Fiber-Optic Multiplexers

Public Data Network Systems (Equipment)
- X.21 Switches

Servers

Value-Added Networks (Equipment)

X.25
- Classification by Type
  - Packet Assemblers/Disassemblers (PADs)
    - Asynchronous Only
    - Synchronous Only
    - Multiprotocol
  - Packet Switches (Nodes)

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Classification by Capacity
  - Low End (Up to 100 Packets per Second)
  - Midrange (Up to 1,000 pps)
  - High End (More than 1,000 pps)

Public Network Equipment

- Cable
  - Coaxial
  - Fiber-Optics
    - Monomode
    - Multimode
  - Multipair
- Cable TV
- Carrier Equipment
- Central Office
  - Classification by Type
    - Local
    - Trunk
    - Gateway
  - Classification by Technology
    - Analog
    - Digital
      - ISDN
        - Basic Rate Interface (BRI)
        - Primary Rate Interface (PRI)
    - Others
  - Classification By Size
    - Less than 2K Lines
    - 2K to 10K Lines
    - More than 10K Lines
- Digital Access Crossconnect Systems (DACS)
  - Classification by Type
    - 1/0 DCS
    - 1/1 DCS
    - 3/1 DCS
    - 3/1/0 DCS
    - 3/3 DCS
    - 4/1 DCS
    - 4/3 DCS
    - 4/4 DCS
    - OCN/OCN

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Classification by Capacity
  - Low End
  - Midrange
  - High End
- Fiber-Optic Terminal (FOTs)
- Line Conditioners
- Main Distribution Frame (MDF)
- Connectors
- Microwave
  - Classification by Type
    - Systems
    - Antenna
    - Accessories
    - Electronics
  - Classification by Usage
    - Short Haul
    - Long Haul
  - Classification by Technology
    - Analog
    - Digital
- Multiplexers
  - Classification by Type
    - Multiplexers
    - Fiber-Optic Terminals
  - Classification by Technology
    - Analog
    - Digital
  - Classification by Standards
    - European/CEPT Standard
      - 2 Mbps
      - 8 Mbps
      - 34 Mbps
      - 140 Mbps
      - 565 Mbps
      - 2.4 Gbps
    - U.S. Standard
      - 1.5 Mbps
      - 6 Mbps
      - 45 Mbps
      - 90 Mbps
      - 135 Mbps
      - 1.2 Gbps

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EQUIPMENT

- SONET
- Synchronous Digital Hierarchy (SDH)
- Asynchronous Transfer Mode (ATM)
- Fast Packet Switching
- Frame Relay

Network Termination Units
- ISDN
- DSU/CSU
- NTU

Operating Support Systems
Pay Phones
Public Paging Systems
Local Loop Equipment
- Analog
  - PCM Repeaters
  - Digital
- Twisted Pair
- SLC-96 and Compatibles
- Others
- Fiber Optics
  - Universal Digital Line Carrier (UDLC)
  - Integrated Digital Line Carrier (IDLC)
  - Flexible Access System (FAS)
  - SONET
  - 802.6 Metropolitan Area Network (MAN)
  - Others
- Wireless
  - Basic Exchange Telephone Radio Service (BETRS)
  - Cordless

Satellite Communications
- Space Stations
- Earth Stations
  - VSAT
  - Master—Hub
  - Remote
    - Receive Only—Data Broadcast
    - Interactive
- Direct Broadcast
- Teleport
- Television Receive Only
- Video Distribution

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Satellite Communications (Continued)
  - Home
  - Intelsat
  - Eutelsat
  - Others
- Signaling
- Telex
  - Low End (Less than 20 Ports)
  - Midrange(20 to 80 Ports)
  - High End (More than 80 Ports)
- X.25
  - Classification by Size
    - Low End
    - Midrange
    - High End

Voice Communication

- Answering Machines
- Attendant Consoles
- Automatic Call Distributors (ACDs)
  - Classification by Type
    - Standalone
    - Integrated
    - Analog
    - Digital
  - Classification by Capacity
    - 1 to 8 Agent Positions
    - 9 to 24 Agent Positions
    - 25 to 48 Agent Positions
    - 49 to 100 Agent Positions
    - More than 100 Agent Positions
- Business Communications Systems
  - Classification by Type
    - Private Branch Exchange (PBX)
    - Key Telephone System (KTS)
  - Classification by Technology
    - Analog
    - Digital
    - ISDN
      - Terminals
      - ISDN
      - Proprietary
      - Servers
    - Network
      - BRI

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Network (Continued)
  - PRI
  - Proprietary
  - Gateways
- Basic
- Classification by Capacity
  - 1 to 8 Lines
  - 9 to 24 Lines
  - 25 to 48 Lines
  - 49 to 100 Lines
  - 101 to 400 Lines
  - 401 to 1,000 Lines
  - More than 1,000 Lines
- Cable (Private)
- Call Management Systems
  - Centrex
  - KTS
  - PBX
- Integrated Voice/Data Workstations (IVDT)
- Intercom Systems
- ISDN Terminals
  - Voice
  - Data
  - Video
  - Integrated
- Private Paging Systems
- Trading Turrets/Dealer Boards
- Voice-Messaging Systems
  - Classification by Capacity
    - 1 to 4 Ports
    - 5 to 8 Ports
    - 9 to 16 Ports
    - 17 to 32 Ports
    - 33 to 64 Ports
    - 65 to 128 Ports
    - More than 128 Ports
- Voice Response Units (VRUs)
  - Classification by Capacity
    - 1 to 4 Ports
    - 5 to 8 Ports
    - 9 to 16 Ports
    - 17 to 32 Ports
    - 33 to 64 Ports
    - 65 to 128 Ports
    - More than 128 Ports

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

Voice Terminals
Classification by Type
Corded
Cordless
Classification by Technology
Analog
Digital
Pulse Dial
Tone Dial (DTMF)

Industrial Electronic Equipment
Security/Energy Management
Alarm System
Intrusion Detection Alarm System
Fire Detection Alarm System
Discrete Device, Security/Energy Management
MPU Load Programmer
Computerized Energy Control System

Manufacturing System
Wafer Fabrication Equipment
Lithography Equipment
Proximity/Contact Aligners
Projection Aligner
Steppers
Direct-Write E-Beam
Maskmaking E-Beam
X Ray

Automatic Photoresist Processing Equipment
Etch-and-Clean Equipment
Wet Process
Dry Strip
Dry Etch
Ion Milling

Deposition Equipment
Chemical Vapor Deposition
Physical Vapor Deposition
Silicon Epitaxy Deposition
Metalorganic CVD Deposition
Molecular Beam Epitaxy Deposition
Diffusion
Rapid Thermal Processing

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

Ion Implantation
Medium Current Ion Implantation
High-Current Ion Implantation
High-Voltage Ion Implantation
Optical CD/Wafer Inspection
Other Process Control Equipment
Factory Automation Equipment
Other Water Fabrication Equipment

Test Equipment
ATE (Automatic Test Equipment)
Discrete Component Tester
Semiconductor Tester
Interconnect/Bare PCB Tester
In-Circuit PCB Tester
Functional PCB Tester
Combined PCB Tester
Manufacturing EATE N/A
General Test Equipment

Process Control System
Process Control System, Controller
Process Control System, Recorder
Process Control System, Indicator
Process Control System, Auxiliary Station
Process Control System, Nonunified System
Process Control System, Industrial Process

Programmable Machine Tool
Boring Programmable Machine Tool
Drilling Programmable Machine Tool
Grinding Programmable Machine Tool
Horizontal Turning Programmable Machine Tool
Vertical Turning Programmable Machine Tool
Milling Programmable Machine Tool
Machining Center Programmable Machine Tool
Other Cutting Programmable Machine Tool
Punch/Shear/Bend Programmable Machine Tool
Flexible Manufacturing System Programmable Machine Tool

Mechanical Assembly Equipment
Plastic Processing Machinery

Robot System
Robotic Electronic Assembly
Robotic Nonelectronic Assembly

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EQUIPMENT

- Robot System (Continued)
  - Material-Handling/Loading Robot System
  - Painting Robot System
  - Spot-Welding Robot System
  - Arc-Welding Robot System
  - Machining Robot System
  - Other Robot System
- Automated Material Handling
  - Guided Vehicle
  - Programmable Conveyor
  - Storage/Retrieval Automatic Material-Handling System
  - Programmable Monorail
  - Warehousing
  - Programmable Overhead Crane
  - Other Automated Material-Handling Equipment
- Instrumentation
  - Integrating and Totalizing Meter for Gas
  - Counting Device
  - Digital Panel Meter
  - Analog Panel Meter
  - Panel Type Instrument
  - Elapsed-Time Meter
  - Portable Electronic Measuring Instrument
  - Electronic Recording Instrument
  - Physical Property Test, Inspection, and Measurement
  - Commercial Meteorological and General-Purpose Instrument
  - Nuclear Radiation Detection and Monitoring
  - Surveying and Drafting Instrument
  - Ultrasonic Cleaners, Drill
  - Meteorological Instrument
  - Geophysical Instrument
  - Analytical and Scientific Instrument
- Medical Equipment
  - Diagnostic Medical Equipment
    - Automatic Blood Analyzer
    - CAT Scanner
    - Digital Radiography
    - Electrocardiograph
    - Electroencephalograph
    - Magnetic Resonance Imaging

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Medical Equipment (Continued)
  - Respiratory Analysis
  - Ultrasonic Scanner, Medical
  - X Ray, Medical
  - Other Diagnostic Medical Equipment
- Patient-Monitoring
- Prosthetic Medical Equipment
  - Hearing Aid
- Surgical Support
- Therapeutic
  - Defibrillator
  - Dialysis, Diathermy
  - Electrosurgical
  - Pacemaker
  - Ultrasonic Generator
  - Other Therapeutic Medical Equipment

- Other Industrial Electronic Equipment
  - Vending Machine
  - Laser System (Excluding Communication)
  - Power Supply
  - Traffic Control
  - Particle Accelerator
  - Industrial and Scientific X Ray
  - Laboratory and Scientific Apparatus
  - Teaching Machine and Aid
  - Scientific Not Elsewhere Classified

- Consumer Electronic Equipment
  - Audio Consumer
    - Audio Amplifier
    - Compact (Disc) Player, Music
    - Consumer Radio
    - Stereo (Hi-Fi) Component
    - Stereo Headphone
    - Electronic Musical Instrument
    - Tape Recorder, Consumer
  - Video, Consumer
    - Video Camera, Consumer
    - VTRs (VCRs)
    - Videodisc Player

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Video, Consumer (Continued)
  - Color Television
  - Black-and-White Television
  - HDTV
  - Remote Control
  - LCD Television
- Personal Electronic
  - Game
  - Camera
  - Watch
  - Clock
  - Toy
  - Sewing Machine
  - Other Personal Electronic
- Appliance
  - Air Conditioner
  - Microwave Oven
  - Washer and Dryer
  - Refrigerator
  - Dishwasher, Disposal
  - Range and Oven, Consumer
  - Rice Cookers
  - Fans
  - Heaters
  - Vacuum Cleaners
  - Food Processors
  - Other Consumer Appliance
- Other Consumer Electronic
  - Automatic Garage Door Opener
  - Residential Smoke Alarm
  - Consumer Electronic Equipment Not Elsewhere Classified

Military/Aerospace Electronic Equipment

- Military Electronic Equipment
  - Radar, Military
  - Sonar, Military
  - Missile-Weapon
  - Space Military Equipment
  - Navigation, Military
  - Communication, Military
  - Electronic Warfare

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

EQUIPMENT

- Military Electronic Equipment (Continued)
  - Reconnaissance
  - Aircraft System
  - Military Computer System
  - Simulation and Training, Military
  - Miscellaneous Military Equipment
- Civil Aerospace
  - Radar, Civilian
  - Civilian Space
  - Civil Navigation/Communication
  - Civil Aircraft Flight System
  - Civil Simulation and Training

- Transportation Electronic Equipment
  - Entertainment, Transportation
  - Body Controls
  - Driver Information
  - Powertrain
  - Safety and Convenience
- Other Electronic Equipment

SOFTWARE

- Application Software (See Applications Segmentation)
- System Software
  - Operating System Software
    - Database
      - Document Management
      - Data Acquisition and Control
      - Storage Management
      - Database Administration
      - On-Line Transaction Processing
    - Development Tools
    - Editors
    - Language
      - Compilers
      - Assemblers
      - Translators
      - Data Translator
      - Query Languages

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SOFTWARE

- Interactive Languages
  - Fourth-Generation Languages
  - Visual Programming Languages
- Graphic
- Communication Management
  - User Interface
  - Device Interface
- Protocol
- Security

Operating Environment

Operating System

- Proprietary
  - IBM/VM/MVS
  - DEC VMS
  - Others
- Open
  - UNIX
    - OSF1
    - Sun OS
    - System V/BSD
    - Mach
    - XENIX
    - Others
      - Pick
      - Theos
      - Others
  - Real-Time
- PC
  - DOS
  - OS/2
  - Macintosh
  - Others
- Operating Utilities
  - Peripheral I/O Management
  - System Subroutine Libraries
  - Data Center and System Management
  - Information Resource Management
  - Information Center
  - System Utilities

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CONSUMABLES

- Paper
  - Cut Sheet
  - Form
  - Label
- Toner and Developer
- Print Ribbon
- Photoreceptor
- Print Element
  - Printwheel
  - Golf Ball
  - Thimble
- Computer Storage Media
  - Flexible Disk
  - Rigid Disk
  - Computer Storage Tape
  - Optical Media
- Transparency
- Other Consumable

SERVICES

- Telecommunications Services
  - Core Services
    - Classification by Type
      - Local Telephone Services
      - Long Distance Services
      - International Services
    - Classification by Technology
      - Analog
      - Digital
        - ISDN
          - HO
          - BRI
          - PRI
        - Others
    - Classification by Product
      - Toll Revenue
      - WATS Outgoing
      - WATS Incoming (800 Service)
      - 900 Service
      - Switched Digital Services
        - Switched 56 Kbps
        - X.21

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

SERVICES

- Classification by Product (Continued)
  - Analog Private Lines
    - Conditioned
    - Unconditioned
  - Digital Private Lines
    - Classification by Capacity
      - 0 to 19.2 Kbps
      - 19.2 Kbps to 64 Kbps
      - 64 Kbps to H11
      - H11 to 772 Kbps
      - T1
      - E1
      - 8 Mbps
      - T3
      - 34 Mbps
      - More than T3
  - Centrex
    - Classification by Type
      - ETN
      - ACD
      - CLASS
      - Routing
      - Billing
      - Network Management
    - Classification by Size
      - 1 to 8 Lines
      - 9 to 24 Lines
      - 25 to 48 Lines
      - 49 to 100 Lines
      - 101 to 400 Lines
      - 401 to 1,000 Lines
      - More than 1,000 Lines
  - B-ISDN
  - Operator Services
- Enhanced Services
  - Audiotex Access Services
  - Voice Mail
  - Cable TV
  - Directory Inquiry
  - Electronic Messaging
    - X400
    - EDI
    - Others

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

SERVICES

- ISDN
- Public Data
- Satellite
  - VSAT
  - Others
- Teleconferencing
- Teleport Services
- Telex Services
- Facsimile Services
- Value-Added Networks (VANs)
- VideoConferencing
  - Ad Hoc
  - Carrier Provided
- Virtual Private Network Services
- Videotex Access Services
- X.25
- Voice Messaging

Mobile Services
- Cellular
  - Classification by Technology
    - Analog
      - C450
      - NMT450
      - NMT900
      - TACS
      - ETACS
      - Radiocom 2000
      - AMPS
      - RTMS-Italy
    - Digital
      - GSM
      - Others
- Cordless
  - Portable
    - CT2
    - CT3
    - DECT
  - Mobile
    - GSM
- Global-Positioning Systems
  - Location Identification Systems

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

SERVICES

- Personal Communications Networks (PCN)
  - SubGSM
- Public Mobile Radio (PMR)
  - Data Services
- Public Paging Systems
- Messaging Services

Hardware Maintenance
- Contract Maintenance
- Time and Materials

Parts

Software Support

Customer Training/Education

Network Support

Professional
- Systems Integration
- Facilities Management

OTHER PRODUCTS

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

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Geographic Regions

The geographic regions segmentation shows the classification scheme used by Dataquest to define the regions of the world. Dataquest classifies the world into the following regions:

- North America
- Europe
- Japan
- Rest of Asia—Rest of World

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Geographic Regions

Worldwide

North America
Europe
Japan
Rest of Asia—Rest of World

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

North America

North America

United States

East North Central Division
- Illinois
- Indiana
- Michigan
- Ohio
- Wisconsin
- East North Central Other

East South Central Division
- Alabama
- Kentucky
- Mississippi
- Tennessee
- East South Central Other

Mountain Division
- Arizona
- Colorado
- Idaho

Mountain Division (Continued)
- Montana
- Nevada
- New Mexico
- Utah
- Wyoming
- Mountain Other

Middle Atlantic Division
- New Jersey
- New York
- Pennsylvania
- Middle Atlantic Other

New England Division
- Connecticut
- Maine
- Massachusetts
- New Hampshire
- Rhode Island
- Vermont
- New England Other

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

United States (Continued)

- Pacific Division
  - Alaska
  - California
  - Hawaii
  - Oregon
  - Washington
  - Pacific Other
- South Atlantic Division
  - Delaware
  - District of Columbia
  - Florida
  - Georgia
  - Maryland
  - North Carolina
  - South Carolina
  - Virginia
  - West Virginia
  - South Atlantic Other
- West North Central Division
  - Iowa
  - Kansas
  - Minnesota
  - Missouri
  - Nebraska
  - North Dakota
  - South Dakota
  - West North Central Other
- West South Central Division
  - Arkansas
  - Louisiana
  - Oklahoma
  - Texas
  - West South Central Other
- Puerto Rico Division
  - Puerto Rico
- United States Other

Canada

North America Other

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Europe

Western Europe

Western Europe Major
- France
- Germany
- Italy
- Netherlands
- Spain
- Sweden
- United Kingdom

Western Europe Other
- Austria
- Belgium
- Cyprus
- Denmark
- Finland
- Gibraltar
- Greece
- Iceland
- Ireland
- Liechtenstein
- Luxembourg
- Malta
- Monaco
- Norway
- Portugal
- San Marino
- Switzerland

European Community (EC)
- Belgium
- Denmark
- France
- Germany
- Greece
- Ireland
- Italy
- Luxembourg

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

European Community (EC) (Continued)
- Netherlands
- Portugal
- Spain
- United Kingdom

European Free Trade Association (EFTA)
- Austria
- Finland
- Iceland
- Norway
- Sweden
- Switzerland

Eastern Europe
- Albania
- Bulgaria
- Czechoslovakia
- Hungary
- Poland
- Romania
- Union of Soviet Socialist Republics
- Yugoslavia

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Japan

Japan

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Rest of Asia—Rest of World

Rest of Asia—Rest of World

Four Tigers

- Hong Kong
- Korea
- Singapore
- Taiwan

Other Asia

- Bangladesh
- Brunei
- Burma
- Cambodia
- China
- East Timor
- India
- Indonesia
- Laos
- Macau
- Malaysia
- Maldives
- Nepal
- Pakistan
- Philippines
- Sri Lanka
- Thailand
- Vietnam

Rest of World

Australia/New Zealand

- Australia
- Christmas Island
- Cocos Islands
- New Zealand
- Norfolk Island

Oceania

- American Samoa
- Canton and Enderbury Islands
- Cook Islands
- Fiji
- French Polynesia

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Oceania (Continued)

- Guam
- Johnson Island
- Kiribati
- Midway Islands
- Nauru
- New Caledonia
- Niue
- Pacific Islands
- Papua New Guinea
- Pitcairn
- Samoa
- Solomon Islands
- Tokelau
- Tonga
- Tuvalu
- Vanuatu
- Wake Island
- Wallis and Futuna Islands

Africa
Central America
Caribbean
Middle East
South America
Atlantic
Inner Asia

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Distribution

The distribution segmentation outlines the path by which a product moves from the manufacturer to the ultimate end user. This segmentation is used by Dataquest to analyze markups, discounts, and buyer behavior.

Dataquest defines the major distribution classifications as follows:

- Distribution channel
- Distribution method

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Distribution

DISTRIBUTION CHANNEL

- Direct
- Indirect
  - Value-Added Reseller/Systems Integrator
  - Original Equipment Manufacturer
  - Distributor
    - Regional Bell Operating Company (RBOC)
      - Independent Telephone Company
      - Telephone Interconnect Supplier
  - Dealer
  - Mass Merchandiser
  - Manufacturers' Representatives/Agents

DISTRIBUTION METHOD

- Direct Sales Force
- Telemarketing
- Mail Order
- Company-Owned Store

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Applications

The applications segmentation describes the use to which a product is put or the function it performs. Sometimes there are one-to-one relationships between products and their applications and the actual functions that a product performs.

The major applications as defined by Dataquest are as follows:

- General productivity
- Organizational
- Entertainment
- Industry specific

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Applications

GENERAL PRODUCTIVITY

- Document/Media Creation and Editing
  - Computer-Aided Printing and Publishing
    - Electronic Publishing
    - Technical Publishing
  - Graphics
    - Chart and Map Generation
    - Image Generation
    - Graphic Design Art
      - Image Editing
      - Draw/Paint
      - Image Capture
      - Clip Art
      - Illustration
    - Presentation Graphics
    - Color Prepress
      - Input
      - Image Processing
        - Image Manipulation
        - Color Correction
        - Color Pagination
      - Composition and Translation
      - Color Separation
    - Page Composition and Page Makeup
      - Page Description
      - Page Imaging
      - Document Architecture
      - Desktop Publishing
      - Scientific Visualization/Simulation
    - Multimedia
      - Animation
      - Desktop
        - Video
          - Compression
          - Digitizer
          - Full-Motion
          - Real-Time
        - Videodisc

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

GENERAL PRODUCTIVITY

- Holography
- Photo Realism
- Information Retrieval

Forms

Publishing Utilities
- Tagging
- PostScript Printing
- Compression/Decompression
- File Translation/Data Conversion

Document Management
- Author/Editor
- Image Processing
- Scanning
  - Text
  - Image
- Word Processing
- Typography

Communication
- Electronic Mail

Spreadsheet/Decision Support/Executive Information Systems
- Spreadsheet
- General-Purpose Simulation
- Modeling
- Forecasting

Learning/Education/Training
- Instructional
  - Computer Training/Assisted Instruction
- Educational Simulation
- Learning

Project Management
- Calendaring
- Scheduling
- Ticketing
- Library Management

Time Management
- Application Utilities
- Integrated Applications
- Relational Database Management System

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

ORGANIZATIONAL

- Management and Administration
  - Accounting
    - Accounts Payable
      - Checkbook Management
    - Accounts Receivable
      - Billing/Invoicing
    - General Ledger
    - Payroll
    - Tax Accounting
    - Personal Finance
  - Capital Assets
    - Fixed Assets
    - Lease Accounting
  - Human Resource/Personnel Management
    - Benefits Administration
    - Employment Administration
  - Finance
    - Financial Planning
    - Budgeting
    - Cost Accounting
    - Investment/Portfolio Management
    - Cash/Money Management
    - Deposit/Loan Management
    - Treasury/Stocks/Bonds
  - Purchasing
    - Contract Administration
    - Vendor Management
  - Planning
    - Business Planning
    - Strategic Planning
    - Command, Control, Communications, and Intelligence
  - Facilities Management
    - Facility Planning
    - Facility Simulation
    - Equipment/Maintenance Management
    - Property/Real Estate Management
    - Facility Security Management

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

ORGANIZATIONAL

- Sales and Marketing
  - Marketing Research
  - Advertising and Promotional
  - Public Relations
  - Order Entry/Processing
    - Customer/Prospect Management
      - Credit Management
    - Sales Support/Administration
- Research, Engineering, and Development
  - Industrial Automation
    - Shop Floor Plan and Control
    - CAM/Automated Assembly
    - Manufacturing Engineering Tools
    - Other Planning and Control
    - Test and Measurement
    - Others
  - Design Automation
    - CAD/CAM/CAE
      - Modeling
        - Two-Dimensional
        - Three-Dimensional
        - Solid
      - Mechanical
        - Documentation/Drafting
          - Detail Drafting
          - Document Management
          - Schematics
          - Technical Illustration
          - Charts
        - Conceptual Design
          - Industrial Design
          - Design Layout
          - Styling
        - Functional Design
          - Component
          - Assembly Verification
          - Linkage/Mechanism
        - Analysis
          - Fatigue
          - Structural

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

ORGANIZATIONAL

- Analysis (Continued)
  - Thermal
  - Vibrational
  - Magnetic
  - Composite
  - Mass Property
- Manufacturing Engineering
  - Tool Design
  - Fixture Design
  - Part-Processing Design
- Manufacturing Process Simulation
  - NC Part Programming
  - Coordinate Measuring Machines
  - Off-Line Robotics
  - QC Analysis

AEC (Architectural, Engineering, and Construction)
- Architectural
- Civil
- Facility Design
- Process Plant Design

Geographical Information Systems
- GIS/Mapping
- Raster-Based GIS Systems

Electronic Design Automation
- Electronic Computer-Aided Engineering
  - Digital Design
    - Design Entry
      - Schematic Entry
      - Libraries
    - Design Verification
      - Simulation
      - Simulation Acceleration
      - Hardware Modeling
      - Static Timing Analysis
    - Logic Synthesis
    - Test Automation
      - Automatic Test Vector Generation
      - Design for Testability/Test Synthesis
      - Fault Simulation

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ORGANIZATIONAL

- Analog Design
  - Design Entry
    - Schematic Capture
    - Libraries
  - Design Verification
    - Circuit Simulation
    - Mixed Signal Simulation
- IC Layout and Verification
  - Editing
  - Layout
  - Verification
  - Module Generation
- PCB Layout

- Software Development
  - Computer-Aided Software Engineering
  - Artificial Intelligence
  - General Software Development
- Earth Resources
  - Seismic Analysis
    - Geophysical Seismic Imaging
  - Oil Field Services
  - Remote Sensing
- Technical Data Analysis
  - General Scientific
    - Scientific Research/Analysis
    - Scientific Visualization
    - Scientific Simulation
  - Chemistry
    - Crystallography
    - Modeling
    - Analysis
  - Simulation
  - Laboratory
  - Analytical Instruments
  - Instrument Automation
  - Quality Control/Assurance
  - Research and Laboratory Analysis
  - Others

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ORGANIZATIONAL

- Medical
  - Body Scanning
  - Patient Monitoring
  - Others
- Diagnostic
- Therapeutic

Manufacturing and Distribution
- Distribution Planning and Control
  - Transportation/Fleet Management
    - Route Planning
    - Dispatching
  - Warehouse Management
    - Automated Warehousing and Materials Handling
  - Inventory and Distribution Management and Control

Manufacturing Planning and Control
- Material/Process Requirements Planning, Production and Process Management
- Shop Floor Planning and Control
- CAM/Automated Assembly
- Manufacturing Engineering Tools
- Other Planning and Control
  - Simulation
    - Robot Programming and Simulation
  - Quality Assurance
    - Detection and Tracking
  - Fault Management/Adaptive Control
- Test and Measurement
- Inspection
  - Machine Vision

Others
- Real-Time Data Acquisition and Control
  - Simulation
  - C^3i
  - Others
- Building Automation

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ORGANIZATIONAL

Others (Continued)
- Traffic Control
- Railroad Control
- Power Grid Control
- Water Quality and Sewage Control
- Atmospheric Monitoring

ENTERTAINMENT

INDUSTRY SPECIFIC

The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

User Environment

The user environment segmentation is based on industry classifications derived from a format that reflects the United States Department of Commerce's Standard Industrial Classification (SIC) code scheme and the International Standard Industrial Classification of all economic activities used by the United Nations.

Environments are a description of where a product is used ultimately. The major user environments as defined by Dataquest are as follows:

- Home
- Business
- Education
- Government

Dataquest has a classification scheme available at the two-, three-, and four-digit SIC levels, which can be provided on request.

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User Environment

HOME

BUSINESS

Natural Resources and Construction

- Agricultural Production—Crops
- Agricultural Production—Livestock
- Agricultural Services
- Forestry
- Fishing, Hunting, and Trapping
- Metal Mining
- Coal Mining
- Oil and Gas Extraction
- Nonmetallic Minerals, except Fuels
- General Building Contractors
- Heavy Construction, except Building
- Special Trade Contractors

Process Manufacturing

- Food and Kindred Products
- Tobacco Products
- Textile Mill Products
- Lumber Wood Products
- Paper and Allied Products
- Printing and Publishing
- Chemicals Allied Products
- Petroleum and Coal Products
- Rubber and Miscellaneous Plastics Products
- Leather and Leather Products
- Stone, Clay, and Glass Products
- Primary Metal Industries

Discrete Manufacturing

- Apparel and Other Textile Products
- Furniture and Fixtures
- Fabricated Metal Products
- Industrial Machinery and Equipment
- Electronic and Other Electric Equipment
- Instruments and Related Products

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BUSINESS

Discrete Manufacturing (Continued)
- Miscellaneous Manufacturing Industries
- Transportation Equipment

Transportation
- Railroad Transportation
- Local and Interurban Passenger Transit
- Trucking and Warehousing
- Water Transportation
- Transportation by Air
- Pipelines, except Natural Gas
- Transportation Services

Communication
- Communication

Utilities
- Electric, Gas, and Sanitary Services

Wholesale Trade, Durable Goods
- Wholesale Trade—Durable Goods

Wholesale Trade, Nondurable Goods
- Wholesale Trade—Nondurable Goods

Retail Trade
- Building Materials and Garden Supplies
- General Merchandise Stores
- Food Stores
- Automotive Dealers and Service Stations
- Apparel and Accessory Stores
- Furniture and Home Furnishings Stores
- Eating and Drinking Places
- Miscellaneous Retail

Finance
- Depository Institutions
- Nondepository Institutions
- Security and Commodity Brokers

Insurance
- Insurance Carriers
- Insurance Agents, Brokers, and Service

Real Estate
- Real Estate
- Holding and Other Investment Offices

Hotels And Other Lodging
- Hotels and Other Lodging

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BUSINESS

Business Services

Business Services
Legal Services

Health Care

Health Services

Other Services

Personal Services
Auto Repair, Services, and Parking
Miscellaneous Repair Services
Motion Pictures
Amusement And Recreation Services
Social Services
Museums, Botanical, Zoological Gardens
Membership Organizations
Engineering and Management Services
Services, NEC

EDUCATION

Elementary
Secondary
Higher Education
Four-Year Institution
Two-Year Institution
Public
Private

GOVERNMENT

Government by Function

Executive, Legislative, and General
Justice, Public Order, and Safety
Finance, Taxation, And Monetary Policy
Administration of Human Resources
Environmental Quality and Housing
Administration of Economic Programs
National Security and International Affairs

Government

Federal
State
Local

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SIZE (BUSINESS, EDUCATION, GOVERNMENT)

Revenue (Millions of U.S. dollars)
- 0 to 99.9
- 100 to 499.9
- 500 to 999.9
- 1 to 4.9
- 5 to 9.9
- 10 to 49.9
- 50+

Employees
- Small
  - 0 to 9
  - 10 to 19
  - 20 to 49
- Medium
  - 50 to 99
  - 100 to 249
- Large
  - 250 to 499
  - 500 to 999
  - 1,000+

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Research Items

The research items segmentation is a listing of general terms used by Dataquest to organize, describe, and analyze data for technology markets and industries. A typical use of research items is to describe market data in terms of shipments, retirements, and installed base.

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Research Items

- Application
- Assembler
- Average Selling Price
- Average Usage
- Average Volume
- Balance of Trade
- Bit
- Byte
- Capital Spending
- Captive Production
- Compound Growth Rate
- Consumption
- Conversion Revenue
- Cost
- End User
- End-User Average Selling Price
- End-User Revenue
- Environment
- Export
- Factory Average Selling Price
- Factory Revenue
- Gross Lease Additions
- If-Sold Value
- Import
- Industry
- Input/Output (I/O) Ratio
- Installed Base
- Internal Transfer
- Inventory
- Joint Venture
- Lease
- Lease/Rental Conversions
- List Price
- Manufacturer
- Manufacturer's Suggested Retail Price
- Market
- Market Share
- Markup
- Merchant Production
- Net Additions
- New Placement Demand
- Placement
- Product
- Product Category
- Production
- Replacement Demand
- Research and Development
- Residual Value
- Retirement
- Return
- Revenue
- Shipment
- Subsidiary
- Tie Ratio
- Unit
- Useful Life
- Users per System
- Year-Average Population

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The segmentation represents Dataquest's view of the high-technology marketplace and is not intended to represent the availability of data.

Glossary

This glossary includes definitions of the major terms associated with Dataquest's segmentation of the high-technology marketplace.

III-V discrete semiconductor. 1: A semiconductor device with low noise, low power, and high power in the range of one-half watt to one watt. 2: A device of gate structures based on D-MESFET and E/D MESFET devices.

A

academic support. College expenditures that include expenditures for support services that are an integral part of the institution's primary missions of instruction, research, or public service. Includes expenditures for libraries, galleries, audio/visual services, academic computing support, auxiliary support, academic administration, personnel development, and course and curriculum development.

accounting software. 1: A software application that supports a system of recording and summarizing business and financial transactions and analyzing, verifying, and reporting results. 2: A software application used to manage an organization's money and/or assets. This type of software includes general ledger, accounts payable/receivable, and inventory control.

accounts payable (AP). An application that supports the accounts payable function, which is the amount owed by a business to its suppliers and other regular trading partners.

accounts receivable (AR). An application that supports the accounts receivable function, which is the amount owed to a business by its customers.

ACD. See **automatic call distributor.**

adaptive control. 1: The property of a control system that allows it autonomously to maintain a manufacturing or process environment within predetermined control limits. 2: A device with parameters that adjust automatically to compensate for changes in the dynamics of the process to be controlled.

add-on graphics board. A graphics board that is added to a basic computer to enhance the computer's current graphic capability.

add-on graphics board, Mac-type. Personal computers that were designed to run applications exclusively through a graphical user interface (i.e., windows, menus, and icons). Mac-type systems include Apple's Macintosh series (512E, Plus, SE, and II), Atari's ST series (524 and 1024), and Commodore's Amiga. This term also refers to peripherals intended for use in Mac-type systems.

add-on memory board. A printed circuit board populated with memory integrated circuits (IC), usually DRAMs or SRAMs, that plugs into personal computers via connectors on the central processing unit bus. These boards are used to increase central processing unit storage capacity.

AEC. See **architecture, engineering, and construction.**

aerial. See **antenna.**

AGVS. See **automatic guided vehicle system.**

AI. See **artificial intelligence.**

air conditioner. 1: An apparatus for controlling the temperature and humidity of air. 2: A broad field including numerous processes, among which are refrigeration, heating, ventilation and humidification, and electronic air filtering.

aircraft system (military). Electronic power devices used in airplanes to perform functions like flight control, communication and navigation, lighting computer system (including air data, mission and fire control), engine control, instrumentation, integral targeting system, associated test system, and integrated system.

alarm system. A system designed to warn of an intrusion, a fire, or other undesired occurrence. Alarm systems have three functions in common: detection, control, and annunciation signaling.

alphanumeric CRT controller. A character set of both letters and numbers that is used to control electron beams, which are used to present data in a visual form.

alphanumeric CRT terminal. A display terminal that provides character information to the operator.

amateur radio. A radio used for two-way radio communications by private individuals. It is not used for enterprise activity.

AMH. See **automated materials handling.**

amplifier IC. A linear IC that provides a voltage or power gain to an applied signal.

analog. 1: Representation of data by means of continuously variable physical quantities, such as voltage, current, or frequency. 2: A circuit or system in which the output signals bear a continuous relationship to the input signals. 3: A representation of an event in another form, e.g., the representation of voice sounds as continuously variable electrical signals.

analog design verification. A software application that includes analog simulation, analog synthesis, monte carlo analysis, worst-case analysis, and parametric plotting.

analog loop. A nondigital portion of the telecommunications network.

analog panel meter. 1: An electrical switchboard or instrument board with continuously variable electrical signals known as analog signals. 2: A mounting plate for the controls and/or other parts of equipment, utilizing analog signals.

analysis. Separation of a whole into its parts; proof of a mathematical proposition by assuming the result and deducing a valid statement by a series of reversible steps. Includes mass properties, kinematic and dynamic mechanism analysis, structural, thermal, composite, fluids, and vibration analysis. Finite element and finite difference are common analysis technologies used.

analytical and scientific instrument. Instruments used to measure, access, control, and monitor objects and systems.

animation. A software application to present either continuous pictures or images or to present them in rapid succession.

answering machine. A device, hooked to a telephone, that can record and play messages as they pass through a phone when a user is unable to pick up the telephone.

antenna. 1: A conductor or system of conductors that serves to radiate or intercept energy in the form of electromagnetic waves. 2: A device for transmitting or receiving radio waves. Also called aerial.

AP. See **accounts payable.**

appliance. 1: An instrument or device designed for a specific household or office purpose. 2: A piece of equipment for adapting a tool or machine to a special purpose.

application. The use to which a product is put; the function it performs.

application software. A software program or set of programs designed for a specific application, such as inventory control or linear programming.

application-specific integrated circuit (ASIC). A single-user IC that is manufactured using vendor-supplied tools and/or libraries. (May be sold by an ASIC or standard-product group.)

application utilities. A software application that enhances the operation of other standalone applications; Typically operates concurrently with these standalone applications.

AR. See **accounts receivable.**

architectural. Computer-aided tools intended for use in design and drafting of facilities' architectural aspects.

architecture, engineering, and construction (AEC). The use of computer-aided tools by architects, contractors, plant engineers, civil engineers, and others associated with these disciplines to aid in designing and managing buildings, industrial plants, ships, and other types of nondiscrete entities.

arc-welding robot systems. A system in which a robot carries an arc-welding torch to produce welds.

argon. An inert gas extensively used in discharge tubes.

artificial intelligence (AI). The ability of a machine to perform functions normally associated with human intelligence, such as learning, adapting, reasoning, self-correcting, and improving automatically.

ASCII. Standardized coding for alphanumeric and other standard keyboard characters.

ASIC. See **application-specific integrated circuit.**

ASP. See **average selling price.**

AS/RS. See **automated storage/retrieval system.**

assembler. A company that adds manufacturing value to a product.

assembly. 1: A group of subassemblies and/or parts that, when put together, create a major subdivision of the final product. When two or more components or subassemblies are put together by the application of labor and machine hours, it is called an assembly. An assembly may be an end product or a component for a higher-level assembly. 2: The semiconductor manufacturing steps of mounting a die in a package, bonding the pads to the package leads, and sealing the package.

assembly verification. The integration of various component designs into an assembly to test size/shape and functional characteristics.

asynchronous telecommunications software. A software application that emulates a standard computer terminal (e.g., DEC VT-100) and performs file transfer between asynchronously connected computers and/or provides remote operation of another computer.

ATE. See **automatic test equipment.**

ATM. See **automated teller machine.**

atmospheric monitoring. A real-time software application that monitors weather-related data from satellites and other monitoring sites around the world.

atmospheric/purge cylinder gas. A specialty gas; a cylinder gas for purging certain processing systems and equipment when manufacturers are concerned about possible back contamination of the house lines.

attendant console. A specialized telephone instrument that allows fast and efficient answering and routing of telephone calls.

audio amplifier. A device that uses transistors or vacuum tubes to obtain voltage, current, or power to amplify sound.

audio conferencing. The ability to communicate among more than two people at one time via a speakerphone or the telephone system/network.

audio equipment. Amplifiers, preamplifiers, control consoles, and other equipment used in studio, broadcast, and home environments. Equipment interprets frequencies corresponding to audible sound waves.

automated assembly system. The assembly of parts into subassemblies and/or complete assemblies using programmable equipment that may include robots. In discrete piece manufacturing, this system includes spot- and arc-welding and adhesives. In electronics, this system includes component placement and printed board component insertion. Usually, these automated assembly systems include sensors.

automated guided vehicle system (AGVS). An unmanned mobile transporter under programmable control that moves materials and tooling throughout a factory and/or warehouse. Includes towing vehicles, pallet trucks, light-load transporters, unit-load transporters, and self-loading and unloading vehicles.

automated materials handling (AMH). The automated handling of discrete or bulk materials in manufacturing systems. Materials handling includes the movement, storage, identification, and controlling of materials.

automated storage/retrieval system (AS/RS). All computer hardware, software, and equipment that are used together for mechanical hoists and carriages and that interface with racks and bins for automatic storage and retrieval of unit loads, pallets, and individual parts. An AS/RS moves materials from inventory to operations and back to inventory, frequently for work-in-process inventory.

automated teller machine (ATM). A machine used by financial institutions and designed to perform many of the banking functions performed by human tellers. (See also **funds transfer terminal.**)

automatic blood analyzer. Equipment used to analyze, detect, and decipher blood types and blood-related diseases.

automatic call distributor (ACD). A computer-based system located at a customer's premises that: (1) provides real-time monitoring of a telephone system's work load; (2) distributes calls to the agent who is idle longest; and (3) uses a queuing or waiting list assignment that holds the callers in queue until an agent is available, averages the random flow of traffic, and decreases peak traffic load. An ACD also contains features known as gates or agent split groups that provide functional divisions within the routing scheme and allow calls to be directed to a specific group or agent.

automatic photoresist processing equipment (colloquial: track). Equipment used to dispense and process photoresist material onto a wafer. Track equipment, as this equipment is usually called, includes wafer clean/bake, wafer prime, wafer coat/bake, wafer develop/bake, and resist stabilization equipment.

automatic test equipment (ATE). Computer-controlled equipment that inspects electronic devices, both active and passive. ATE usually includes analytical and statistical data-reduction capabilities and can document test results by display, hard copy, and electronic storage. ATE can perform printed circuit board (PCB) inspection by mechanical, electrical, and visual means in an automatic, programmable mode. ATE includes both bare boards and boards that have been loaded with electronic devices. In the latter case, diagnostic capabilities are included as a part of the system definition if they are part of the equipment.

automatic warehousing system (AWS). A dedicated storage and retrieval system that is used not on the factory floor but in a warehouse that may or may not be located within a manufacturing facility. An AWS includes a control system and associated material-handling equipment and structures, but excludes the building unless it is a structural part of the automated system. The control system includes both hardware and software.

automation. The system or technique of the production process that minimizes human intervention. Self-controlled machines are used to accomplish human tasks or tasks not able to be accomplished by human intervention.

average selling price (ASP). The average price of a product, inclusive of any discounts. (See also **end-user ASP** and **factory ASP.**)

average usage. The average number of units of product used per unit of time.

average volume. The average number of units of product produced per unit of time.

awarded contract. A binding agreement granted to a specific company.

AWS. See **automatic warehousing system.**

B

balance of trade. 1: The difference between the value of a country's exports and imports of tangible goods over a given period, usually one year. 2: The difference between the value of a country or region's exports of tangible goods to and imports of tangible goods from a second country or region.

banking system. Systems used in the banking/finance industries to facilitate the transmission of funds to improve efficiencies. Systems include: payroll allocation and deduction; demand deposit accounting; savings, both regular and certificates of deposit; and loan processes.

baseband modem. A type of modem that utilizes all of the available analog bandwidth on a line.

basic exchange telecommunications radio system (BETRS). A radio system network that provides cost-effective basic telephone service within remote areas.

benefits administration. A software application with the primary function of administering and aiding in managing an organization's employee benefits.

BETRS. See **basic exchange telecommunications radio system.**

BiCMOS. Bipolar complementary metal oxide semiconductor. See **BiMOS.**

BiMOS (BiCMOS). Bipolar metal oxide semiconductor (MOS). An integrated circuit (IC) manufactured with both bipolar and MOS processes that yields a component with the benefits of both technologies.

bipolar. 1: A semiconductor technology employing two junction transistors. 2: A device in which both majority and minority carriers are present. A transistor structure with electrical properties determined within the silicon material.

bipolar application-specific IC. See **application-specific integrated circuit.**

bipolar cell-based IC. See **cell-based integrated circuit.**

bipolar custom IC. See **custom integrated circuit.**

bipolar digital logic. See **logic circuit.**

bipolar digital microcomponent. See **microcomponent.**

bipolar FPGA. See **field-programmable gate array.**

bipolar gate array. See **gate array.**

bipolar memory. See **memory.**

bipolar nonvolatile memory. See **nonvolatile memory.**

bipolar PLA. See **programmable logic array.**

bipolar PLD. See **programmable logic device.**

bipolar PMD. See **programmable multilevel logic device.**

bipolar standard logic. See **standard logic.**

bipolar transistor. A transistor that uses positive- and negative-charge carriers. Bipolar transistors provide current gain—that is, a current input results in a larger current output.

bit. Abbreviation for binary digit. A unit of information equal to one binary decision, or the designation of one of two possible and equally likely values or states of anything used to store or convey information.

black-and-white television. Television in which the reproduced picture is displayed in shades of gray between black and white. Also known as monochrome television.

board-level computer. A single, or multiple, board-level CPU that is sold individually or incorporated in systems-level products (boxes). Typically, these are products that are not considered complete packaged systems. Prices range from the low hundreds to the low thousands of dollars. Frequently, software is bundled with the board for a specific application.

body control. Electronic equipment used to direct, manage, or guide an automobile or truck. Examples include electronic suspension, cruise control, intermittent wipers, load-sensitive braking, antitheft devices, electronic steering, and electronic mufflers.

book publishing software. Software with the main purpose/use of printing books or written or printed literary works.

boring programmable machine tool. A factory tool designed to machine internal work such as cylinders, holes, and castings.

broadband communications. Communications that utilize a bandwidth greater than a voice-grade circuit.

broadcast. 1: The transmission of packets on a contention bus where all data are heard by all devices on the channel and are selected by each device through address-recognition techniques. 2: To send messages or to communicate simultaneously with many or all points on a circuit. 3: The transmission of radio frequencies from a source to all devices that are capable of receiving the signal. Microwave transmission is one method of transmission. 4: Radio or television transmission intended for public reception.

broadcast and studio equipment. Equipment used to make information public by means of radio or television.

broadcast transmitter antenna. An electronic device for generating and amplifying a radio-frequency carrier for transmission through space from an antenna.

bubble memory. A storage medium that allows information to be stored on magnetically charged crystal chips. Bubble memories can hold data without electricity to sustain them; blackouts, changes in current, and static charges do not affect them. Such memories process material 75 times as fast as disk memories. However, bubble memory processors cannot handle multi-programming, i.e., performing parallel operations with several programs.

budgeting. An application that supports future resource planning.

building automation. A software application with the primary functions of managing the operations of a facility, including fire detection, energy management, and alarm systems. Large manufacturing plants and skyscrapers use real-time computers to control and monitor conditions. This may include fire detection and control systems; security systems; clocking, documenting, and energy management for heating, ventilation, and air conditioning.

bulk gas. A discrete delivery of gas in a liquid state.

bundled distribution and warehouse package. Hardware and/or software modules used for planning and control of warehouse or product distribution systems. These packages are not available separately from the total warehouse or distribution system.

business. A commercial or mercantile environment usually referred to as a vertical market. See "User Environment" section.

byte. 1: A single group of eight bits processed together. 2: The number of bits that a computer processes.

C

C^{3}I. See **command, control, communications, and intelligence.**

cable. An assembly of one or more conductors within an enveloping protective sheath, constructed to permit the use of the conductors singly or in groups.

cable television equipment. All equipment for both the head and subscriber ends of a cable television system.

cache. A fast, small memory (typically SRAM) used to enhance CPU performance, separate from main processor memory.

cache controller. A device that governs the area of a system that stores only data the system may need in the immediate future.

CAD. See **computer-aided design, drawing, or drafting.**

CAE. See **electronic computer-aided engineering** and **mechanical computer-aided engineering.**

CAGR. See **compound annual growth rate.**

calculator. A device capable of performing logical and arithmetical digital operations of any kind.

calendaring. 1: An application to support the scheduling of meetings and other events. It is usually a tickler file, reminding people of upcoming commitments. 2: In the papering industry, paper with a hard, smooth finish.

call management systems. The equipment and service that records the calling activity of a centrex, PBX, or key telephone system in order to generate reports that support telephone cost allocation and other telephone management information needs.

call processing equipment. Call processing equipment provides additional functions and capabilities beyond traditional call processing. This classification includes add-on products such as voice-messaging systems, call accounting systems, and automatic call distributors.

CAM. See **computer-aided manufacturing.**

capacitor. A commonly used component that stores electrical energy. It is sometimes referred to as a condenser.

capital assets. An application that assists a company in managing its capital assets, which are any physical property or right that is owned and has a money value.

capital spending. The purchase of a capital asset or an asset that is needed to create a product and is acquired with the intention of keeping (rather than being resold).

captive production. The sale of a good to a division within the manufacturing company.

carrier equipment. A cable-based system that provides transmission of multiple signals over a common metallic or fiber-optic cable. This segment includes subscriber carrier systems, trunk carrier systems, Basic Exchange Transmission Radio (BETR) systems, and repeaters.

cartography. An application that supports map production and/or resource management. May contain a spatially indexed data structure.

cartridge tape drive. A tape drive that uses a special metal and plastic protective device for the tape, which can be used for 1/4-inch or 1/2-inch tape products.

CASE. See **computer-aided software engineering.**

cash register. A device that automatically registers visibly the amount of a specific sale. Many are used to trace inventory and other product information through the sale of the product.

cassette tape drive. A tape drive that uses a small container of tape similar to that used for commercial audio recording purposes.

cathode ray tube (CRT). A television-like display screen which, on receipt of information bearing electronic signals, produces a visual display of the information (text, graphics). The CRT consists of a vacuum tube display in which a beam of electrons is projected onto a fluorescent surface of phosphors, producing a visual display. Used in most computer display terminals. Also referred to as video display terminal/visual display tube (VDT).

CAT scanner. A computerized axial tomography—frequently shortened to CT. A reconstructive imaging technique employing an X-ray source and array of detectors rotated about the body of the patient. The host computer calculates an image based on the appearance of a thin volume in the plane of the rotation.

CBIC. See **cell-based integrated circuit.**

CCD. See **charge-coupled device.**

CCIT. A French acronym for the International Telegraph and Telephone Consultative Committee, a committee of the international standards organization made up of telecommunication authorities of member countries. The committee's primary purpose is to develop and produce standards for telecommunication networks.

CCME. See **computational chemistry/molecular engineering.**

CCTV. See **closed circuit television.**

CD. See **critical dimension** and **compact disc.**

CD-ROM (compact disc read-only memory). See **CD-ROM disc drive.**

CD-ROM disc drive. All CD-ROM discs are 4.7 inches (12cm) in diameter, have a 1.6-micro-inch-pitch single-spiral track, and have 2.048 data bytes per sector.

cell-based integrated circuit (CBIC). An ASIC device that is customized using a full set of photomasks and uses automatic placement of cells and automatic routing.

cellular handset. See **cellular telephone.**

cellular service. One type of mobile communications, where a low-power radio is used between limited-distance "cells."

cellular telephone. Mobile radio equipment associated with cellular radio services.

central office (CO). 1: The physical location that contains the equipment that supports the telephone network. 2: The switching equipment that connects local access lines to toll circuits.

central office switching equipment. Equipment comprised of electronic systems that interconnect local telephone lines (loops) and connect local telephone lines to long distance trunk lines.

central processing unit (CPU). A microprocessor or microcontroller. Central processing unit of a computer.

centrex. An optional service that provides voice/data switching by using the utility's central office.

charge-coupled device (CCD). ICs that combine charge-coupled signal transfer with arrays of photosensors to provide image sensing. CCDs are available as linear or area arrays.

chart. Any table, graph, or drawing depicting a range of technical data.

chart and map generation. A graphics software application that is designed specifically for charts and predefined maps.

check-handling system. A system to improve the speed and accuracy of check-handling processes within the banking and finance industries.

chemical vapor deposition (CVD). A formation of a stable compound on a heated substrate by thermal reaction or decomposition of gaseous compounds. A process that chemically isolates and deposits a specific material on a wafer. CVD equipment includes atmospheric-pressure CVD (APCVD), plasma-enhanced CVD (PECVD), and low-pressure CVD (LPCVD) techniques. Historically, the CVD market was split into APCVD, PECVD, and LPCVD technologies, because each had its own applications. Now, because of advanced reactors that are crossing application boundaries, it makes more sense to divide the market by film application rather than by equipment technology.

chemistry. 1: An application to support the science dealing with the composition structure and properties of substances and with the transformations that they undergo. 2: Chemical processes and phenomena.

circuit. 1: The electrical path between two or more points. 2: A means of two-way communication between two points, consisting of a sending and a receiving channel or a combined sending and receiving channel. 3: A transmission path between two or more points.

CISC MPU. See **complex-instruction-set computing microprocessor.**

citizens band: mobile and base. A frequency band allocated for private individual radio service (460 to 470 megahertz or 26.965 to 27.405 megahertz).

civil aerospace. Civilian travel in space.

civil aircraft flight system. Same as military aircraft, except related to civilian activity.

civil application. A software application used for civil engineering tasks, typically for design and drafting of sites for buildings, streets, highways, bridges, dams, airports, and utilities.

civilian space. Equipment used by civilians to explore the earth's atmosphere. Includes satellites, reconnaissance equipment, and ground control equipment.

civil navigation/communication. Same as military navigation/communications, except related to civilian activity.

civil radar. Same as military radar, except related to civilian activity.

civil simulation and training. Same as military simulation and training, except related to civilian activity.

closed circuit television (CCTV). A television system where television signals are not broadcast, but are transmitted over a closed circuit and received by interconnected receivers.

CMOS. See **complementary MOS.**

CO. See **central office.**

coaxial cable. Type of transmission cable with one or more central conductors, surrounded by an insulator.

CODEC. See **coder/decoder circuit.**

coder/decoder circuit. An integrated circuit that codes a voice signal into a binary waveform or decodes a binary waveform into a voice signal. Such circuits now are used in digital communications applications.

college. A postsecondary school that offers general or liberal arts education, usually leading to an associate, bachelor's, master's, doctor's, or first professional degree. Junior colleges and community colleges are included under this category.

color prepress. A process that converts visual material to electronic signals.

color separation. A process of photographing objects using three filters, each corresponding in color and light transmission to one of the additive primary colors; analogous to seeing.

color television. An electronic system that transmits signals to a visual image that can be viewed in an array of colors on a screen.

combined elementary and secondary school. A school that encompasses instruction at both the elementary and secondary levels. Examples of combined elementary and secondary school grade spans would be 1 through 12 or 5 through 12.

combined PCB tester. Testing equipment that combines functional and in-circuit test techniques and capabilities that result in a test strategy to suit any given board's production history and fault spectrum to achieve the highest board fault coverage at the lowest cost.

command, control, communications, and intelligence (C^3I). Systems used to display the ongoing status of tactical or strategic operations in dynamic scenarios for rapid decision making.

commercial antenna. See **antenna.**

commercial meteorological and general-purpose instrument. Equipment used to obtain quantitative information about the weather.

communication. 1: The transmission of information from one point or person or equipment to another. 2: The sensing of a measurement signal or phenomenon for display, recording, amplification, transmission, computing, or processing into useful information.

communication management. The organization of stations, peripherals, and devices capable of intercommunications but not necessarily on the same channel.

communication peripheral. An interface device for machine-to-machine connections.

compact disc (CD). A disc from which data are read optically by means of a laser.

compact disc player. 1: A recording and playback system used to play recorded music by means of a small plastic optical disc similar to multiplex stereo broadcast and reception. Each wall of the record groove carries a single channel of information. 2: A recording device in which the sounds are mechanically impressed onto a disc.

comparator. A type of amplifier that produces a logic output (1 or 0) based on comparison of an input voltage with a fixed reference voltage. A widely used form of linear integrated circuit.

compiler. 1: Computer routine that translates symbolic instructions to machine instructions and replaces certain items with subroutines. 2: An automatic coding system in a computer that generates and assembles a program from instructions written by a programmer. 3: A computer language system consisting of various subroutines that have been evaluated and computed into one routine handled by a computer. 4: Software used to convert application programs from computer language to machine language.

complementary MOS. A semiconductor technology that uses both P-channel and N-channel transistors on the same silicon substrate to gain the primary advantages of very low power and high noise immunity.

complex-instruction-set computing (CISC) microprocessor. The number of instructions a microprocessor runs for a specific application. Known as a general-purpose processor.

component. An assembly, device, or piece of equipment that is part of a larger assembly or system.

component design. Design of the individual components in an assembly.

composite analysis. The analysis of composite materials (such as carbon fiber) as they change in the manufacturing process and are used in the final assembly.

compound annual growth rate (CAGR). The average rate of growth compounded over a specified period. The formula used to calculate CAGR is:

$$\left(\frac{\text{Value in period 1+n}}{\text{Value in period 1}}\right)^{\left(\frac{1}{n}\right)} -1$$

computational chemistry/molecular engineering (CCME). The use of computers to model molecular structures, to predict physical properties of molecules, and to design new compounds for specific purposes.

computer-aided design (CAD). Systems that function as tools to expedite mechanical and electronic design. Most CAD systems consist of a graphics computer terminal linked with a computer and a software package with features that aid in design and drafting, keep track of parts, run simulations, and provide illustrated parts or circuit diagrams. Programs complete the layout, geometric transformations, projections, rotations, magnifications, and interval (cross-sectional) views of a part and its relationship with other parts.

computer-aided manufacturing (CAM). The use of computers to program, direct, and control production equipment in the fabrication of manufactured items.

computer-aided software engineering (CASE). A combination of artificial intelligence and structured programming techniques used to aid in the development of large software programs.

computerized energy control system. A system with the resources for producing heat, electricity, and/or power and the capability of running on computers.

computer plotter. A visual display on which a dependent variable is graphed by an automatically controlled pen or pencil or other image development device/technique as a function of one or more variables. See also **plotter.**

computer storage media. The substance upon which data are stored electronically. Media may be flexible disks, rigid disks, tape, or optical disks.

computer storage tape media. Long, thin, flexible tape appropriate for digital magnetic recording and storage of computer data.

computer system. A combination of hardware, software, firmware, and peripheral components that has been assembled to satisfy a particular goal or set of goals.

computer systems performance segments. The following are Dataquest segments for computer systems performance: Level I—low-performance minicomputers, microcomputers, and personal computers; Level II—medium-performance minicomputers and microcomputers, very low end workstations, and high-end personal computers; Level III—low-performance superminis, midrange workstations, and high-performance minicomputers; Level IV—midrange superminis, low-end mainframes, and high-end workstations; Level V—high-performance superminis and midrange mainframes; Level VI—low-end supercomputers and very high performance superminis; and Level VII—supercomputers and high-end mainframes.

computer to PBX interface/digital multiplex interface (CPI/DMI). Two different standards for communication between systems.

computer to plate. A process that merges type and black-and-white images and combines the functions of typesetting, camera photography, and contact platemaking.

conceptual design. An application that supports styling, industrial design, and other design applications emphasizing visualization, aesthetic, and ergonomic considerations.

connector. A device used to join or fasten transistors, establishing a relationship between active and passive devices.

consortium. An international business agreement; an association or society.

consumable. Material that is capable of being consumed.

consumer electronics. The application of electronics in consumer equipment.

consumer integrated circuit (IC). An analog circuit that meets specific consumer end-market applications. These circuits are dedicated to specific applications, such as audio or radio, and would not be used for general purpose.

consumer N.E.C. Consumer equipment not elsewhere classified.

consumer radio. A device used by the general public for communication by electromagnetic waves transmitted through space to produce sound.

consumption. The markets' purchase and use of goods and services, including lease or rental.

contract administration. The management of agreements between a company and its vendors and/or customers.

contract maintenance service. Ongoing repair services based on agreed upon terms and conditions (such as hours of coverage and level of services) as stipulated in a written agreement between the customer and the service provider.

controller. A device or group of devices that serve to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

controller board. A printed circuit board that provides programmable logic that controls the sequence of operations of the functional stages of a peripheral device.

conversion revenue. The revenue generated by changing from an equipment rental contract to a purchase or lease contract.

coordinate measuring machine. Machine used to measure the physical dimensions of a part.

copier. A reproduction device designed to produce replicas of hard-copy originals. Copiers may use either an analog or a digital scanning system.

coprocessor. A logic device that operates in association with a microprocessor to enhance system performance. Coprocessors are not capable of independent operation.

cordless telephony. The transmission of speech or other information via radio, enabling two persons to converse over almost any distance without a connecting cord to a base unit.

corporate publishing. Publishing that supports the main business of an organization or person; printed and published products are produced in the normal course of operations, but not as a primary source of revenue.

corporate supercomputer. An information system priced at more than $2 million. Performance speed is more than 200 mflops; current upper limit is approximately 2 Gflops. Currently used mainly for batch applications, but the trend is toward interactive use. Optimized for very heavy, numerically intensive applications. Requires special environmental controls and cooling techniques.

cost. The expenditure necessary to produce a product.

cost accounting. An application that supports a branch of accounting that is concerned with the collection, determination, and control of costs, particularly those costs associated with producing products or services.

counter/timer circuit. A circuit that receives uniform pulses representing units to be counted and provides a voltage proportional to their frequency.

counting device. A device register or location in computer storage for storing numbers or number representations in a manner that permits these numbers to be increased or decreased by the value of another number or to be changed or reset to zero or to an arbitrary value.

CPE. See **customer premise equipment.**

CPI/DMI. See **computer to PBX interface/digital multiplex interface.**

CPU. See **central processing unit.**

critical dimension (CD). Refers to a line, element, or feature that must be manufactured and controlled to very tight specifications.

CRT. See **cathode ray tube.**

CT2. See **digital cordless telephone.**

custom/contract programming. Programming services that include applications development and software systems conversions.

customer management. A software application used to maintain lists of purchasers of a company's products and services.

customer premise equipment (CPE). Telecommunication equipment used at an end user's location, as compared with use at the local telephone utility.

customer training/education service. Activities designed to instruct customers in the installation, usage, programming, management, and maintenance of hardware, software, and networking products.

custom integrated circuit. A handcrafted, single-user integrated circuit that is customized using a full set of photomasks and requires manual placement and routing. Can be either bipolar or MOS technology process.

CVD. See **chemical vapor deposition.**

D

daisywheel. See **printwheel.**

DAT. See **digital audiotape.**

data acquisition and control. See **real-time data acquisition and control.**

database. The entire body of data that has to do with one or more related subjects. Typically, it consists of a collection of data files stored in a computer system.

database administration. A control program function that provides access to data sets, enforcement of data storage conventions, and regulation of the use of input/output devices.

database management system (DBMS). 1: A software application that provides storage maintenance functions for data stored in sequential, hierarchical, relational, or object format. Example of DBMS products include FOCUS (hierarchical), Ingres (relational), and GBASE (object oriented). 2: A systematic approach to storing, updating, and retrieving information stored as data items, commonly referred to as data files.

database publishing. A system with the main purpose/use of printing the ordered collections of data.

data capture. A process that takes possession or control of information.

data center. A program designed primarily to acquire, analyze, process, store, retrieve, and disseminate one or more types of data.

data center construction/relocation services. Services in which a vendor performs or manages the contracting of site management services including the design and building of a customer's data center and/or the relocation and installation of customer's equipment.

datacom equipment. See **data communications equipment (DCE).**

data communications equipment (DCE). Equipment used for transmitting data between points of origin and reception. It includes products such as modems, statistical multiplexers, T-1 multiplexers, front-end processors, data PBX systems, data network management systems, DSU/CSU equipment, local area networks, and private packet data switching equipment.

data converter. An integrated circuit that changes alternating current to direct current or direct current to alternating current.

data creation. The process of producing or originating information.

data network management system. A product or device that diagnoses, isolates, reinstates, or accumulates information for network components or provides reports and analysis of network performance.

data PBX system. A digital private branch exchange system that allows terminals to switch and contend for computer ports by providing RS-232-C connections. This system does not provide voice switching. Data PBX base units and add-on channels also are included in this classification.

data processing (DP). 1: The preparation of source media that contain data or basic elements of information and the handling of such data according to precise rules of procedures to accomplish such operations as classifying, sorting, calculating, summarizing, recording, and computing. 2: The handling of information in a sequence of reasonable operations.

data service unit (DSU) and channel service unit (CSU). These provide an interface to digital services, such as the AT&T Dataphone Digital Service (DDS).

data storage device. A product designed to hold data until needed. Storage devices are rated by technology (rigid, flexible, and optical disk drives and tape drives), physical size in inches (diameter for rigid and flexible disk drives, width for tape drives), and capacity in bytes. (See also **disk drive, tape drive.**)

data translation. 1: A device that transforms computer information to data from one language to another language without affecting the meaning. 2: To change one binary word to another.

DBMS. See **database management system.**

DCE. See **data communications equipment.**

dealer. 1: Independent businesses selling products under contract to one or more vendors. 2: A product reseller selling to end users. A dealer's primary added value is distribution; secondary added values are service, training, and support.

defibrillator. An electronic instrument used for stopping spontaneous, local contraction of muscle fibers (fibrillation) during a heart attack by applying controlled electronic pulses to the heart muscles.

departmental supercomputer. An information system with price ranging from $100,000 to $2 million. Performance speed ranges from 10 to 200 mflops. Acquired usually by users who need heavy number-crunching capabilities but cannot afford a full-scale supercomputer costing more than $2 million. This computer is a vector processor and thus uses a fundamentally different execution technique from scalar processors, such as mainframe computers and superminicomputers, and is typically configured as a uniprocessor rather than a parallel processor. Typical environment is a "cool room" with a raised floor and/or an ordinary office with no special environmental controls. Number of concurrent users typically ranges from 10 to 50.

deposition. The layering of various chemicals on a wafer. The introduction of dopant to wafers in high-temperature furnaces, chemical vapor deposition (CVD), sputtering, and implant.

deposit/loan management. An application that facilitates the control and earning potential of loans and deposits.

design layout. An initial design process in which the major components and part interfaces are defined.

desk-side personal computer. The desk-side personal computer meets all the qualifications listed for desktop personal computers but is further defined as being a personal computer that has been specifically designed to be placed next to or under the computer operating or desk surface, including foot/stand on bottom of system.

desktop personal computer. The desktop computer classification includes all personal computers except those products that are designed and sold as local area network servers, desk-side personal computers, and all forms of portable computers. Further, these systems are based on keyboard input devices.

desktop publishing. 1: Generalized computing platforms used to perform electronic publishing tasks as one of many applications. 2: The formatting of text and graphics into publishing-quality printed output.

desktop terminal equipment. Telecommunications equipment that is actually used on a desktop. This segment includes products such as single-line telephone equipment and integrated voice/data workstations.

desktop video. Tabletop televised images.

detail drafting. The representation of a part in standard geometric drafting format. This representation will include all part geometry dimension and notations describing mechanical/structural, functional, and material characteristics.

detection and tracking. A real-time application that detects, tracks, and controls various systems and processes. (See also **data acquisition and control.**)

device interface. 1: An electronic device that enables one piece of gear to communicate or control another. 2: A device linking two incompatible devices. 3: A card containing circuits that allow a device to interface with other devices.

diagnostic. 1: Pertaining to the detection, discovery, and further isolation of a malfunction or mistake. 2: Medical applications that aid in diagnosing medical problems. X-rays, CAT scans, and ultrasound are examples.

dialysis. The separation of substances in solutions by means of their unequal diffusion through semipermeable membranes.

diathermy. The therapeutic use of high-frequency electric currents to produce localized heat in body tissue.

dictating/transcribing machine. A device that automatically records human speech onto a form of magnetic tape that can be played back for transcription.

diffusion. 1: A process used in the production of semiconductors that introduces minute amounts of impurities into a substrate material. 2: The movement of particles away from regions of higher concentration caused by the random thermal motion of atoms and molecules to areas of lower concentration.

digital. 1: Pertaining to the class of devices or circuits in which the output varies in discrete steps. 2: Circuitry in which data-carrying signals are restricted to either of two voltage levels, corresponding to logic 1 or 0.

digital access cross-connect system. A system that is composed of multiplex equipment that allows digital lines to be remapped electronically at a different digital level.

digital audiotape (DAT). A 4mm helical scan device (i.e., data recorded at an angle rather than parallel).

digital cordless telephone. Mobile telephone that uses digital radio transmission technology. CT2 is a standard for these devices.

digital design verification. A software application that includes logic simulation, timing analysis, hardware accelerators, hardware modelers, electrical rule checking, mixed signal simulation, transmission line simulators, and signal noise analysis.

digital panel meter. 1: An electrical switchboard or instrument board using continuously variable electrical signals known as analog signals. 2: Digital signals versus analog signals.

digital radiography. Equipment used for electronically detecting the arrival of X-ray photons transmitted through or emitted from an object on various media and converting the sensed analog signals to digital signals.

digital signal processor (DSP). High-speed general-purpose arithmetic unit used for performing complex mathematical operations such as Fourier transforms.

digitizer. A device used for the creation of digital information from alphanumeric or line artwork. More sophisticated digitizers are able to reproduce halftone images and usually are termed scanners.

diode. 1: A semiconductor device used to permit current flow in one direction in a circuit and to inhibit current flow in the other direction.

direct channel. The sale of equipment directly to the end user by a vendor that contributes significant development or integration to the product. Can be either sales of complete systems by turnkey vendors or sales of components of systems sold by individual suppliers.

direct memory access (DMA). A computer feature, set up by the central processing unit (CPU), that provides for high-speed direct data transfer from a peripheral device to the computer memory or to magnetic disk or tape storage units. This feature releases CPU time to perform other procedures. Most DMA devices employ a CPU-cycle-stealing approach.

direct sales force. A sales method that employs a sales force to move a product through the distribution channel by making face-to-face contact with the consumer. Also referred to as outside sales.

direct thermal printer. A printer that uses point-specific heat and heat-sensitive substrate that change color when exposed to heat.

direct write e-beam. Equipment used in semiconductor manufacturing where electron beams are used to create heat that will expose selected areas of a wafer's surface to create a specific design. (See also **lithography.**)

disaster recovery and contingency planning. The planning and implementation of data backup and recovery procedures for a customer's site, based on an analysis of the critical business functions.

discrete component testers. Equipment used to test, check, and monitor the functionality of devices that have a single functional capability per package. These devices include resistors, capacitors, diodes, transistors, and other devices not classified as integrated circuits.

discrete device, security energy management. A circuit complete in itself used in the security and energy industries.

discrete semiconductor. An individually packaged semiconductor component complete in itself, such as a diode or transistor.

disk. 1: A high-capacity random-access storage device. Data are written onto and read from the surfaces of a stack of revolving record-like disks coated with magnetic material. May be fixed or removable. Capacity ranges from 0 to more than 1,000 pages per disk. Referred to as a rigid disk. (See also **random access.**) 2: A random-access magnetic storage medium in the form of a platter or thin wafer. (See also **magnetic disk.**)

disk drive. The unit that controls the reading and writing of disks.

disk drive IC. An analog IC designed for the mass-storage peripheral market. These ICs include read/write amplifiers, data separators, data processors, servo controllers, and motor controllers.

diskette (floppy disk). A record-like disk of magnetically coated Mylar enclosed in a protective square envelope. Holds from 80 to 250 pages of text. Unlike cassettes or cartridges, which store text serially, diskettes are formatted in a random manner, which allows faster access.

disk, magnetic. A storage device containing information recorded on the magnetizable surface of a rotating disk; a magnetic disk storage system is an array of such devices, with associated reading and writing heads mounted on movable arms.

disk operating system (DOS). 1: A computer system based on the Intel 80XX or 80XXX architecture that use the MS/PC-DOS operating system software. 2: An operating system that uses magnetic disks as its primary on-line storage.

dispatching. A software application used to execute the route plans of multiple vehicles, taking real-world events into account.

display peripheral. A component used to address the man-to-machine interface, whereas communication peripherals are used to address the machine-to-machine interface.

distribution. 1: The act or process of distributing. 2: The path by which a product moves from the manufacturer to the ultimate end user. 3: To place or position so as to properly apportion over or throughout an area.

distribution channel. The route taken either by the title to a product or by the physical product itself as it moves from the producer to the ultimate end user. The channel for a product extends to the last consumer who buys it without requesting any significant change in its form. When form is altered and another product emerges, a new channel is started.

distribution frame. A unit for terminating telephone wiring. This unit is typically used for terminating and cross-connecting telephones to the switching system.

distribution method. A method employed to move a product through the distribution channel. It is separate and distinct from the channel in that many channel members may employ the same distribution method.

distributor. A wholesaler that sells to other resellers or end users. The distributor's primary function is to stock the inventory of multiple manufacturers to provide volume buying power to its end users.

DMA. See **direct memory access.**

documentation/drafting. A software application that includes detail drafting, schematics, technical illustration, charts, specifications, bills of materials, training manuals, and other drawing- or drafting-related applications. International standards such as ISO, DIN, or ANSI can be used to define text and feature format.

document management. A documentation system, generally computerized, that links and tracks all documents (drawings, procedures, specifications) related to an assembly or process.

dopant. Atoms of materials such as phosphorus, boron, or arsenic that are diffused into silicon to create resistors, diodes, and transistors.

DOS. See **disk operating system.**

dot matrix printer. A printer that produces images through selective printing of dots chosen from a dot array matrix. Dot matrix printers are segmented by the number of wires in the printhead: 9, 18, or 24 and greater wires. Within these technology segments, additional segments are defined by speed of printing, expressed in characters per second (cps).

DP. See **data processing.**

DRAM. See **dynamic random-access memory.**

DRAM controller. A device that governs DRAMs in some predetermined manner. Holds a process or condition at a desired level or status as determined by comparison of the actual value with the desired value.

drilling programmable machine tool. A machine tool fitted with an end-cutting tool that is rotated with sufficient power to create a hole or enlarge an existing hole in solid material.

drive. See **tape drive.**

drive, disk cartridge. A disk drive using a removable one- or two-platter cartridge; may incorporate a fixed-media capability.

drive, fixed Winchester. A disk drive that includes all fixed-media Winchester drives.

driver information. An electronic device used to assist the driver by giving visual or audio signals for direction. Examples include digital gauges, service reminders, digital clocks, trip/navigation computers, heads-up display, audio annunciator, CRT display, miles-to-empty indicator, and shift indicator.

dry etch. A technique in semiconductor manufacturing used to produce more uniform pattern definition on wafers without immersing the wafer in a liquid bath. Techniques include plasma etching and reactive etching through which gases and energetic ions remove unwanted chemical material from a wafer.

dry silver. A photosensitive film or paper coated with silver compounds that is developed by the application of heat. Popularized by 3M.

dry strip. A process in semiconductor manufacturing for removing photoresist from the wafer after etching. Dry strip comprises barrel strippers and single-wafer strippers.

DSMPU. See **DSP microprocessor.**

DSP. See **digital signal processing.**

DSP microprocessor (DSMPU). A general-purpose, programmable integrated circuit similar to a conventional microprocessor. Its distinction is characterized by the efficiency with which it implements repetitive multiplications and additions required by DSP algorithms.

DSU/CSU. See **data service unit (DSU) and channel service unit (CSU).**

DTMF. See **dual-tone multifrequency signaling.**

dual-disk drive. A system that provides for the use of two disks at the same time.

dual-tone multifrequency signaling (DTMF). A standard signaling method for touch-tone telephones using a combination of two different tones for any button pushed.

duplicator. 1: A small offset printing press that uses a planographic image carrier. These presses are usually capable of one or two colors and are smaller, easier to operate, but less sturdy than offset presses. 2: Machine that requires a special master to make copies but produces copies at a higher rate of speed than copying. It differs from printing in that a direct-image master is used that yields a limited number of copies. Offset, spirit, gelatin hecto, stencil, and sometimes xerography are considered duplicating processes. (See also **copier.**)

dynamic random-access memory (DRAM). A random-access memory device that must be electrically refreshed frequently (many times each second) to maintain information storage. DRAM densities can range from 16K, with approximately 16,000 bits, to 16Mb, with approximately 16 million bits.

E

8mm tape cartridge. A class of tape drives using 8mm cartridges; used in camcorders.

E-1 multiplexer. An electronic device that consolidates or pools multiple digital streams representing voice or data signals onto a single high-speed E-1 data line. An E-1 line operates at 2.048 Mbits/second, a standard within Europe. See **T-1 multiplexer** for U.S. standard.

earth resources application. Studying the earth resources by performing seismic analysis, mapping, and oil field services.

EATE (electronic automatic test equipment). See **automatic test equipment.**

e-beam. A sophisticated system used in semiconductor manufacturing that uses an electron beam for maskmaking or for projecting patterns onto wafers. E-beam equipment allows smaller geometries (typically less than 1 micron) than are possible under other production methods.

ECAE. See **electronic computer-aided engineering.**

ECL. See **emitter-coupled logic.**

EDA. See **electronic design automation.**

education. The process of providing schooling or training by formal instruction and supervised practice.

educational publishing. A system with the main purpose/use of printing materials used for the process of educating.

EEPROM. See **electrically erasable programmable read-only memory.**

elapsed time meter. An electronic measuring instrument that counts the actual time taken to observe a recurring event.

electrically erasable programmable read-only memory (EEPROM). A nonvolatile memory device that can be erased and programmed electrically.

electrocardiograph. An instrument used to graphically record electrical manifestations of heart activity obtained from the body's surface.

electroencephalograph. An instrument used to graphically record electrical discharges of the cerebral cortex by electrodes attached to the surface of the scalp.

electronic calculator. A product with components that perform calculations and digitally display results. (See also **calculator.**)

electronic computer-aided engineering (ECAE). Computer-aided tools used in the engineering or design phase of electronic products (as opposed to the physical layout phase of the product). Examples of ECAE applications are schematic capture, simulation, and test pattern creation. ECAE systems are used most often by electrical engineers.

electronic design automation (EDA). Computer-based tools that are used to automate the process of designing an electronic product, including boards, ICs, and systems. Formerly referred to as ECAD.

electronic forms generation. The process of automatically producing documents requesting information.

electronic game. Home electronic games that typically are attached to television receivers.

electronic keyboard. A keyboard on which characters are generated or encoded by electronic means, usually by contact closure, as opposed to mechanical linkages. Electronic keyboards have a different feel, and some have a built-in artificial bottoming feel and/or audible click to assure the operator a key actually has been depressed.

electronic mail (e-mail). An application that supports the movement of information between users connected to a networked computer system.

electronic musical instrument. An instrument that allows the transmission of musical sound by the use of transistors.

electronic publishing. Fully integrated automation of the printing procedure.

electronic warfare (EW). Electronic operations between enemies. Includes warning receivers, jammers, assorted electronic countermeasure systems, and associated test equipment.

electrostatic plotter. A plotter using the corona from high voltages applied to needles or nibs to produce shaped electrostatic charges on paper; toner is attracted to the charged area, and heat and pressure are used to fuse the toner to the paper.

elementary/secondary school. A regular school, defined as schools that are part of state and local school systems and most nonprofit private elementary/secondary schools, both religiously affiliated and nonsectarian.

e-mail. See **electronic mail.**

emerging technology. A technology that is not in widespread use and that appears to have potential for widespread acceptance.

emitter-coupled logic (ECL). 1: A form of integrated circuit used to implement very high speed logic functions. 2: The emitters of the input logic transistors are coupled to the emitter of a reference transistor.

employees. All civilians, who, during a reference time period, did any work for pay or profit (minimum of an hour's work) or worked 15 hours or more as unpaid workers in a family enterprise.

encryption. Process of encoding data, voice, or video transmissions for security purposes.

encryption unit. A device that encodes/decodes data, voice, or video transmissions for security purposes.

end user. The final purchaser of a finished product.

end-user average selling price. The average price that a user pays for a product inclusive of channel markups and discounts.

end-user revenue. End-user average selling price multiplied by shipment quantity.

enhanced service. Equipment and service charges associated with enhanced data communication networks, which may include protocol, electronic mail, or facsimile.

enrollment. In education, the total number of students registered in a given school unit at a given time, generally in the fall of a year.

entertainment system. 1: Electronic equipment used for amusement or pastime and not intended to, but may, increase productivity or skill. Examples include: radio, seek/scan, graphic equalizer, power amplifiers, noise reduction, cellular telephone, optical disk, CB radio, and digital audiotape. 2: A computer application to keep or hold the mind, something directing or engaging.

entry-level workstation. A low-cost computer workstation, priced less than $15,000. It is targeted at the end user who is sensitive to price. This segment tends to be dominated by occasional users who are not paid for producing documents on their system. Entry-level workstations mainly run 2-dimensional graphics and have a rating of less than 12 mips and a rating of 0.5 to 1.5 mflops.

environment. Where a product is used ultimately.

epitaxial wafer. Single-crystal silicon grown on a crystalline silicon substrate.

EPROM. See **erasable programmable read-only memory.**

equipment/maintenance management. A software application that assists in the management of equipment and the respective maintenance requirements and contracts. May also calculate depreciation.

erasable programmable read-only memory (EPROM). A nonvolatile memory device that can be erased by ultraviolet (UV) light and reprogrammed by the user.

ET. See **typewriter.**

etch-and-clean equipment. Equipment used in semiconductor manufacturing to remove and clean material from wafers.

EW. See **electronic warfare.**

expenditure. Charges incurred, whether paid or unpaid, which are presumed to benefit the current fiscal year. These include all charges for current outlays plus capital outlays and interest.

export. The delivery of products to a foreign country for the purpose of trade or sale.

F

fab. Abbreviation for wafer fabrication. See **fabrication.**

fabrication. A manufacturing operation that makes components rather than assemblies.

fabric ribbon. Fabric ribbons are struck repeatedly by the print mechanism until all the ink is depleted. Such ribbons are used commonly for general-purpose printing and are the most economical and durable ribbon substrate. Most fabric ribbons are made of nylon and are available in several forms, e.g., cartridge or web ribbon.

facilities design/management. A software application used to lay out, inventory, and manage assets (such as personnel, space, equipment, and utilities) within a building or geographic service area.

facilities management service. The responsibility of providing ongoing administration of a data processing or communications facility by a vendor.

facility planning and simulation. A facility system model is exercised and refined through a series of simulation steps until a detailed, optimum configuration is reached.

facsimile (fax). 1: An electronic device that uses telephone lines to transmit documents to and receive documents from a second facsimile machine. 2: An exact copy or the process of transmitting printed matter or still pictures by a system of either telephones, telegraph, or radio for reproduction.

factory automation equipment. Equipment that includes various types of capital equipment that are automated and used throughout a manufacturing facility.

factory average selling price. The average price per unit that is paid for a product. This figure takes into account discounts given to the distribution channel and multiple-purchase discounts.

factory revenue. The amount of money received by a manufacturer for its goods.

fast packet switch. A packet-switching technique in which small packets are switched at high-speed using hardware for the transport of voice, data, and video.

fast SRAM. A static RAM device that runs at speeds less than 70 nanoseconds. (See also **static random-access memory.**)

fatigue. In electronics, the degradation of the performance of materials, parts, or circuits with time.

fault detection, fault management, and adaptive control. A software application that determines if a manufacturing system or a process is functioning or performing within control limits. Fault management and adaptive control is a control method in which control parameters are continuously and automatically adjusted in response to measured process variables to achieve near-optimum performance.

fax. See **facsimile.**

FDDI. See **fiber distributed data interface.**

federal government. A form of government in which power is distributed between a central authority and a number of constituent territorial units.

FERRAM. See **ferroelectric random-access memory.**

ferroelectric random-access memory (FERRAM). A nonvolatile, radiation-hard, fast read/write memory that can store data over long periods of time without power.

fiber distributed data interface (FDDI). A standard for high-speed packet switched data.

fiber optic. 1: The technique of transmitting light through long, thin, flexible fibers of glass, plastic, or other transparent material. Bundles of fiber can transmit complete images. 2: A technique used in electromagnetic wave propagation in which infrared and visible light frequencies are transmitted by a light-emitting diode (LED) or a laser through a low-loss glass fiber. This method is used in very high frequency (VHF) radiation transmission.

field-programmable gate array (FPGA). An integrated circuit incorporating an array of programmable logic elements that are not preconnected. Interconnections between the various elements are user programmable and consist of predetermined levels of interconnect that can be connected to, or disconnected from, other interconnect lines as defined by the user. Can be of either bipolar or MOS technology.

field-programmable logic array (FPLA). A logic array in which programming is accomplished by blowing fuse links or shorting base-emitter junctions.

film ribbon. See **single-strike ribbon** or **multistrike ribbon.**

finance. An application to support the management of money or other liquid resources and their respective management within an organization.

fixed asset. An application that supports the management of an organization's fixed assets, which are a capital asset that cannot be readily liquidated, such as plant, land, equipment, and long-term investments. Management of expected costs based on a specific level of production or other activity.

fixed disk. A memory disk that cannot be removed from the read/write device, as opposed to a removable hard disk, diskette, or magnetic tape.

fixed media rigid disk drive. A fixed media rigid disk drive has the platter enclosed in a housing that is not designed to be accessible to the user.

fixture design. The design of a variety of structural aids that hold the component or assembly during the manufacturing process.

flexible disk. See **flexible disk computer storage media.**

flexible disk computer storage media. A flexible disk made of a 3-mil polyester substrate coated with gamma ferric iron oxide particles dispersed in an epoxy binder and encased in a vinyl jacket. These are commonly supplied in 3.5- or 5.25-inch diameters.

flexible manufacturing system programmable machine tool. A manufacturing system that typically consists of a computer-integrated group of numerical control (NC) machines or workstations linked with material transfer devices for complete automatic processing of differing product parts or the assembly of these parts into different units.

floating-point coprocessor. A separate microprocessor used in the efficient handling of floating-point operations.

floppy (flexible) disk. A small, thin, electromagnetic media used for storing digital information.

floppy disk controller. A device controlling the storage and retrieval of data from a floppy disk.

font generation. Process whereby typeface and size is selected.

font management. The understanding, use, and control of fonts or typefaces that are displayed on a terminal or monitor, or printed out on a device such as a printer, plotter, or typesetter. Font management requires the understanding of the physical location of where the fonts reside—whether in diskette, hard disk, ROM, RAM, card, or cartridge. It also requires the knowledge of the type of font—whether bit map or outline, scalable or fixed point and pitch—and the applications and print system capability to address and place the fonts accurately on the screen or printing media.

forecasting. To estimate in advance or anticipate; to predict future events, trends, business conditions, etc.

form. 1: Any material that has been printed for the primary purpose of facilitating the entry of written information by hand or machine. A form has repetitive information printed in fixed positions. Blank paper may be included, especially if it is continuous and has undergone some alteration such as punching or perforating to facilitate manual or machine entries. 2: Allows the user to graphically design a form for publication—may include data entry and database capabilities.

four-year institution. An institution legally authorized to offer and that does offer at least a four-year program of college-level studies wholly or principally creditable toward a baccalaureate degree.

FPGA. See **field-programmable gate array.**

FPLA. See **field-programmable logic array.**

front-end processor. A computer-based product expressly designed to relieve host computers of certain communications processing tasks. Included are remote concentrators that are not attached directly to a host computer. This segment does not include general-purpose computer systems functioning as front-end processors.

full-color copier. A reproductive device that can recognize the full range of colors on an original and reproduce them using the three subtractive primary colors and produce a full-color copy.

fully formed printer. A printer that prints fully formed characters by applying pressure on or to the paper and obtaining the characters from a wheel, band, type train, or drum. Such devices can be serial, fully formed printers and line, fully formed printers.

functional design. An application that supports component design, assembly verification, linkage and mechanism design, and other detail or functional design activities.

functional PCB tester. An equipment tester that accesses the normal input/output interface of the unit under test (UUT). Generally, this consists of the edge-connector pins, plus any special interface that may have been provided for testing. Provides stimulus patterns and measurement verification that the UUT actually operates correctly.

funds transfer terminal. A machine used by financial institutions and designed to perform many of the banking functions performed by human tellers. (See also **automated teller machine.**)

G

GaAs. See **gallium arsenide semiconductor.**

GaAs analog IC. There are two overlapping subsets in this segment; analog products and monolithic microwave integrated circuits (MMICs). Analog products have output that are linearly proportional to their inputs and function at a varying range of frequencies across the spectrum, depending on particular device design. MMICs operate in the microwave frequency spectrum (above 3 GHz).

gallium arsenide semiconductor (GaAs). A compound of gallium and arsenic used as a semiconductor material. GaAs devices are relatively expensive devices exhibiting very low internal noise and very high speed.

game. A software application or activity engaged in for diversion or amusement.

gas. A consumable material used throughout the fabrication of semiconductor devices. Includes both bulk and specialty gases.

gate array. 1: An ASIC device that is customized using the final layers of interconnect. (Included in this category are generic or base wafers that include embedded functions such as static RAM.) May be of either bipolar or MOS process technology.

gateway. Equipment or conceptual point that connects two otherwise incompatible systems. (See also **protocol converter.**)

general analysis. A software application designed to solve various technical problems and to further research subjects. The analysis is usually mathematical in nature and performed by scientists, physicists, chemists, biologists, and engineers.

general ledger. A software application that supports the business function of entering accounting transactions and their subsequent transferring and reporting.

general operating system. An operating system with use not restricted to a particular type of computer or a specialized application.

general productivity. A software application that is used to enhance productivity within general disciplines.

general-purpose computer system. A computer system that is not configured for a specific purpose but rather for a general application. This category includes supercomputers, minisupercomputers, parallel processor computers, mainframes, workstations, and the like.

general-purpose input/output (I/O) circuit. A circuit that permits a system to communicate via a wide variety of input/output (I/O) devices with the outside world, which can include printers, modems, and monitors.

general test equipment. Test equipment not included under the definition of automatic test equipment (ATE).

geographic information system (GIS). A mapping software application that contains the functions of cartographic software and also allows data analysis through Boolean operations on multiple data layers.

geophysical instrument. An instrument used to observe and measure the physics of the earth and its environment.

GIS. See **geographic information system.**

global positioning system. Equipment that calculates location based on one of several technologies such as radio or internal navigation.

golf ball. A type of print element invented by IBM for use in the IBM Selectric typewriter. It is a round, metal element with raised characters.

government. The organization, machinery, or agency through which a political unit exercises authority and performs functions and which is usually classified according to the power within it. Includes the executive, legislative, judicial, administrative, and regulatory functions.

graphic design art. A method of applied art used to form a visual end product that conveys information. Methods include drawing, painting, photography, printing, and bookmaking.

graphics. Software that permits the pictorial representation of information at a screen or printer. Early graphics packages showed bar charts or line graphs on a character-based terminal by placing characters such as + or * on grids created by repetitions of characters such as | and or _ . The term has come to apply usually to bit-mapped graphics, which are capable of processing images, freehand input, and icons on a pixel-by-pixel basis. Examples of graphics software include MacDraw and MacPaint.

graphics/animation/imaging. A software graphics application used by scientists and engineers to process and display complex technical data. It also includes applications that use computers to generate or manipulate graphics images that are the end product, i.e., cartoons.

graphics board. An add-on board connected to the bus that provides video capabilities for a personal computer.

graphics controller. A device that governs information flow used to create visual images of data.

graphics draw/paint. A software application that creates, retrieves, modifies, and prints graphic images.

graphics supercomputer. The performance of mips, mflops, transforms per second, and shaded polygons per second distinguishes graphics supercomputers from superworkstations. Performance ratings range from 20 to 40 mips and 16 to 40 mflops. The best distinction between graphics supercomputers and superworkstations is the graphics performance ratings, 100K to 600K 3-D vector transforms/second and 25K to 150K Gouraud-shaded polygons/second. The average price ranges from $75,000 to $150,000.

graphics terminal. A display terminal that provides graphical presentation of information to the operator. 1: Data conversion graphics terminals support the use of graphics to summarize or otherwise relate discrete data that were not originally graphics data. 2: Concept design graphics terminals support graphics displays that help realize accurate images of ideas conceived in the human mind. 3: Imaging graphics terminals display a real image, visible or nonvisible, that was digitized to allow enhancements or data extraction.

grinding programmable machine tool. A standalone machine with expanding use of computer numerical control (CNC) and with advance efforts to incorporate grinders into flexible, automated systems. Creep-feed is a type of grinding technology.

gross lease additions. The total volume of new equipment leases.

H

hand-held personal computer. The hand-held personal computer is a less-than-2-pound, fully functional personal computer. To be considered a hand-held personal computer, units must operate using a fully implemented version of MS-DOS and be able to run some of the shrink-wrapped MS-DOS-based applications. These units are expected to have a subsize keyboard and utilize nonstandard mass storage devices. The criterion for inclusion in this classification is that the device may be held in one hand using the other hand for data entry via the included keyboard. They are fully battery powered units.

hard disk. See **rigid disk.**

hard disk controller. A device that controls the storage and retrieval of data from a user's hard disk drive.

hardware. Electronic equipment, systems, or peripheral devices.

hardware maintenance service. Remedial repair services for equipment, systems, and peripherals. Hardware maintenance can include on-site support, telephone/remote support, preventive maintenance, and other activities necessary to maintain hardware operation.

HDTV. See **high-definition television.**

head; manganese-zinc, landable. A type of head used in sealed fixed-media drives where heads land on the lubricated media surface and use hot-pressed manganese-zinc pole pieces.

health care. An environment or industry that includes establishments primarily engaged in providing medical, surgical, and other health services.

helical scan tape drive. A storage tape drive that records data on an angle rather than parallel. Tape dimensions can be 4mm, 8mm, 13mm, or 19mm. Segments of this category are VHS, DAT, 8mm, and other. (See also **VHS, DAT.**)

high-definition television (HDTV). A television standard with high-resolution, digitized images; wide, theater-like screen; and digital stereo sound. Requires a broader video bandwidth to accommodate increased picture transmission.

higher education. Study beyond secondary school at an institution that offers programs terminating in an associate, baccalaureate, or higher degree.

high school. A secondary school offering the final years of high school work necessary for graduation, usually including grades 10, 11, and 12 or grades 9, 10, 11, and 12.

home. The usual place of residence. A home-based business is an enterprise producing goods or services that is operated in or from the home.

horizontal-turning programmable machine tool. The tool of a machine that holds a piece along the horizontal axis for a certain function to be performed such as cutting, boring, or drilling.

host/vendor independent terminal. A host-independent display terminal produced by an independent manufacturer. It may operate in either character or block mode. The independent manufacturer does not supply mainframes or minicomputers to which its display terminals may attach. Not included is any terminal that is from an independent manufacturer and that is protocol-specific to either a minicomputer-based or a non-IBM, protocol-specific terminal.

hotels and lodging. An environment or industry that includes commercial and noncommercial establishments engaged in furnishing lodging, or lodging and meals, and camping space and camping facilities.

household. The set of persons occupying a housing unit. Thus, counts or estimates of households, householders, and occupied housing units are always defined the same.

hybrid. 1: Made up of several different components. 2: A hybrid integrated circuit is made by putting several integrated circuit die and/or passive components on a ceramic substrate with a metal pattern. 3: A substrate containing more than one component. The substrate consists of multiple ceramic layers and also can contain multiple packages. 4: A device in a speech transmission system consisting of transformers that convert a two-wire channel into a four-wire channel, thus creating a separate wire pair for each direction of transmission.

hybrid analog IC. An analog IC that combines one or more semiconductor chips with other technologies, such as chip capacitors and film resistors, on a single substrate.

hydrogen. A chemical element used for hydrofining for sulfuration of petroleum products or to reduce metallic oxide ores.

I

IBM 3270 protocol terminal. A terminal that is protocol-specific to IBM's 3270 Information Display System. Included is any IBM 3270-type terminal or 3270-compatible terminal produced by another manufacturer. A terminal that can provide the appearance of a 3270 device when used with a protocol converter is **not** included.

IBM/VM/MVS. An IBM standard multiuser operating system.

IC. See **integrated circuit.**

IC layout and verification. A software application tool that is used to create and validate physical implementations of an integrated circuit (IC). IC layout tools include polygon editors for creating geometric data, symbolic editors, placement and routing (gate array, cell, and block), and DRC/ERC verification tools.

IDVT. See **integrated voice/data workstation.**

if-sold revenue. The amount of money paid for products based on list price. List price does not take into account discounts or markups.

if-sold value. A measure that reflects unit shipments multiplied by list price.

IGBT. See **insulated gate bipolar transistor.**

illustration software. An object-oriented software program that allows the user to create original artwork consisting of lines, arcs, and other mathematically generated geometric objects. (Line art is a term sometimes used to describe the results of illustration software.) Some illustration software can perform raster-to-vector conversion by allowing users to trace over scanned raster art. This trace can occur on screen or on a graphics tablet. Illustration software usually offers raster-fill patterns that extend to cover an area in an illustration bounded by geometric objects.

image communication. Equipment used in a business or residence to transmit image and text. Facsimile equipment, video teleconferencing, telex, and videotex are included in this classification.

image-editing software. A software program that allows a user to modify existing artwork existing in raster format. This art may have been scanned or captured as analog signal data and converted to digital data. Image-editing software can handle binary data, in which case it is called print software; or it can handle grey-scale and/or color data, in which case it is called image-retouching software.

image generation. Synonymous with image synthesis and equivalent to the historical use of graphics.

image management. The process of directing, controlling, or handling something that closely resembles another.

image processing. A series of actions, changes, or functions that bring about a particular result for something that resembles another.

imaging. See **graphics/animation/imaging.**

imaging subsystem. A peripheral device that does not possess video display terminal (VDT) functionality, but acts as output devices for the display of graphics and/or image data.

impact printer. A family of printers that use direct impression impact of a type bar, type head, or matrix pin to exert pressure against a paper ribbon and a platen to create a character.

import. The supply of products from a foreign country for the purpose of trade or sale.

in-circuit PCB tester. An equipment tester that incorporates pin electronics (drivers and receivers) that verify the functionality of each part on an assembled circuit board. Verifies each component's parameter and limited functionality.

indirect channel. A variety of distribution channels in which product is brought to the end user. It includes value-added resellers (VARs) and original equipment manufacturers (OEMs).

inductor. A passive component that stores energy in the form of a magnetic field (flux) around a core body.

industrial design. A process that integrates the design tools defining the style and functional aspects of the total design.

industrial electronic equipment. Electronic equipment used in a manufacturing environment or industry.

industrial marking. A specified format on media that is recognized by electronic or visual means. Examples are the printing and use of forms, bar codes, ticket printing (lottery and airline, for example), and labels.

industry. A collective term for many of the productive activities of a nation or other large group. A collective term in which a number of firms produce the same kind of commodity or service or are engaged in the same kind of operation.

INEWS. See **integrated electronic warfare system.**

information center. A center designed specifically for storing, processing, and removing information for dissemination at regular intervals, on demand or selectively, according to the user's needs.

information resource management. A program that works with definitions, uses, values, and distribution of information that is processed by a user and handled by a computer system.

infrared. Those radiations, such as are emitted by a hot body, with wavelengths just beyond the red end of the visible spectrum. Wavelengths longer than those of visible light and shorter than those of radio waves.

ink jet. An image-producing process currently used in electronic printers, plotters, and full-color copiers that uses piezoelectric technology to expel a very small droplet of liquid ink through nozzles onto the output paper.

ink jet printer. A nonimpact printing method that uses ink droplets to form a printed image. This technology usually is classified by the nature of the drop stream; two major categories are continuous flow and drop-on-demand.

input/output (I/O) device. 1: Equipment used to communicate with a computer. 2: A general term applied to equipment used in communicating with a computer and the data involved in the computer. 3: The transmission of information from an external source to a computer or vice versa.

input/output (I/O) ratio. 1: A ratio of the value of a resource input to the value of the final product output, typically expressed as a percentage. 2: A measure of throughput for a computer system.

inspection. The process of testing or measuring an object or process by remote sensing in imaging technology.

installed base. The total number of product in active, day-to-day use.

institutional support. In higher education, the expenditures that include day-to-day operational support for colleges, excluding expenditures for physical plant operations. Examples of institutional support include general administrative services; executive direction; planning, legal and fiscal operations; and community relations.

instruction. In higher education, expenditures of the colleges, schools, departments, and other instructional divisions of higher education institutions and expenditures for departmental research and public service that are not separately budgeted. Includes expenditures for both credit and noncredit activities. Excludes expenditures for academic administration where the primary function is administration.

instructional. Products used to increase the understanding (either problem-solving or self-improvement) of a specific subject matter. The primary focus of these products is the imparting of knowledge or skills to the user.

instructional staff. In education, the number of full-time equivalent positions, not the number of different individuals occupying the positions during the school year.

instrumentation. Designing, manufacturing, and using instruments for detection, observation, measurement, automatic control, automatic computation, communication, or data processing.

insulated gate. A gate that is separated from other conducting surfaces through a nonconducting material.

insulated gate bipolar transistor (IGBT). A power transistor that has the insulated gate properties of a MOS transistor with the low saturation ON voltage of a bipolar transistor.

insurance. An environment or industry that covers carriers of all types of insurance and insurance agents and brokers.

integrated application. A software application that combines several functions into one software package, which may include word processing, database management, and spreadsheet capabilities but is not exclusive to these functions. Data must be able to be shared among these functions.

integrated circuit (IC). A combination of interconnected semiconductor elements inseparably associated on or within a continuous substrate. Complete module of components manufactured as single, solid units made by either a film deposition or a diffusion process.

integrated electronic warfare system (INEWS). A combination of interconnected circuit elements associated on or within a continuous substrate to produce integrated systems used specifically in military operations.

Integrated Services Digital Network (ISDN). A digital network having the capabilities of simultaneous signaling, switching, and transporting over a single facility. A new worldwide telephone standard that will make it easier to communicate information such as voice, data, and video over phone lines.

integrating and totalizing meter for gas and liquid. A meter that registers consumption and positive displacement, including meters, fuel dispenser meters, and gas meters.

integrated voice/data workstation (IDVT). Terminal that possesses both telecommunications and computational capability.

integration. Integration of data types can be achieved using page composition and pagination applications.

intelligent terminal. An interactive terminal in which part of the processing is accomplished by a small computer or processor contained in the terminal itself. This type of terminal is sometimes referred to as a smart interactive terminal. Such a terminal has the following characteristics: (1) self-contained storage; (2) user interaction—with the terminal or the central computer; (3) stored program; (4) part of processing accomplished in the terminal; (5) on-line via communications line with large central computer and database; (6) human-oriented input—such as keyboard and light pen; and (7) human-oriented output—such as serial printer and CRT.

interactive language. Within a system, a human user or device serviced by the computer can communicate directly with the operating program or language.

intercom systems. A system that provides internal communication, allowing calling to be confined to inside the system. In most cases, key systems provide the intercom lines that allow quick communication between stations on the key system.

interconnect and bare-board tester. Equipment designed to check, monitor, and identify printed circuit boards for electrical connectivity and detect manufacturing defects.

interface IC. An analog IC that is dedicated to interfacing digital information (in bits) with external nonsemiconductor devices such as displays, lines, solenoids, and other peripheral devices.

internal transfer. The process of conveying or moving goods and services from the producer within a company.

international telephone service. Telecommunication services between offices or stations in different states or between mobile stations that are not in the same state or are subject to different states.

interrupt controller. 1: An internal controller chip that can break into the normal flow process of a routine such that the flow can be resumed from that point at a later specified time. 2: A condition or event that temporarily suspends normal processing operations. 3: A temporary disruption of the normal operation of a routine by a special signal from the computer. 4: Copying technology: A feature that allows a job to be stopped to allow another job to be run without the loss of programming for the first job.

intrusion-detection alarm system. A warning system used to detect when someone or something has intruded in a specified area. (See also **alarm system.**)

inventory. Items used in the process of manufacturing a product and distributing it to the end user. Inventory can be stored at a stock point or at a work-in-process location. Inventory may consist of finished goods, parts of intermediate items, work-in-process, or raw materials.

inventory and distribution management. An application that monitors the status of materials at all levels of production, including receipts, issues, and inventory balances. It identifies both unit quantities and dollar values and provides essential input to both the general ledger for cost accounting and the production planning modules.

I/O device. See **input/output device.**

ion implantation. The use of an ion beam to bombard a silicon wafer, altering the concentrations of p-type and n-type material. This method of doping allows for very precise control of the device parameters. This process introduces dopant atoms into the surface of silicon wafers and accelerates them so that they bombard the wafer, causing them to penetrate the exposed portions of the wafer.

ion milling. A technique in semiconductor manufacturing in which a beam of charged particles is used to remove material from a wafer.

I/O ratio. See **input/output ratio.**

IR. See **infrared.**

ISDN. See **Integrated Services Digital Network.**

IVR. See **interactive voice response system.**

J

joint venture. Two or more companies providing capital or other resources to invest or make available for investment in the ownership of a new enterprise.

K

keyboard. An input device that allows an operator to enter alphanumeric characters through a typewriter-style key arrangement augmented with special function keys—manual operation of keys will generate electrical signals or cause tape to be punched, or both.

keyboard controller. A device that governs the functions of a keyboard transmitting a command to do something within a system.

key entry equipment. Data entry equipment such as key disk, key tape, or keypunch equipment.

key telephone system. A customer premises telephone switching system that allows telephones to interface to the public telephone central exchange or office without using an access code. This category includes the electromechanical 1A2 and electronic segments.

L

label. 1: A set of symbols used to identify or describe an item, record, message, or file. May be the same as the address in storage. 2: Matter attached to a document to identify or provide information. 3: To assign a symbol, acronym, or word as a means of identification to create a specialized record or filing handle. 4: A descriptive or identifying word or phrase. 5: To address, using self-adhesive addressing labels.

laboratory. 1: A software application that involves the use of computers inside analytical instruments and in linking these instruments together (instrumentation automation). Mass spectrometers and blood/gas analyzers are examples. 2: A place equipped for experimental study in a science or for testing and analysis.

laboratory and scientific apparatus. Any instrument, material, or equipment designed for a specific operation or particular use in the laboratory.

LAN. See **local area network.**

LAN-based e-mail. A software application that enables users of a local area network (LAN) to send and receive textual data. Some LAN-based e-mail software can send and receive computer files and graphic images.

language. In software, a set of commands that permits the programmer to perform arithmetic functions on data and/or give commands to specific hardware components of the computer system, such as the printer, terminals, disk, or memory. Statements in languages are generally required to be performed in a fixed order, although the order may be affected by loops and branches in the program and the values of parameters that control the looping and branching. Examples of low-level languages are C and assembler; high-level, or third-generation, languages include FORTRAN, COBOL, BASIC, and PL/1.

language editor. A set of computer commands forming code to edit files. May involve deleting undesired information, selecting desired information, inserting invariant symbols, and applying standard processes.

laptop A/C. The laptop A/C units reflect the standard laptop design, i.e., clamshell-style case with the display mounted in the top portion of the shell and covering the keyboard until the unit is opened for use. These units, like transportables, are designed to be easily moved from place to place but operate only on A/C power and do not contain batteries of any kind.

laptop D/C. The laptop D/C units are identical in style to the laptop A/C units except that they are powered by batteries and can be operated without direct connection to A/C power lines. Some of these laptop D/C units have a combination of battery- and A/C-power capability.

laptop personal computer. The laptop-case style is conducive to operation on the user's lap and is designed to be used in areas where space is restricted. This case style is referred to as the clamshell-type of system, with the display screen mounted in the top of the unit in such a way as to cover the keyboard when closed and be at the proper viewing angle in relationship to the keyboard when opened and ready for operation. This unit is completely self-contained and can be carried as a single unit that includes the keyboard, display, mass storage, and main system unit.

large-format plotter. This plotter uses media engineering size C (17 x 22 inches) or larger and corresponding metric sizes. (See also **plotter.**)

laser (light amplification by stimulated emission of radiation). 1: A device that transmits an extremely narrow and coherent beam of electromagnetic energy in the visible light spectrum. 2: A laser that operates at optical frequencies. In communications, lasers may be amplitude-modulated and used to carry speech information that is received by a light beam detector.

laser diode. A laser diode is a laser that is constructed with a semiconductor material. Many III-V semiconducting materials can be made to emit coherent light, creating a laser.

laser plotter. A device that produces an inscribed visual display of the variation of dependent variable as a function of one or more variables by the use of intense coherent beams of light.

laser printer. A type of nonimpact printer that combines laser beams and electrophotographic technology to form images on paper.

laser system. Any electronic device or system that is actuated by beams of coherent visible and infrared light to accomplish a task.

LCD. See **liquid crystal display.**

learning. An application that assists the user in learning. The subject can range from classic school subjects to games, art, and languages.

lease. A contract by which one conveys equipment, facilities, or property for terms specified.

lease accounting. An application that supports the management of leases.

leased circuit. A service offering that provides a customer with permanent (rather than dialed) connections to all points on the circuit for the duration of a contract.

lease/rental conversion. The volume of contractual conversions between rental and lease options.

LED. See **light-emitting diode.**

library management. A software application that supports the administration of a library, including cataloging.

LIDM. See **line, impact, dot matrix.**

LIFF. See **line, impact, fully formed.**

light communication system. Electromagnetic radiation of a wavelength originating at one place and reproduced at a distant point.

light-emitting diode (LED). A pinhead-size device with a pn junction formed from combinations of gallium, arsenic, and phosphorus. Light emission is the result of hole-electron recombinations that take place near the junction of the p-doped and n-doped regions. As the electrons in the n region of the diode travel through the area near the junction, they recombine with a hole. As a result of this recombination between an electron and atom, light in the form of photons is produced. The wavelength of color of the light is determined by the energy level.

light-emitting display. Light-emitting diodes grouped together in a matrix of dots to form characters.

linear array/ASIC. An ASIC that is purely analog.

linear IC. An IC that is purely analog; both inputs and outputs are analog signals. Sometimes, linear and analog ICs are used interchangeably. Dataquest uses linear as an analog-only segment of the analog market (mixed signal analog/digital is the other segment).

line conditioner. Equipment that changes/enhances the transmission characteristics of a circuit.

line, impact, dot matrix (LIDM). A printer that prints one line of dots at a time using an array of elements in a printhead.

line, impact, fully formed (LIFF). A printer that creates one line of characters at a time by placing characters—from a band, type train, or drum—on the paper by the pressure of an impact mechanism (hammer).

line, nonimpact, thermal transfer (LNTT). A printer that prints a line at a time, using an electrically heated element to produce images.

line printer. A printer that usually prints one line at a time at a higher speed than a character printer. Typical line printers use a drum, chain, or train of print elements and have a hammer for each print position in the line. They usually have a buffer to hold one print line. Line printers are segmented by technology (dot matrix, fully formed, thermal) and by speed, expressed in lines per minute (lpm).

linkage mechanism. An assembly of components, with two or more movable parts usually providing some means of power, control, or fastening application.

liquid crystal display (LCD). A high-contrast, black-on-white display screen that uses closely spaced crystal segments on a square dot matrix. The crystal segments butt together to form solid characters. A liquid crystal hermetically sealed between two glass plates.

list price. The price of a product as indicated in the seller's price book. This figure is usually quantity one and is synonymous with manufacturer's suggested retail price.

lithography. 1: A printing process that prints from a planographic image on a printing plate. Lithographic presses are configured as sheetfed and web presses, depending on the format of the paper used. 2: A technique used in semiconductor manufacturing in which a silicon wafer is coated uniformly with a radiation-sensitive film (the resist) and an exposing source illuminates selected areas of the wafer's surface through a mask or template for a particular design.

LNTT. See **line, nonimpact, thermal transfer.**

local area network (LAN). The hardware, software, and peripherals that enable connection of a device to a cable-based network system that serves a building or a campus environment. Excluded are connections that are point-to-point, or go through PBXs or data PBXs. Ethernet and Token-Ring are popular LAN technologies.

local government. The political unit or organization governing counties, municipalities, townships, school districts, and numerous kinds of special districts.

local loop. The portion of the telecommunications system that connects the customer's equipment with the local telephone company's network.

local telephone service. A service that includes message telecommunications services, private line services, wide-area telecommunications services (WATS), and centrex services.

logic circuit. 1: A circuit (usually electronic) that provides an input-output relationship corresponding to a Boolean-algebra logic function. 2: An electronic device or devices used to govern a particular sequence of operations in a given system. 3: Circuits that perform basic logic decisions *and/or/not,* used widely for arithmetic and computing functions. Circuits can be of either bipolar or MOS technology.

long distance telephone service. The revenue generated by all long distance carriers for interstate and intrastate long distance telephone services.

M

machining-center programmable machining tool. A machine that is designed to fabricate a complete or near complete part of a single machine, with machining centers that perform a number of different operations in a single setup.

machining robot system. A robot that can pick up parts and place them in a new location. Parts are usually moved in and out of machinery or transferred from station to station.

mag card/mag tape. A tape or card that is coated or impregnated with magnetic material, on which information may be stored in the form of coded polarized spots.

magnetic. The effects of magnetism/flux on the system.

magnetic disk. 1: A random-access storage device consisting of magnetically coated disks accessible to a reading and writing arm, similar to an automatic record player. Data are stored on the surface of each disk as small, magnetized spots arranged in circular tracks around the disk. The arm is moved mechanically to the desired disk and then to the desired track on that disk. 2: A flat, circular plate with a magnetic surface on which data can be stored by selective magnetization of portions of the flat surface.

magnetic ink recognition. Property of automatic devices that can detect or read ink-containing particles of magnetic substance, i.e., the ink used for printing on some bank checks for magnetic ink character recognition (MICR).

magnetic media. Any of a wide variety of belts, cards, disks, or tapes (as contrasted with paper tape) coated or impregnated with magnetic material for use with the appropriate equipment and on which dictation or keystrokes can be recorded and stored.

magnetic recording head. A magnetic head that transforms electric variations into magnetic variations for storage on a magnetic medium such as tape or disk.

magnetic resonance imaging. Equipment used on an object placed in a spatially varying magnetic field that is subjected to pulses of radiation; the resulting nuclear magnetic resonance spectra are combined to give cross-sectional images.

magnetic tape. A serial-access magnetic storage medium. Typically, a flat ribbon of metal, plastic, or paper that is coated on one side with material that can be magnetized; information is stored on the tape by a combination of magnetized spots in certain patterns. (See also **magnetic media.**)

mailing/letter-handling/addressing equipment. Mailing systems and equipment that have been automated with components to increase capabilities and to streamline efficiencies.

mail order. A sales method by which a consumer may order products through a catalog.

main distribution frame (MDF). A unit used in telephone wiring for terminating and cross-connecting telephone wiring to the telephone-switching system. The MDF is the primary (or first) distribution point. (See also **distribution frame.**)

mainframe computer. A general-purpose information system with price range of $350,000 and up. CPU bit width ranges from 32 to 64 bits. Physical environment can be either with or without special environmental controls and requires full-time support by professional computer systems support staff with 10 or more members. Number of concurrent users is 250 or more.

maintenance management. The upkeep of property, equipment, or tooling through planning, analysis, and documentation of maintenance functions.

management. An application that supports the management of data that can be achieved using document image management software and systems.

manufacturer. A producer or assembler of goods.

manufacturer's representative/agent. An independent contractor who represents multiple manufacturers. She or he does not take title to the product.

manufacturer's suggested retail price. See **list price.**

manufacturing automation. The use of a computer to aid and improve a manufacturing process.

manufacturing EATE N.E.C. Equipment that tests electronic systems that are composed of a number of subsystems. The testing equipment must verify operability and be capable of locating a faulty subsystem or component in event of failure.

manufacturing engineering tools. The small segment of manufacturing engineering that is concerned with tool and fixture design and the development of manufacturing processes.

manufacturing system. A system used to process raw material into a finished product.

mapping. Computer-aided tools that allow geographically related data to be captured, edited, analyzed, and managed. Typical users are civil and utility engineers, geophysicists, and geologists.

market. The demand for a product or service.

market share. A comparison of a company's performance with the total market so that its relative position and the amount of the market it captured is derived.

markup. 1: The amount added to the cost to determine the selling price for a specific product. 2: The amount added to the cost to determine the selling price for a specific product.

maskmaking e-beam. Semiconductor production equipment utilizing a method that allows submicron pattern generation for producing semiconductor mask plates or maskless lithography. (See also **lithography.**)

mask ROM. A semiconductor read-only memory programmed to the customer's specified pattern during the manufacturing process. (See **read-only memory.**)

mass merchandiser. A segment of the distribution channel with storefront locations. It differs from a dealer in that its primary business is the sale of a broad range of consumer goods.

mass property. The analysis of the physical characteristics of a part, assembly, or system. The evaluation of multiple properties—measures volume, weight, and surface area and locates center of gravity.

mass storage peripheral. A device that interfaces with the system or machine to external memory storage.

material. The designation of a number of basic metals, compounds, and gases to make up thermoelectric materials.

material-handling equipment and systems. Equipment such as 1: Movement—Automated guided vehicle systems, conveyors, and monorails;

cranes and lift trucks are included only when they are computer-controlled; material-handling robots are included in Robotics in Manufacturing. 2: Storage—Automated storage and retrieval systems; miniload, microload, and carousels. 3: Identification—Bar codes, radio frequency, machine vision, and other sensors used for identification are covered in Sensors in Manufacturing. 4: Controls—Computers, programmable controllers, and software used in material handling are included in Computers in Manufacturing and Software in Manufacturing.

material-handling/loading robot systems. Robotics used in the loading, moving, storage, and unloading of materials.

material requirement planning (MRP). A planning method that uses bills of material, inventory data, and a master production schedule to calculate material requirements. This method makes recommendations to restock materials inventory. Further, because material requirements planning is time-phased, this method makes recommendations to reschedule open orders when due dates and need dates are not in phase. Originally seen only as a better way to order inventory, material requirements planning is thought of today primarily as a scheduling technique, i.e., a method to establish and maintain valid due dates on orders.

matrix printer. An impact printer that uses wire, hammer-like bristles, or needles to create characters formed by small dots. Matrix printers produce either serial or line output. The serial printer employs a moving printhead with a matrix block (i.e., 5 x 7 or 7 x 9) of needles. The printhead sweeps across the page to print full characters one at a time. The line printer uses a horizontal band with raised dots that moves from left to right across the paper. The individual needles strike programmed character dots to form one row of dots per sweep across the page. Successive passes of the line printer form complete characters and complete rows of textual data. High-resolution text, comparable to daisywheel output, may be produced by overlapping matrix printers that print characters via a highly concentrated matrix or successive, staggered passes of the printhead. Fonts for matrix printers are stored in ROM or PROM memory.

MBE. See **molecular beam epitaxy deposition.**

MCAE. See **mechanical computer-aided engineering.**

MCU. See **microcontroller.**

MDF. See **main distribution frame.**

mechanical. Mechanical CAD/CAM is the software application of computer-aided tools to design, analyze, document, and manufacture discrete parts, components, and assemblies.

mechanical assembly equipment. 1: Machinery or equipment that assembles mechanical parts into subassemblies or final products. 2: Dial or rotary assembly machines; in-line transfer machines; flexible assembly equipment (except robots).

mechanical computer-aided engineering (MCAE). The application of CAD/CAM tools for mechanical design and analysis. MCAE applications range from conceptual product design through detailed product design and analysis to supporting production design. Commonly used MCAE products are solid modeling and finite element analysis technology.

mechanical computer-aided manufacturing. See **mechanical.**

media-to-media data conversion equipment. Computer output-to-microfilm recording units, tape print units, card-to-tape conversion units, as well as document entry devices.

medical. An environment or industry that uses computers to control and/or collect and analyze data from patients, medical equipment, and/or instruments.

memory. 1: A device into which data can be entered and stored for later retrieval. 2: An integrated current (IC) designed for the storage and retrieval of information in binary form; can be either bipolar or MOS technology and includes dynamic random-access memory (DRAM), static random-access memory (SRAM), read-only memory (ROM), programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), and electrically erasable programmable read-only memory (EEPROM).

memory management unit (MMU). 1: An integrated circuit that manages the storage and retrieval of data found by cell location or address. 2: A component (or set of components) that implements the memory management function in a processor-based system.

merchant production. The sale of a good to a company other than the manufacturing company.

merger and acquisition. In financial terms, it means to absorb or acquire one company by another.

metalorganic CVD (MOCVD). A technique used to deposit material onto a wafer.

metal oxide silicon (MOS). 1: A circuit in which the active region is a metal oxide semiconductor sandwich. The oxide acts as the dielectric insulator between the metal and the semiconductor. 2: A process that results in a structure of metal over silicon oxide over silicon. 3: Technology that employs field effect transistors having a metal or conductive electrode that is insulated from the semiconductor material by an oxide layer of the substrate material.

meteorological instrument. An instrument used to monitor and observe the weather.

metropolitan statistical area. A large population nucleus, together with adjacent communities, that has a high degree of economic and social integration with that nucleus. Each metropolitan statistical area (MSA) must include at least: (a) one city with 50,000 or more inhabitants, or (b) a census bureau-defined urbanized area of at least 50,000 inhabitants and a total MSA population of at least 100,000 (75,000 in New England).

microcomponent. 1: An integrated circuit (IC) with high-speed, low-power density considered as a single part. 2: An IC that contains a processing unit or acts as an interface chip to such a device. Types of microdevices include microprocessor (MPU), microcontroller (MCU), microperipheral (MPR), and digital signal processor (DSP).

microcomputer. An information system with price ranging up to $100,000, with the majority priced at less than $50,000. CPU bit width is normally 32 bits, but can be as low as 8 bits. Traditionally used as a desk-side or desktop system configuration. Normally a multiuser system used in a common work area. Usually has a merchant (nonproprietary) microprocessor.

microcontroller (MCU). An integrated circuit, containing a CPU, memory, and I/O capability, that can perform the basic functions of a computer.

microperipheral (MPR). A support device or circuit for a microprocessor or microcontroller that either interfaces with external equipment or provides system support.

microprocessor (MPU). A single-chip component, or a collection of architecturally interdependent components, functioning as the central processing unit (CPU) in a system. A microprocessor may contain some input/output circuits, but it usually does not operate in a standalone environment.

microprogrammable digital signal processor (MPDSP). An integrated circuit that allows high-performance, modular DSP architectures to be designed using standard off-the-shelf components. Products include bit-slice and building block components.

microwave. 1: Any radio wave with a frequency higher than 890 MHz or a wavelength of between 1ml and 1m. 2: A form of electromagnetic radiation that has frequencies of 1 GHz. These high-frequency bands of energy are used extensively for radar and wideband communications.

microwave antenna. A device used for receiving and transmitting microwave signal beams. (See also **antenna.**)

microwave monolithic integrated circuit (MMIC). An electronic circuit employing monolithic integrated circuit technology fabricated by microelectronic techniques and capable of operating at frequencies above 1 GHz.

microwave oven. An oven that uses electron waves to produce heat for faster cooking of foods.

microwave radio equipment. Equipment that includes transmitter/receiver systems, power supplies, repeaters, and other equipment used in microwave radio systems. It also includes analog and digital equipment used both in common carrier and in private industrial systems.

midrange. The combination of microcomputer, minicomputer, and superminicomputer.

military/aerospace electronic equipment. Electronic equipment used in the military and civilian aerospace industries.

military communication equipment. Voice, data, and cryptographic equipment used for communication in the military.

military computer system. A computer system used for military purposes; a set of hardware components that form a system intended solely for military applications. This category includes general-purpose CPUs, storage, input/output, and terminals and includes both commercial, ruggedized, and mil'spec versions for integration into military systems and for government-sponsored programs.

military electronic equipment. Electronic equipment used exclusively by the military. Usually, this equipment must meet government specifications and regulations.

military simulation and training. The performance of military maneuvers/exercises as training for real-life military situations. This category includes flight and battle simulators and equipment operation and maintenance systems.

milling programmable machine tool. A machine tool for the removal of metal by feeding a workpiece through the periphery to remove the material through the motion of workpiece and cutter.

minicomputer. An information system with prices ranging from $10,000 to $300,000 but mainly falling between $25,000 and $150,000. CPU bit width ranges from 8 to 16. Minicomputers are situated usually in a common work area and occupy more floor space than most tower configurations. Number of concurrent users ranges from 15 to 100. System usually incorporates proprietary processor, with notable exceptions, and is often packaged with third-party application software and/or peripherals and then resold into specialized applications or vertical markets. Examples of models are the HP 1000, HP 3000/70, PDP-11/84, and IBM Series/1.

minicomputer-based terminal. A display terminal provided by a minicomputer manufacturer or a display terminal that is protocol-specific to an IBM System/34, /36, or /38 computer. This terminal may operate in either character or block mode. Excluded from this category is any minicomputer-compatible terminal supplied by an independent manufacturer.

miscellaneous military equipment. Equipment that includes classified systems, test equipment (N.E.C.), vehicle control, medical equipment, assorted development and office equipment, and research and development equipment; all used in the military.

mixed signal ASIC. An ASIC that has one analog input or output and one digital input or output.

mixed signal IC. An integrated circuit that has one analog input or output and one digital input or output.

MMIC. See **microwave monolithic integrated circuit.**

MMU. See **memory management unit.**

mobile communications equipment. Equipment (base stations, mobile units, and antenna) used primarily for portable public or private communications.

mobile infrastructure. The central base station and other central equipment that provide mobile communication services.

mobile radio base station equipment. The base/centralized station equipment associated with cellular radio systems. This category includes both switching equipment and radio transmitter/receiver equipment.

mobile radio service. Service or network revenue associated with cellular radio systems. (See also **mobile service.**)

mobile radio system equipment. Electronic equipment used in the transmission and receiving of radio signals. Equipment includes main central control, base control mobile stations, and hand-held car units. Used primarily with cellular and other mobile communication technologies.

mobile service. Radio service between a fixed location and one or more mobile radio stations, or between mobile stations.

mobile telephone service (MTS). Radio communication between a mobile (portable) unit and the public switched network including cellular service.

modeling. An application that supports the representation of a process or system by using equations that simulate and represent behavior under varying conditions.

modem. 1: An electronic device that provides modulation and demodulation functions of transmitted data signals over telephone lines. They convert digital data signals to analog for transmission over leased lines or the analog public switched telephone network. 2: The integrated circuits used in a modem.

molecular beam epitaxy deposition (MBE). A technique used in semiconductor manufacturing to deposit a single crystal layer on a substrate by use of a molecular beam.

molecular engineering. See **computational chemistry/molecular engineering.**

money management. An application that identifies and controls the source, flow, location, and earning potential of an organization's cash and investments.

monitor. 1: To check the operation and performance of a system or circuit by examining parts of transmissions. 2: The physical CRT unit, associated electronics, and housing used in display systems. 3: A station or equipment arranged to supervise system operation. 4: To supervise and verify the correct operation of a system, device, or program. 5: The screen of a video display terminal. 6: An analog monitor can display an almost infinite number of colors, while a digital monitor can display a more limited range of colors.

monolithic analog integrated circuit. An analog IC constructed from a single piece of material. All circuit components are manufactured in or on top of a single crystal of semiconductor material.

MOS. See **metal oxide silicon.**

MOS application-specific IC. See **application-specific integrated circuit.**

MOS cell-based IC. See **cell-based integrated circuit.**

MOS custom IC. See **custom integrated circuit.**

MOS digital. A semiconductor technology in which the active devices are n-channel, p-channel, or complementary MOS transistors that operate in a digital or binary mode. (See also **digital.**)

MOS FPGA. See **field-programmable gate array.**

MOS gate array. See **gate array.**

MOS logic. See **logic circuit.**

MOS memory. See **memory.**

MOS microcomponent. See **microcomponent.**

MOS microcontroller. See **microcontroller.**

MOS microperipheral. See **microperipheral.**

MOS microprocessor. See **microprocessor.**

MOS nonvolatile memory. See **nonvolatile memory.**

MOS PLA. See **programmable logic array.**

MOS PLD. See **programmable logic device.**

MOS PMD. See **programmable multilevel logic device.**

MOS standard logic. See **standard logic.**

MOS transistor. A field-effect transistor (FET) with a gate that is insulated from the semiconductor substrate by a thin layer of silicon dioxide. Being field-effect transistors, MOS-FET provide a voltage-input-to-current-output relationship called transconductance. MOS-FET are excellent switches because voltage at the gate turns the output current on or off.

mouse. A hand-held device that is moved on a surface to provide coordinate input to a graphics system. It is used most often to position a pointer or cursor.

MPDSP. See **microprogrammable digital signal processing.**

MPR. See **microperipheral.**

MPU. See **microprocessor.**

MPU load programmer. A device that allows engineers and IC designers to program a variety of programmable devices (ICs), thereby speeding up the design process. The device to be programmed is loaded directly on the device programmer.

MTS. See **mobile telephone service.**

multilingual publishing. A system with the purpose/use of printing in a variety of languages.

multimedia. A process that uses more than one form of communication.

multiplexer equipment. Public telecommunication equipment used to combine a number of channels for transmission over a common medium, such as satellite, microwave radio, cable carrier, or fiber-optic cable. Excluded from this are data-only customer premises multiplex equipment and multiplex equipment that is integral to carrier or microwave radio systems.

multistrike ribbon. A ribbon that advances only part of a character width; characters slightly overlay one another on the ribbon, but no character hits the exact same spot on the ribbon.

multiuser system. A computer system inherently designed for environments with multiple users.

N

natural resources and construction. An environment or industry that includes establishments primarily engaged in agricultural production, forestry, commercial fishing, hunting and trapping, and related services; and mining or quarrying, developing mines, or exploring for nonmetallic minerals except fuel. Also, certain well and brine operations and primary preparation plants, such as those engaged in crushing, grinding, washing, or other methods of concentration.

navigation, military. A process for directing ships, aircraft, spacecraft, and other crafts to a specific destination. Equipment determines position, distance, and course of vessel or craft.

n-channel metal oxide semiconductor (NMOS). Pertaining to MOS devices made on p-type silicon substrates in which the active carriers are electrons that flow between n-type source and drain contacts. The opposite of PMOS. NMOS is two to three times faster than PMOS. (See also **MOS.**)

net additions. 1: The change in stock, such as installed base or inventory. 2: The relative increase or decrease in the total installed base of a product.

NETVIEW. IBM network management product.

network management. A software application that controls the logical connections and information flow among computers on a network. This software may have additional functions such as performance measurement and diagnostic and accounting functions.

network support services. All services that help customers better utilize their networking facilities. The services include site planning, installation, and ongoing on-site and remote maintenance support, as well as professional services such as network design/planning, integration, administration, and operations management.

network terminating devices. Equipment that connects a data network to the data terminal.

new placement demand. The total end-user demand for new products (as compared with replacement products).

newspaper publishing. A system with the main purpose/use of printing newspapers; typically daily or weekly publication containing such elements as news, feature articles, and advertising.

nitrogen. A chemical element.

NMOS. See **n-channel metal oxide semiconductor.**

non-IBM, protocol-specific terminal. A terminal that is protocol-specific to a Burroughs, Honeywell, or Sperry mainframe computer. Included is any terminal of this type that connects to another computer by means of protocol emulation.

nonimpact printer. A hard-copy computer output device that forms images through electrostatic or other nonimpact methods. These printers include ink jet, laser, and thermal printers. (See also **ink jet printer.**)

nonvolatile memory. An integrated circuit using two-junction transistor technology where memory retains information when the power is off. Also known as core or permanent memory. Can be either bipolar or MOS technology process.

nonvolatile random-access memory (NVRAM). A read/write semiconductor memory device that does not lose information when the power is turned off.

notebook personal computer. The notebook personal computer is a system that resembles a laptop personal computer in general form factor and appearance. This personal computer is smaller and lighter in weight than a laptop D/C unit. The "standard" notebook size is 8.5 inches by 11 inches by 2 inches or less, and the weight of these units is in the 5- to 7-pound range. Notebook computers also, presently, make use of industry-storage mass storage media including 3.5-inch floppy disk.

nuclear radiation detection and monitoring instrument. An instrument used to detect, inspect, monitor, and control alpha particles (neutrons, protons, and electrons) that emanate from the atomic nucleus as a result of radioactivity and nuclear actions.

numerical control. 1: Computer instructions that automate machining and drafting tools. 2: A technique of simulating the operation of a machine tool. 3: Descriptive of systems in which digital computers are used for the control of operations, particularly of automatic machines. A technique of controlling a machine or process through the use of command instructions in coded numerical form.

numerical-control (NC) part programming. The programming of a numerical-control machine tool or automated processing system. Graphics and language-based programming tools are available.

NVRAM. See **nonvolatile random-access memory.**

O

OCR. See **optical character reader.**

OEM. See **original equipment manufacturer.**

office equipment. Equipment used in a business or office environment. Equipment may include copiers and duplicators, electronic calculators, dictating machines, electronic typewriters, word processors, banking systems, cash registers, and mail- and letter-handling equipment.

off-line robotics programming. A special-purpose process simulation that graphically represents the sequence of steps to program a robot for a particular operation. The resulting data can be downloaded to a robot to update its control program.

oil field services. A software application that uses small computers in the oil rigs or the wellhead areas to log and analyze data from sensors in the well.

OLTP. See **on-line transaction processing.**

one-time programmable read-only memory (OTP ROM). An EPROM packaged in plastic without a quartz window for erasure. Such a device is therefore programmable only once.

on-line transaction processing (OLTP). The input, tracking, and output of a well-defined record of information, processed in real time rather than batch. Examples include ATMs and airline reservations systems. OLTP systems are usually large and complicated enough that each one is customized, so there are few generic OLTP products. The RAMP-C and Debit-Credit benchmarks are examples of OLTP standards.

op amp. See **operational amplifier.**

open systems interconnection (OSI). A communication standard for network architecture that allows communication between various equipment.

operating environment. A set of conventions for screen appearance, keyboard, mouse and screen operations, and program functions. Operating environments function within an operating system.

operating system. 1: The software program in a computer that maps logical constructs to physical locations in the computer. The operating system is the program that lets a user access data by a file name without knowing where the file is physically located on the disk. 2: The operating system controls the computer's operations by managing disk, screen, file maintenance, and printer activity, while loading and running application programs.

operating utilities. A program or routine of general usefulness and applicable to many jobs or purposes.

operational amplifier (op amp). A type of integrated circuit (IC) that generates an amplified output that is exactly proportional to its input.

operator support system. Special equipment and/or software that facilitates the operation of a switchboard or comparable equipment.

optical CD/wafer inspection. Critical dimension (CD) refers to the line, element, or feature that must be manufactured and controlled to stringent specifications. Wafer inspection refers to the inspection of a patterned wafer for process defects by visual image process techniques.

optical character reader (OCR). 1: A device or scanner that can read printed or typed characters and convert them into a digital signal for input into a data or word processor. 2: The machine identification of printed characters through the use of light-sensitive devices; computer-input-only hardware.

optical disk controller. A device that controls the storage and retrieval of data from a video disk that is sensed through a laser beam.

optical disk drive. A data storage device utilizing laser technology. Types include CD-ROM, WORM, and erasable optical disk drives.

optical jukebox. A library system that holds multiple disk drives and optical disks to create a large storage environment on optical media.

optical media. The substance on which data are stored electronically and read by laser technology.

optical-scanning equipment. See **optical character reader.**

opto. See **optoelectronic.**

optocoupler. 1: A device that transmits electrical signals, without electrical connection, between a light source and a receiver. Also called an optoisolator. 2: A device that consists of an LED separated from a photo detector by a transparent, insulating, dielectric layer, all mounted in an opaque package. A current pulse in the LED causes a radiation pulse to flow across the dielectric layers to a photo detector, which produces a current pulse at the output. The input and output circuits are coupled with high-standoff voltage isolation.

optoelectronic (opto). A semiconductor device in which photons cause electron flow or vice versa. Optoelectronic chips contain transducers used between photonic circuit media and electronic media; they also may contain amplifiers, logic functions, and/or other photonic or electronic functions.

order entry and sales support. An application to support the process of accepting and translating what a customer wants into terms used by the manufacturer. This can be as simple as creating shipping documents for a finished goods product line to a more complicated series of activities including engineering effort for make-to-order products.

order entry/processing. Acceptance and translation of customer requirements into terms used by a manufacturer.

organization operation. A software application that supports the day-to-day running of an organization.

original equipment manufacturer (OEM). 1: An OEM may manufacture a product for assembly into another system or larger configuration by another manufacturer or vendor. 2: A purchaser of materials, components, or equipment to be incorporated into its product line. 3: A product reseller that integrates hardware, software, and/or services. The reseller may or may not own the hardware or software. An OEM differs from a VAR in that it adds its own label to the product and backs up its warranties.

OSI. See **open systems interconnection.**

OS/2. Computer systems based on the Intel 80XXX architecture and using OS/2 operating system software.

other. A subject or segment that is not distinctly defined within the Dataquest High-Technology Segmentation scheme.

OTP ROM. See **one-time programmable read-only memory.**

P

PABX. See **private automatic branch exchange.**

pacemaker. An electronically pulsed oscillator implanted in the body to deliver electric pulses to the heart at a fixed rate in response to a sensor that detects when a person's heart rate slows.

packet assembler/disassembler (PADS). A system element that buffers data sent to and from character-mode devices and assembles and disassembles the packets needed for X.25 operation.

packet data switching. Data network switches that connect terminals and packet assemblers/disassemblers to a pre-edit node using a high-speed link (56,000 bps). Can be public or private.

PADS. See **packet assembler/disassembler.**

page composition. Refers to the page composition software used to produce finished draft or camera-ready pages whereby text and graphics have been aesthetically laid out using an editable WYSIWYG display environment.

page, nonimpact, plain paper (PNPP). A printer with the ability to buffer, in part or in whole, a page of images received from an electronic source and then to transfer these images to a receiving substrate.

page printer. A printer that prints characters one at a time to full-page format. Page printers are rated by speed categories, expressed in pages per minute (ppm).

paging equipment. Communication equipment that produces an audio signal in a radio receiver carried by an individual to tell him that he is needed at the telephone. Communication system for summoning individuals or making public announcements.

paging system. The equipment necessary to selectively alert individuals by tone or voice paging, either by pocket radio receivers or speakers within a building.

painting robot system. A system consisting of a number of robots programmed to paint by carrying spray guns and applying a coating of material. Also known as finishing robot.

PAL. See **programmable array logic.**

panel-type instrument. 1: Switches, dials, and buttons that are mounted on an electronic unit that controls and monitors a system. 2: Electronic instrumentation devices mounted on a panel for a variety of equipment purposes.

paper. Sheets of fiber formed on a fine screen from a water suspension. There are hundreds of different types of paper based on weight, brightness, color, opacity, and coating.

particle accelerator. A device that accelerates electrically charged particles (protons, electrons) to high energies.

part process design. The design of the actual manufacturing process and sequence.

parts service. Spare hardware modules or components used in the repair and/or replacement of failed hardware units.

passive device. 1: An inert component that may control, but does not create or amplify, energy. 2: A device that exhibits no transistance. A component that does not provide rectification, amplification, or switching but reacts to voltage and current. 3: Pertaining to a general class of device that operates as signal power alone.

patient monitoring. Equipment used to monitor, control, and record data on activity concerning or affecting a patient's health.

pay phones. A telephone instrument located in a public location that accepts coins for operation.

payroll. A software application that supports an organization making payment to its employees for work performed.

PBX-private branch exchange. See **PBX telephone system.**

PBX telephone system. A telephone switching system on the customer premises that, by dialing an access code, permits a telephone to interface to the public telephone central exchange or office.

PC. See **personal computer system.**

PCB layout. Products that are used to create the layout of the traces and components to be placed on a printed circuit board.

p-channel metal oxide semiconductor (PMOS). An MOS device made on an n-type silicon substrate in which the active carriers are holes (p) flowing between p-type source and drain controls.

PC logic chipset. A semiconductor device (or set of devices) that integrates standard logic and controller functions onto a very large scale integration (VLSI) chip, resulting in a reduced component count on the PC motherboard.

PCN. See **personal communications network.**

pen-based personal computer. This is a new classification of portable computers for 1991. The general identifier for this class of machines is that they utilize a pen or stylus for data input and do not normally require a keyboard to operate. (Keyboard options are included in some of these models, but the system can be fully utilized without the inclusion of a keyboard.) Pen-based computers do not have to be able to run MS-DOS or applications that run under DOS. It is expected that there will be three or more operating systems utilized in this product: PenPoint by GO Corporation, Pen Windows by Microsoft, and others that have not been made public at the time of publication.

percent retirement. See **retirement.**

periodical publishing. A system with the main purpose/use of printing publications issued at intervals.

peripheral device. 1: Any instrument, device, or machine that enables a computer to communicate with the outside world, or areas in the operation of the computer. 2: Equipment that is connected to a computer but is not part of the computer. Examples include printers, terminals, and disk drives.

peripheral I/O management. 1: A program that interacts with the central processing unit (CPU) of a computer to communicate with devices beyond the CPU. The program interprets and responds to instructions from the CPU. 2: Information flows between the CPU and a unit of peripheral equipment.

personal communications network (PCN). A class of communications technology that allows communication with a mobile entity. Sample technologies include mobile radio, cellular, and paging services.

personal computer operating system. A personal computer operating system is a program that supervises and controls the operation of a personal computer.

personal computer system. A personal computer intended for use on the user's desk or work surface and not designed to be readily moved from place to place. Personal computers are those systems that include, as part of the basic system, a BIOS- or ROM-based software code that is designed to permit the use of the system with any of the existing personal computer operating systems.

personal electronics. Electronic equipment for personal use.

personal finance. A software application that records, processes, and reports on personal financial data, including personal banking, credit card management, and budgeting. These applications are suitable for small businesses as well as home use.

personnel management. A software application that supports an organization in managing its employees; may include many subapplications.

photoblank. A blank glass plate that is processed to become a photomask for use in semiconductor manufacturing.

photomask. A glass plate covered with an array of patterns, used to form circuit patterns on semiconductor wafers. Photomasks may be made of emulsion, chrome, iron oxide, silicon, or a number of other materials.

photoreceptor. The photoreceptor is the central element in an electrophotographic copier or nonimpact printer. The photoreceptor consists of two parts; a support or substrate, usually in the form of a drum or flexible belt, and a photoconductive coating consisting of one or more layers.

photoresist. The light-sensitive film spun onto semiconductor wafers and exposed using high-intensity light through a photomask.

photosensitive. Capable of emitting electrons when struck by light rays.

photosensitive plotter. A plotter that uses photosensitive properties to create an image.

photosensor. An optoelectronic semiconductor that responds to radiant energy. Examples are photodiodes and phototransistors.

physical property test, inspection, and measurement. An instrument designed to inspect and measure physical property.

physical vapor deposition (PVD). A process through which specific materials are physically layered on a wafer. Includes sputtering and evaporation.

pin diode. A diode made by diffusing the semiconductor with p-dopant from one side and n-dopant from the opposite side with the process so controlled that a thin or intrinsic region separates the n and p regions. (See also **power diode.**)

PLA. See **programmable logic array.**

placement. End-user consumption of a product that is either purchased, leased, or rented.

planning. An application that facilitates the quantitative aspects of business planning, such as modeling, budgeting, analysis, and forecasting.

plasma etchant. A highly ionized gas (plasma) in the manufacture of high-density semiconductors.

plastic-processing machinery. Numerically controlled machinery used for injection, structural foam, extrusion, blow molding, thermoforming, and reaction injection.

plastics. 1: A polymetric material of large molecular height that can be shaped by flow; usually refers to the final product. Examples include polyvinyl chloride, polyethylene, and urea formaldehyde. 2: Displaying or associated with plasticity.

PLC. See **programmable logic controller.**

PLD. See **programmable logic device.**

plotter. 1: A recorder that charts, in graph form, a dependent variable as a function of one or more variables with an automatically controlled pen or pencil. 2: Any (vector or raster) computer hardcopy devices that perform mainly graphics functions. These devices include pen plotters, electrostatic plotters, photographic and laser plotters, and ink jet plotters.

PMD. See **programmable multilevel logic device.**

PMOS. See **p-channel metal oxide semiconductor.**

PMR. See **private mobile radio.**

PMR. See **projection microradiography.**

PNPP. See **page, nonimpact, plain paper.**

point-of-sale terminal. A terminal device that operates as a cash register in addition to transmitting information.

polysilicon. A silicon layer grown on a wafer in a furnace.

population. The total of individuals occupying an area or making up a whole. A *de facto* population should include all persons physically present in a country (state, province, region, city, or town) or designated area at a reference date. A *de jure* population, by contrast, should include all usual residents of a given country or designated area, whether or not they are physically present at the reference date. By definition, therefore, a *de facto* total and a *de jure* total are not entirely comparable.

portable electronic measuring instrument. An electronic measuring instrument that can be carried or transported with ease.

portable radio receiver transmitter. A device for converting radio waves into perceptible signals.

portfolio management. A software application that allows investors to clarify, estimate, and control the sources of risk and return in their portfolio.

postsecondary education. The provision of formal instructional programs with a curriculum designed primarily for students who have completed the requirements for a high school diploma or equivalent.

potentiometer. A device for the measurement of an electromotive force by comparison with a known potential difference.

power diode rectifier. A diode is a two-terminal device that permits current flow in only one direction. This property is used in diodes and rectifiers to convert AC current to DC.

power grid control. See **power management.**

power IC. An analog integrated circuit that can control one or more amps of current, dissipate one or more watts of power, or is capable of operating with voltages exceeding 100 volts.

power management. A real-time application that monitors and controls power generation equipment and power line grids.

power supply. 1: A unit that supplies electrical power to another unit. 2: Energy source that provides power for operating electronic apparatus.

power train. The mechanism by which power is transmitted from the engine to other part of the vehicle that it drives. Examples include ignition, spark timing, fuel control, turbo control, emissions systems, voltage regulator, alternator, engine control, and diagnostics.

power transistor. 1: A transistor that dissipates power of one or more watts. 2: A transistor designed for high-current, high-voltage applications.

premises switching equipment. Voice equipment that provides switching or call-routing functions. Includes equipment such as PBX telephone system and key telephone system.

presentation graphics. 1: A software application with a principal function of formatting text or numeric data into specified formats for the presentation of ideas. This may include graphs, charts, and/or lists suitable for professional presentations. 2: An image written, printed, drawn, or engraved; an image outlined or set forth for commercial, professional, or industrial purposes.

print element. The mechanisms used in fully formed character printers and typewriters by which marks are made on the paper. The three types of print elements are printwheels, also known as daisywheels, golf balls, and thimbles.

printer. The unit that produces copy on paper—a typewriter or a line printer. Often connected to a CPU that transforms electronic data into hardcopy form. (See also **ink jet printer** and **line printer.**)

printer controller. 1: Within a printer, the device used to regulate, accelerate, decelerate, start, stop, reverse, or protect devices connected to an electric controller. 2: A device or instrument that holds a process or cartridge at a desired level. 3: Hardware and/or software, usually either printed circuit board- or diskette-based, that takes data streams from software and converts it to printer-specific commands. The controller may reside in a CPU; may be connected to the print engine by an interface cable, a diskette or chip set in the CPU or printer; or, as in most cases, may be a physical attachment to or integrated component of the printer itself.

printer controller board. See **printer controller.** (Except all devices are loaded onto a board.)

printer, impact. Family of printers that use direct impression impact of a typebar, type head, or matrix pin to exert pressure against a paper ribbon and a platen to create a character.

printer, nonimpact. A printer capable of imaging on a substrate without physically striking it; these include ink jet, laser, and thermal printers.

print system network. Hardware and software that is integrated to manage the information sent to one or a number of printers, usually shared by more than one user. The system may be as simple as a switch box connected to two CPUs and one printer, or as complex as a full local area network that controls print streams to many printers from multiple CPU systems and controls job-queuing management, printing error conditions, spooling, and rerouting.

printwheel. A print element for certain character printers. The characters are engraved at the end of spokes, the entire printwheel resembling a daisy. Also known as daisywheel.

private automatic branch exchange (PABX). One type of telephone switching system that is typically used in larger businesses. The PABX allows computer-like programming of incoming and outgoing calls to optimize network configurations and provide additional call management features.

private line. A telecommunications network connection for the exclusive use of one organization. (See also **leased circuit.**)

private mobile radio (PMR). See **cellular service.**

private packet data switching. A private packet data network switch connects terminals and packet assemblers/disassemblers to a packet node using a high-speed link (56,000 bps). (See also **packet data switching.**)

private school or institution. A school or institution that is controlled by an individual or agency other than a state, a subdivision of a state, or the federal government; usually supported primarily by funds other than public funds; and is operated by other than publicly elected or appointed officials.

process control, nonunified system. System-type instruments and related equipment for process control activated from standardized electrical transmission signals, in which control and signal conditioning are separated from the display and operator interface.

process control system. 1: Monitoring and maintaining the operation of plants that manufacture homogeneous materials such as oil, chemicals, and paper. Process control systems are capable of detecting errors in input variables and environment and taking corrective action. Closed-loop systems are self-correcting, and open-loop systems alert an operator. 2: A computer-based system that controls physical transformation and/or the mixing of products in a fluid state.

process control system, auxiliary station. Peripheral equipment of a process control system not in direct communication with the central processing unit or system.

process control system, controller. The controller describes that portion of a process control system that continuously measures the value of a variable quantity or condition and then automatically acts on the controlled equipment to correct any deviation from a desired present value.

process control system, indicator. A portion of the process control system that produces a diagram measuring the pressure volume changes in a running system.

process control system, industrial process computer. A computer that monitors the manipulations and changes of numerous conditions within a process control system automatically.

process control system, recorder. A portion of a process control system that makes a graphic or acoustic record of one or more variable quantities.

processing terminal. A display terminal that has local processing capability but is dependent on communication with a host, controller, or server to provide files and application programs. Such a terminal does not have a mass data storage device.

process manufacturing. 1: *Continuous process* produces a continuous stream of products, the units of which are not differentiated from one another (i.e., gasoline). 2: *Batch processing* produces product by reference to a recipe (i.e., bread).

processor. A device for handling information in a sequence of reasonable operations. Any device that can perform operations on data.

process planning and control. See **process control system.**

process simulation. The computerized simulation of the sequence and interdependencies of manufacturing processes. Also involves process modeling and includes NC part programming as a subset.

product. A good or service.

product category. A grouping of similar products.

production. The manufacture of goods.

production planning and control. Software used to plan for factory resources of a manufacturing company.

professional publishing. Systems dedicated exclusively to the job of publishing; typically, PC-based professional publishing systems focus on a single task or stage in the document production cycle, rather than managing the entire document production process.

professional services. A range of services including consulting on information technology, contract/custom programming, systems integration, facilities management, education, and ongoing maintenance.

programmable array logic (PAL). PAL is a trademark of Monolithic Memories, Inc. (now part of Advanced Micro Devices), referring to a family of logic devices that are customer programmable.

programmable logic array (PLA). 1: A form of programmable logic device containing a structured, partially interconnected set of gates and inverters that are fuse programmed by the user. Can be manufactured in bipolar or MOS technology.

programmable logic controller (PLC). A device or transmission control unit in which hardwired functions have been replaced with software or microcode. A programmable controller enables a user to add, change, or tailor computer capacities to the user's needs; programmable solid-state devices that replace mechanical relays for controlling sequential operations, timing, counting, and similar simple control actions. Where the capabilities exist as a function of the PLC, this definition includes more sophisticated tasks such as mathematical computations, data acquisitions, reporting, and process equipment control.

programmable logic device (PLD). A type of application-specific integrated circuit (ASIC) that is user programmable (after assembly) rather than mask programmable. The function of a PLD is determined by blowing fuse links or programming memory devices to create the desired interconnections between the fixed logic elements on the device. Can be either a bipolar or MOS technology. (See also **programmable logic array.**)

programmable machine tool. Numerical control (NC), computer numerical control (CNC), direct numerical control (DNC), and flexible machining centers used for metal cutting and metal forming.

programmable multilevel logic device (PMD). A semiconductor that can be manufactured by a bipolar or MOS technology process. The device, evolved from the basic programmable logic array (PLA), incorporates architectures to implement complex logic functions efficiently. PMDs can implement multiple levels of logic without sacrificing input/output or I/O cells or pins.

programmable read-only memory (PROM). A nonvolatile fuse-programmable solid-state memory circuit that is programmable only once, with special equipment. It is a programmed ROM that may be programmed after manufacture by blowing fuse links or shorting base-emitter junctions. PROMs provide high-speed access to frequently needed data and instructions. They allow a vendor company to customize a system before delivery to the user.

projection/aligner. Wafer fabrication lithography equipment that uses mirrors instead of lenses. The wafer and mask are separated by distance, not allowing the entire wafer to be exposed. This process lines up two or more layers of a wafer so that the components of one layer are compatible with the components of the other layer. (See also **lithography.**)

projection microradiography (PMR). An electron beam is focused onto an extremely fine pencil, generating a point source of x-rays; enlargement is achieved by placing the sample very near this source and several centimeters from the recording material.

project management. A software application that supports the ordering of activities across time. This application assists in planning and implementing projects by providing tools for forecasting requirements, projecting costs, and providing other charting and analysis features.

PROM. See **programmable read-only memory.**

prosthetic medical equipment. Equipment used in the surgical and dental specialties concerned with the artificial replacement of missing body parts.

protocol. A set of rules (not a program) for software programs to conform with in data communications. A program that reacts properly to data sent to it in a form that does not conflict with these rules and that sends data in conformance with these rules is said to support, or be in compliance with, the particular protocol. An example of a protocol is the one used by humans over two-way radio: the protocol is that one person finishes speaking by saying "over"; the other party then speaks, until finished and says "over"; the end of transmission is signalled by saying "over and out." Examples of protocols in data communications are BSC (IBM) and T201 (Tymnet).

protocol converter. Equipment that converts data from one format (protocol) to another. (See also **gateway.**)

proximity/contact aligner. Equipment that places a mask in direct contact with the wafer after the mask is aligned. With proximity, the mask does not come into direct contact with the wafer. (See also **lithography.**)

PTT. Postal, telegraph, and telephone organization. An organization that provides basic telecommunications services. For U.S., see regional bell operating companies.

public data network service. A packet-switched or circuit-switched network service available for public use. It includes the equipment and service charges associated with data communications networks that are offered to the general public. These networks connect user terminals and computers to the network and may offer enhanced or value-added services, such as conversion of speeds, codes, protocols, electronic mail, or facsimile.

public packet data switching. See **packet data switching.**

public school or institution. A school or institution controlled and operated by publicly elected or appointed officials and deriving its primary support from public funds.

public switching equipment. Equipment used in public telecommunications to switch or route voice and data calls. This segment includes equipment such as digital central office switching equipment and digital access cross-connect systems.

public telecommunications equipment. Equipment that includes public network services and equipment. It includes the various voice and data communications services provided by common carriers and the transmission and switching equipment used to implement these networks.

public telecommunications service. A service provided by public telecommunications carriers. It includes services such as local telephone, long distance telephone, international telephone, leased circuit, public data network, enhanced network, and mobile communications.

public transmission equipment. The equipment used in public telecommunications to transmit voice and data signals. It includes equipment such as multiplex equipment, carrier equipment, microwave radio equipment, and satellite earth state equipment.

publishing. 1: The business or profession of the commercial production and issuance of literature and information. 2: Computer-aided systems to automate the creation and printing of documents.

punch/shear/bend programmable machine tool. Describes the action that occurs to a composite or material, generally metal, on a machine. Punching literally punches a hole in the material, shearing cuts the material, and bending forms the material to a specified predetermined shape. These three activities are performed on three separate machines.

purchasing. A software application that has computer-assisted generation or procurement documents specifying materials, quantities, and delivery times.

purchasing and vendor management. Contains statements as to the quantity, description, and price of the goods; agreed terms as to payments, discounts, date of performance, and transportation.

PVD. See **physical vapor deposition.**

PW—private wire leased circuits. See **private line.**

Q

QC. See **quality control.**

QC analysis. Quality control analysis is generally performed throughout the manufacturing process, comparing the actual part shape or feature size to the design specification.

quality. The measure of how well a product or service meets customer expectations. Alternately, the ability to produce consistently a product or service within control limits or well-defined specifications.

quality assurance. The establishment and execution of procedures to measure product quality and adherence to acceptance criteria.

quality control. Process by which product is measured to ensure conformance to specification and standards.

query language. A generalized computer language that is used to interrogate a database.

R

R&D. See **research and development.**

radar. A radio device used to locate objects by frequency waves reflected off the object and received by the sender, allowing the sender to determine characteristics of an object. Includes airborne, shipboard, and ground search, flight control acquisition, detection, tracking, and associated test systems.

radio. 1: The use of electronic waves/signals to produce sound. 2: Home radio receivers including AM, AM-FM, and FM radios that are classified as table models, clock models, and portable radios. This category does not include high-fidelity receivers, radio-phonograph combinations, and television receivers, nor does it include automobile radios, stereos, or tape players.

railroad control. An application that monitors and controls railroad and urban rapid transit traffic.

RAM. See **random-access memory.**

random-access memory (RAM). An integrated circuit permitting read-and-write access to any memory cell or address in a completely random sequence. Can be of either bipolar or MOS technology process. A memory device with the qualities of allowing arbitrary reading or writing of a desired data location. The system accesses the addressed material without reading through intervening data. Information may be retrieved more speedily from RAM than from serial media, such as tape. Also called read-and-write and scratchpad memory.

rapid thermal processing (RTP). Process that uses machines of low temperature for contact alloying and systems for the deposition of thin gate oxides. Similar to the diffusion furnace.

RBOC. See **regional bell operating company.**

reactant gas. Molecules that act upon one another to produce a new set of molecules.

read-only memory (ROM). 1: Computer memory that can be read from but not written to. Permanent memory on chips wherein information can be retrieved but not stored. Memory is not lost when the power to the computer system is turned off. 2: A memory device the contents of which can be read but not altered. (See also **mask ROM.**)

real estate. An environment or industry that includes owners, lessors, lessees, buyers, sellers, agents, and developers of real estate.

real-time clock. A clock that indicates actual time, such as elapsed time, as opposed to a fictitious time established by a program.

real-time data acquisition and control. 1: The process by which events in the real world are translated to machine-readable signals. 2: Automated systems in which sensors of one type or another are attached to machinery. 3: Data processing is performed so that the results are available in time to influence the controlled or monitored system.

reconnaissance. Equipment used to secure data/information about activity and resources concerning an enemy or potential enemy's territory.

reduced-instruction-set computing microprocessor (RISC MPU). The number of instructions a microprocessor runs for a specific application are reduced from a general-purpose complex-instruction-set computing (CISC) microprocessor to create a more efficient computing engine.

reel-to-reel tape drive. A tape format in which the running tape is wound onto a separate take-up reel. Also known as open reel.

regional bell operating company (RBOC). Seven holding companies formed by the divestiture of AT&T to provide regulated and nonregulated telecommunications services in the United States.

relational database management system. A software application for the storage, retrieval, update, and analysis of multiple databases. These databases are linked (related) through one or more identical fields, called keys.

relay. 1: An electronic or electromechanical device for transferring a signal from one electrical circuit to another. 2: To forward a message through an intermediate station. (See also **passive device.**)

remote batch. A method of entering jobs into the computer from a remote terminal.

remote control. Any system of control performed from a distance. The control signal may be conveyed by intervening wires, sounds, light, or radio signals.

remote processing. A procedure in which the operating system can be used to process messages received from remote locations via telephone lines and telephone equipment. In effect, it is an extension of the data processing and programming facilities of the computer to remote locations.

remote sensing. The acquisition of information (usually in the form of an image) about an object or area by recording electromagnetic radiation emanating from or reflected from the target. The electromagnetic energy is received and processed by a detector system that is not in physical contact with the target under study. Common platforms for detector systems are aircraft and satellites, but the definition is not restricted to these two.

removable media disk drive. Removable media rigid disk drive has the platter enclosed in a housing that is designed to be user-accessible.

replacement demand. The subsequent demand by end users for new equipment.

research and development (R&D). Basic and applied research directed toward the discovery, invention, design, or development of new products and processes.

research supercomputer. An information system defined by a minimum of 32 low-performance computing nodes. Optimized to run highly parallel applications. Price ranges between $300,000 and $2 million.

residual value. The value of a product at the end of its useful life. Typically used with depreciation and leasing calculations.

resistor. A passive device that measurably opposes the passage of an electric current (e.g., doped silicon). (See also **passive device.**)

respiratory analysis. Equipment used to examine, detect, and analyze the respiratory system.

retail trade. An environment or industry that includes establishments engaged in selling merchandise for personal or household consumption and rendering services incidental to the sale of the goods. In general, retail establishments are classified by kind of business according to the principal lines of commodities sold.

retirement. The number of products that are removed from use. A product is considered retired from the installed base if it is scrapped, returned to the manufacturer, or placed in storage.

return. The number of units previously sold outright that have been returned or retired by the customer. (See also **retirement.**)

revenue. The amount of money that a company receives from its customers for goods and services.

rewritable optical disk drive. An optical disk drive that uses removable media that can be erased and reused many times (also called erasable optical disk drive).

ribbon. A strip of inked material or fabric, which when struck with a print element forms a character on paper. (See also **single-strike ribbon, web ribbon, film ribbon, multistrike ribbon.**)

rigid disk. See **rigid disk computer storage media.**

rigid disk computer storage media. A rigid disk has a nonflexible substrate and can be made of aluminum, plastic, glass, or other rigid material.

RISC MPU. See **reduced-instruction-set computing microprocessor.**

robot. A reprogrammable multifunctional manipulator designed to move objects through variable motions for the performance of a variety of tasks. Intelligent robots commonly rely on vision systems to control their behavior through their ability to recognize objects.

robotic electronic assembly. Electronic manipulative machines that can perform functions ordinarily ascribed to humans in the assembly of material.

robotic nonelectric assembly. Same as robotic electronic assembly except that robots are mechanically maneuvered rather than through the methods and principles of electronics.

robot programming and simulation. The use of computer-controlled manipulators or arms to automate a variety of manufacturing processes such as welding, material handling, painting, and assembly.

robot system. Programmable manipulative machines that can perform functions ordinarily ascribed to humans. Included are robotic mechanisms, control hardware and software, and all associated peripheral equipment. These peripherals include end effectors and grippers that are used for the processing of parts, tools, and assemblies within the factory.

ROM. See **read-only memory.**

routing. An application that supports route planning. It is used to schedule the sequence of stops a transport vehicle makes.

RTP. See **rapid thermal processing.**

S

safety and convenience. Equipment related to the automobile and truck industry including devices that prevent loss, hurt, or injury, or that lend ease and comfort to passengers. Examples include: climate control, light reminder, keyless entry, heated windshield, sensing wipers, automatic door lock, automatic headlights, dimming, rear window defogger, antiskid braking, window control, and airbags/restraint control.

satellite. 1: A specialized radio transmitter/receiver placed in orbit around the earth to provide transmission channels for information to be transmitted over great distances. 2: A celestial body orbiting another of larger size.

satellite communication equipment. Equipment used for communication by use of an active or passive satellite to extend the range of a radio, or other transmitter, by returning signals to earth from an orbiting satellite.

satellite earth station equipment. The total earth-based equipment used in connection with orbiting, geostationary satellites. This category includes the Very Small Aperture Terminals (VSAT), as well as the antennae and electronic transmitting/receiving terminals.

scanner. Input devices used for the optical sensing of images and text and/or graphics for conversion to dot patterns for incorporation into a document. This category includes both ICR and OCR scanners with a resolution of less than 400 dpi.

scheduling. An application that supports the scheduling of events.

schematic. This is a detailed diagram. In a mechanical application, schematics are used to describe hydraulic and pneumatic systems. A set of symbols are available for both applications representing standard components.

scholarships and fellowships. College expenditures applying only to money given in the form of outright grants and trainee stipends to individuals enrolled in formal coursework, either for credit or not. Aid to students in the form of tuition or fee remissions is included. College work-study funds are excluded from this category and are reported under the program in which the student is working.

Schottky TTL (STTL). A form of transistor-transistor logic using Schottky diodes as transistor clamps to increase the speed of circuit operation. A high-speed form of bipolar logic.

scientific application. A diverse group of software applications covering varied subject matter and research on the natural sciences when these are concerned with the physical world and its phenomena. Applications are divided into two subcategories: general analysis and scientific research. General analysis is the use of computers to solve various technical problems and to further research on subjects; this use is generally mathematical in nature. Scientific research applications are used specifically in the following fields: thermonuclear chemistry, nuclear physics, general physics, mechanical sciences, electronics research, geophysics, fluid dynamics, thermodynamics, materials research, and genetic engineering.

scientific research. A software application that pertains to research and development, not to applied science.

scientific visualization. An image computer is used for scientific modeling, technical data analysis, medical imaging, or similar large-volume data analysis.

security. 1: The existence and enforcement of techniques that restrict access to data and the conditions under which data can be obtained. 2: A measure taken by a command to protect a system from espionage, observation, sabotage, annoyance, or surprise. 3: Protection of a system by use of commands and codes.

security/energy management. Safety and power management within industrial equipment and manufacturing.

seismic analysis. 1: Seismic analysis helps support exploration activities by indicating favorable conditions for finding oil or coal reservoirs. 2: Analysis relating to an earth vibration caused by earthquakes, or other natural phenomena.

semiconductor. 1: A group of materials that are electrical nonconductors in a pure state that can be altered by the selective introduction of impurities into its crystalline structure. Its resistivity can sometimes be changed by light, an electric field, or a magnetic field. 2: An electronic device made using semiconductor material.

semiconductor tester. Equipment designed to test, check, and monitor the functionality of electronic circuit packages of varying complexity and functionality.

serial, impact, dot matrix (SIDM). A printer that creates a character image by selectively placing individual dots on the substrate using mechanical force.

serial, impact, fully formed (SIFF). A printer that prints one character at a time using type elements to create fully formed character impressions.

serial input/output (SIO). 1: A device that permits data to be transmitted into and out of a computer over a single conductor one bit at a time. 2: Pertaining to time sequential transmission of, storage of, or logical operations on parts of data words. 3: A technique for handling binary data words (which have more than one bit). 4: A device or technique where data are transferred to or from an I/O port in a serial or in-line manner.

serial, nonimpact, direct thermal (SNDT). A printer that creates the desired image a dot at a time using point-specific heat and a heat-sensitive substrate that changes color when exposed to heat.

serial, nonimpact, ink jet (SNIJ). A printer that creates the desired image a character at a time by emitting ink from an array of orifices or nozzles.

serial nonimpact, thermal transfer (SNTT). A printer that creates the desired image a dot at a time using point-specific heat to transfer ink from a ribbon to a receiving substrate.

server. A processor that provides a specific service to a network, such as connecting nodes of different networks.

services. Intangible items of trade, such as education, transportation, banking, and legal and medical care.

SFDSP. See **special-function DSP products.**

sheet feeder. A sheet feeder is mounted on top of a printer and automatically inserts cut sheets into the printer and receives the ejected paper in a hopper. Sheet feeders may be single or dual tray for the feeding of letterhead and second sheets, or they may incorporate an envelope-feed tray for the printing of letters and envelopes simultaneously.

shipment. The number of products delivered.

shop floor and cell control. A system for utilizing data from the shop floor as well as data-processing files to maintain and communicate status information on shop orders and work centers. Provides actual output data for capacity control purposes.

shop floor planning and control. See **shop floor and cell control.**

SIDM. See **serial, impact, dot matrix.**

SIFF. See **serial, impact, fully formed.**

silicon epitaxy deposition. A process through which vaporized silicon is deposited on a wafer. (See also **deposition.**)

silicon precursor gas. A specialty gas used in semiconductor manufacturing. Gases such as silane, dichlorosilane, trichlorosilane, and silicon tetrachloride are used in epitaxial and chemical vapor deposition (CVD) processes to deposit layers of silicon or silicon components onto silicon substrates.

silicon wafer. A nonmetallic element that is the most widely used semiconductor material today. Silicon is used in its crystalline form as the substrate of semiconductor devices.

simulation. An application or system that uses representative or artificial data to reproduce various conditions in a model that are likely to occur in the actual performance of a system. Simulation frequently is used to test the behavior of a system under different operating policies.

simulation and training equipment. Equipment used to augment the acting out of real-life maneuvers/exercises as training in preparation for real-life situations. Equipment includes aircraft, flight and situation simulators, equipment operation, and maintenance systems.

single-strike ribbon. A film ribbon. Each time a character strikes the ribbon, the ribbon advances far enough so that the next character has a completely new ribbon area to strike. The ink formulation is such that the ink on the ribbon is depleted from the area where the print element strikes the ribbon. These ribbons produce the highest print quality, but ribbon life is low compared with that of fabric and multistrike ribbons.

single-user enhanced system. See **workstation computer.**

SIO. See **serial input/output.**

slow SRAM. A random-access memory (RAM) integrated circuit (IC) that runs at speeds greater than 70 nanoseconds. (See also **static random-access memory.**)

small-format pen plotter. A computer plotter that uses engineering-size A (8.5 x 11 inches) or B (11 x 17 inches), architectural-size 1 (9 x 12 inches) or 2 (12 x 18 inches), or metric-size A4 (21 x 29.7 centimeters) or A3 (29.7 x 42 centimeters) media. (See also **plotter.**)

small-signal diode. A diode with a forward current of less than 100 milliamperes (0.1 amperes). The sides of the silicon chip are metallized and encapsulated in a tubular glass package.

small-signal transistor. A transistor that dissipates power of less than 1 watt.

smart card. A credit card or credit-card-size device that contains one or more integrated circuits. These devices usually are carried by an individual. Common applications include financial transactions, record keeping, and user identification.

smart interactive terminal. See **intelligent terminal.**

smart power. An integrated circuit (IC) that contains both control logic circuits and power control elements.

smoke alarm. A detector that is activated automatically when exposed to smoke.

SNA. See **system network architecture.**

SNDT. See **serial, nonimpact, direct thermal.**

SNIJ. See **serial, nonimpact, ink jet.**

SNTT. See **serial, nonimpact, thermal transfer.**

socket. An opening that supports and electrically connects to vacuum tubes, bulbs, or other devices or components when they are inserted into it.

software. 1: Any set of explicit procedures constituting a computer program. 2: Programs, procedures, rules, and any associated documentation pertaining to computer operations.

software support service. Activities that assist the end user in use and implementation of software products. Software support includes bug fixing, updates, and documentation, as well as support of ongoing operating problems including product-specific consulting, programming services, and training.

solar cell. A pn junction device that converts the radiant energy of sunlight directly and efficiently into electrical energy.

solid modeling. An application that represents the external and internal part geometries, allowing the solid nature of an object to be represented in a computer. Solid models are constructed in two ways: using primitive building blocks (constructive solid geometry) and/or using boundary definitions (boundary representation).

solid state. Pertaining to circuits and components using semiconductors. (See also **semiconductor.**)

solid-state subsystem. Computer memory products that comprise a block of semiconductor memory, a controller/formatter for it, a power source or access to power, a host bus interface, hardware, and software. These include modules external to the computer and kits for installation inside computers.

sonar. A device used to detect submerged objects by sonar waves reflected off the object. Also can be used to measure depth or distance. Includes search, detection, tracking, guidance, navigation, communication, sonabuoys, and associated test systems.

SONET. See **synchronous optical network.**

space military equipment. Military equipment used beyond the earth's atmosphere. Includes satellites with accompanying communication and reconnaissance equipment, various other space platforms, launch vehicles, and ground control.

special automotive IC. An analog IC designed for a specific automotive application.

special consumer IC. An analog IC designed for use solely in consumer home entertainment and appliance products.

special-function analog IC. An analog integrated circuit function used in specialized applications. Examples are sensors, timers, and oscillators. These devices differ from application-specific standard products (ASSPs) in being functional blocks rather than complex configurations of functions for specific applications.

special-function DSP products (SFDSP). Products built using DSP techniques and architectures but designed for specific functions. Examples include: modems, codecs, speech processors, digital television circuits, digital filters, and fast Fourier transform (FFT) chips. Generally, these devices cannot be programmed by users to perform operations other than their defined function.

special-function IC. A linear IC that does not fall into the standard product categories. This product has a specific function such as timer, oscillator, signal generator, or sensor but is not limited to a single application or market.

special-purpose computer system. A computer system designed for a specific purpose. For example: a banking computer system, word processor, or cash register.

specialty gas. A gas used in manufacturing semiconductors that is supplied in gas cylinders rather than in bulk because smaller volumes are used.

splice. A joint used to connect two lengths of conductor with good mechanical strength and good conductivity. (See also **passive device.**)

spot-welding robot system. A robot carries a resistance welding gun to produce welds.

spreadsheet. An application with the principal function of organizing data into columns and rows to allow the user to perform numerical analysis.

SRAM. See **static random-access memory.**

standard cell. An integrated circuit designed to a customer's specifications using precharacterized cells as building blocks.

standard logic. Off-the-shelf integrated circuits belonging to "families." Bipolar digital families include AS, FAST, LS, and ALS. MOS digital families include HC, HCT, and FACT. Standard logic is available from a number of suppliers and may be used in many different applications. Sometimes referred to as glue logic. Normally has less than 150 logic gates.

start-stop tape drive. A tape drive that starts and stops on reading or writing a data record.

state government. One of the constituent units of a nation having a federal government.

static random-access memory (SRAM). A RAM that maintains memory as long as power is applied and does not require refreshing. SRAM densities can range from 1K, with approximately 1,000 bits, to 4Mb, with approximately 4 million bits.

statistical multiplexer. An electronic device that consolidates several data streams onto a single high-speed bit stream for transmission over a telephone line.

stepper. A semiconductor manufacturing device that uses a step-and-repeat process to transform the pattern image of a reticle or mask onto the surface of the semiconductor wafer.

stereo headphone. A device worn on the head that permits the transmission of sound through two earphones connected by a band.

stereo (hi-fi) component. Equipment that produces high-fidelity reproduction of sound.

storage controller board. 1: A board containing input data or parameters for an application of a general routine. 2: Those parts mounted on a board that carry out the instructions in proper sequence, interpret each instruction, and apply the proper signal.

storage management. Functions that manage the storage of information in which information can later be retrieved. Includes storage protection, storage temperature, storage print, and storage allocation.

storage subsystem. Computer memory product that comprises a storage device(s), a controller/formatter for it, a power source or access to power, a host bus interface, hardware, and software. These include modules external to the computer and kits for installation inside computers.

streamer tape drive. A tape drive that uses a continuously moving tape; one that does not start and stop on each data record.

streaming tape drive. Tape drives (1/4-inch and 1/2-inch width) where the data stream over the head without stopping (continuous flow).

structural. The dynamics of the physical system; usually refers to the static stability/integrity of a part, assembly, or system.

structural modeling/analysis. A software application for modeling and analysis of the integrity of a structure.

STTL. See **Schottky TTL.**

studio transmitter link. Equipment used to generate and amplify a radio signal.

styling. A detailed design process where aesthetic considerations are foremost. Systems supporting this application have special refinements for rendering, modeling, and editing functions.

subsidiary. A company partially or wholly owned by another company.

supercomputer. A high-performance computer designed for numerically intensive applications. The current price ranges from approximately $100,000 to $20 million.

superminicomputer. An information system with price ranging typically from $100,000 to $1 million, with a minority below $100,000. CPU bit width ranges from 32 to 48 bits, with emphasis on 32. Environment is almost exclusively an ordinary office with no special environmental controls. Equipment typically is supported full-time by a professional computer systems support staff of fewer than 10 members. It usually is built around proprietary processor and typically supports from 32 to 350 concurrent users. Examples of models are the HP 3000/930 and 950, DEC VAX 8700 and Micro VAX 3500, and IBM 9370.

superworkstation. A superworkstation has higher graphics performance than a traditional workstation. It also has a higher processing performance rating to support graphic computations. The average price is $40,000 to $80,000 with performance ratings of 8 to 20 mips and 2 to 16 mflops.

surgical support. Equipment relating to, or having connection with, surgery.

surveying and drafting instrument. An instrument used to detect, access, and measure radiation. The instrument is used in the drawing of objects, structures, or systems by engineers and scientists.

switch. 1: A mechanical or electrical device that competes with or breaks the pattern of a current or sends it over a different path. 2: A device that connects, disconnects, or transfers one or more circuits and is not designated as a controller, relay, or control valve. (See also **passive device.**)

switch/multiplexer IC. Analog switches gate analog signals under the control of logic. Multiplexers are specialized analog switches that select only one of many inputs.

synchronous optical network (SONET). An emerging standard for optical networks.

system management. The administration and operation of a computer system including staffing, scheduling, equipment, and service contract administration, equipment utilization practices, and time-sharing.

system network architecture (SNA). An IBM standard for data communication.

systems integration service. The implementation phase of tying together dissimilar devices. Services are coordinated by a single contractor who manages the procurement, installation, integration, and support of all software, hardware, and communications devices.

systems integrator. See **value-added reseller.**

system software. Software that provides support structure in which applications may operate. This includes operating systems, operating environments, and utilities.

systems planning and design. "Front-end" consulting services that are required to determine the nature of a customer's needs and the actions necessary to meet those requirements.

system subroutine library. An organized collection of computer programs that is maintained online with a computer system by being held on a secondary storage device and is managed by the operating system.

system support peripheral. An integrated circuit (IC) considered a traditional peripheral, where each processor has a set of six to eight dedicated peripherals that provide rudimentary functions necessary to construct a microprocessor (MPU)-based system. (See also **traditional peripheral.**)

system utilities. Products that aid in the maintenance and/or repair of computer hardware, operating systems, or data recovery.

T

2-D modeling. The representation of a part in two dimensions (has an x and y coordinate). This format requires three or more views (top, front, side) to depict all aspects of the part. This is the most common geometric modeling format and is used extensively with a drafting function.

3-D modeling. The representation of a part in three dimensions, usually in a wire-frame format (has an x, y, and z coordinate). This format is used commonly in high-level CAD systems to determine the placement and fit of components in an assembly. This format is not generally used for final drafting, although some systems have the capability to translate the 3-D image to a 2-D standard drafting format.

T-1. A high-speed, time-division, digital network link operating at 1.544 Mbps and above.

T-1 multiplexer. A unit that allows multiplexing, or combining, several voice and/or data channels onto one communications link, in this case, a high-speed T-1 channel.

tape drive. A class of computer backup device that uses reel-to-reel, cartridge, or cassette tapes as media.

tape recorder. A device that records and plays sound from magnetic tape.

tax accounting. An application concerned with keeping records for tax purposes, setting up accounts for paying taxes, making tax computations, and preparing tax returns.

TDM. See **time-division multiplexer.**

teaching machine and aid. Equipment designed to assist in the training, educating, and instructing of persons to acquire knowledge or skill in a particular field(s) of interest.

technical data analysis. An application that analyzes technical or experimental data. The data may have been generated from instruments, captured from other electronic measuring devices (such as thermocouples or strain gauges), or generated by other analysis programs.

technical illustration. A drawing of a component or assembly that generally is intended for publication. This drawing will omit unnecessary dimensions and other detailed drating items and will be drawn so as to depict the part realistically.

technical productivity. An application that enhances the productivity of technical disciplines and is specialized for the engineering, scientific, or manufacturing fields.

technical publishing. The printing of user manuals or guides.

telecommunication integrated circuit (IC). An analog IC designed for the voice and data communication market.

telecommunications. Products and services that provide or manage the flow of information from person to person, person to machine, machine to person, or machine to machine. The telecommunications market is segmented into a combination of the premises and public telecommunications market segments.

telecom services. Includes that portion of telecommunications charges related to access and use of the public network. These charges typically are seen as a monthly usage charge for local, long distance, and private line access/utilization.

teleconferencing. Equipment and services related to one-way and two-way video communications that use specialized video equipment and/or transmission networks. These communications enable conferencing between locations.

telemarketing. A sales method that employs a sales force to move a product through the distribution channel by contacting the consumer via the telephone. Also referred to as inside sales.

telemetering system. See **telemetry.**

telemetry. Transmission of data from remote measuring instruments by electrical or, usually, radio means.

telephone. A terminal or handset used for voice and data transmission and communications. It functions as an interface between a user and a telephone switching system.

TELeprinter EXchange (TELEX). A worldwide dial-up telegraph service enabling users to communicate directly and temporarily among themselves by means of start-stop apparatus and circuits of the public telegraph network.

teletex. An interactive communications network designed for transmission of text and graphics to televisions or other low-cost terminals.

TELEX. See **TELeprinter EXchange.**

tension arm tape drive. A 1/2-inch reel-to-reel tape drive that uses mechanical tension arms to provide tape tension and buffing.

terminal equipment. 1: A device at a node of a network through which information can be entered, extracted, or monitored. 2: Any device capable of sending and/or receiving information over a communications channel. Includes a keyboard and display that cannot stand alone because it lacks processing capability. Terminals are usually simple ASCII text-entry devices.

terms and conditions. The provisions of a contract that are stated or offered for acceptance that determine the nature and scope of the agreement.

test and measurement. The process of determining the magnitude of the response of an object to a given stimulus. Also the degree to which an object may be characterized along a dimension (quantification of an entity). Computer-based inspection and test systems used for quality and/or process control data analysis; data may be collected by manual input or sensory devices.

test equipment. Equipment designed to test, check, monitor, and identify varying degrees of device functionality and complexity that may include quality, speed, and performance. Automated test systems and equipment such as IC testers and PC-board testers, as well as general test equipment (such as oscilloscopes, spectrum analyzers, and digital multimeters).

text capture. Process whereby words or groups of words are controlled.

therapeutic. Medical applications involved in treating specific medical conditions.

thermal. The effects of temperature on the system.

thermal plotter. 1: A process that produces a visible image by heat-induced chemical reactions or chemically reactive media. 2: A thermally induced phase change process of a pigment-binder mixture, which is transferred from a donor sheet to the media.

thermal transfer printer. An imaging process using heated printing elements to produce prints or copies; can be either dye diffusion (coated paper) or wax based (plain paper). This process currently is used in electronic printing, facsimile machines, and full-color copiers.

thimble. A thimble-shaped print element that floats freely across the platen of a character printer, working in a similar fashion to a daisyprint element. It is shaped like a cup, with the spokes extending around the rim of the cup, with characters positioned at the end of the spokes.

thyristor. A type of diode that consists of a four-layer slice of silicon. The device is characterized by continuous switching. Once a thyristor has been triggered into conducting current, it will continue to conduct current until the main current falls to zero.

ticketing. A software application that supports the sale and management of tickets. The application may be as simple as ticketing a single event or as complex as ticketing airline reservations.

tie ratio. A ratio that describes the relationship between two or more product units, usually used when one product is part of or connected to another product. For example, a disk drive tie ratio to PCs of 0.8 indicates that 80 percent of the PCs contain a disk drive.

time and materials service. Remedial repair services on a per-call basis. Pricing is based on the actual length of time-to-repair, travel charges, and specific parts or materials required to complete repairs.

time-division multiplexer (TDM). One of several technologies used to multiplex, or combine, several voice and/or data channels onto one communications link. TDM uses "time slicing" to allocate blocks of time to each channel. See also **statistical multiplexer.**

TLX. See **TELeprinter EXchange.**

toner. The substance used that develops a latent xerographic image from a photoreceptor onto a substrate, usually paper. Monocomponent toner contains both the imaging material and the carrier (usually called developer) needed to transport the toner to the latent image. In dual-component toner, the imaging material and developer are held separately until they are mixed by the copier or printer itself. Liquid toner has the imaging material suspended in a solvent.

tool design. The design of custom-made tooling to facilitate an effective manufacturing process.

tools. A software program that is used by application developers or users to create applications. Examples are spreadsheets, word processors, editors, macro languages, screen painters, and report generators. Tools are higher-level products than languages; a tool is written in a language. Unlike languages, most tools are nonprocedural, i.e., they do not require users to create code that is sequentially executed. A good example of this is a spreadsheet, where the developer/user navigates up, down, and sideways with the arrow keys or mouse and can add or delete rows and columns at any time. Examples of tools include Lotus 1-2-3 (spreadsheet); Multimate (word processor); EDLIN (line editor); and Ojectworks (graphical editing and object manipulation environment).

trading turret/dealer board. A specialized type of telephone system that allows simultaneous access to multiple telephone lines. This system is used in any business that requires frequent conversations between two or more parties (i.e., stock brokers).

traditional peripheral. An integrated circuit that has an intermediary control device, which links a peripheral unit to the control processors.

traditional workstation. A midrange workstation priced between $15,000 to $50,000. Its performance ratings are 4 to 15 mips and 0.5 to 2 mflops.

traffic control. A real-time software application, mechanism, and system used to monitor and control, exert control over, and/or enforce the movement of vehicles.

transducer. Any device or element that converts an input signal into an output signal of a different form. (See also **passive device.**)

transistor. A transistor is as a current-amplifying device or switch, as follows: 1: Current amplifying—a small change in a small current flows between the collector and the emitter. 2: Switch—a sufficiently large voltage applied to the base causes the maximum amount of collective current to flow. It can be manufactured in bipolar or MOS technology process. A bipolar transistor consists of a sandwich of doped silicon layers. The transistor has three electrical connections: base, emitter, and collector. Each of these areas provides access to one of the doped regions.

transistor-transistor logic (TTL). A logic circuit design with the diode inputs replaced by a multiple-emitter transistor.

translator. The process performed by an assembler, compiler, or other routine that accepts statements in one language and converts them to another language. 2: A device that transforms signals from one form to another form. 3: A system that has a number of inputs and outputs and is connected so that input signals representing information expressed in a certain code result in output signals that represent the input information in a different code.

transmitter. 1: A device for transmitting a coded signal. 2: The carbon device in the telephone handset used to convert speech to electrical energy.

transparency. 1: The property of being insensitive to the meaning of a code being manipulated. An example is a paper-tape transmitter capable of transmitting any code submitted to it. If a device interprets and reacts to coded information that it is handling, it is said to be code sensitive (not transparent). 2: Clear substrates upon which images can be written, copied, or printed for projection onto a screen by an overhead projector.

transportable personal computer. The transportable personal computer is a self-contained system that can be moved from place to place as a single unit. These systems include, in a single unit, the keyboard, display, mass storage, and main system unit. Such a personal computer operates on A/C power only (no battery power).

transportation. An environment or industry that includes establishments providing, to the general public or the other business enterprises, passenger and freight transportation.

transportation electronic equipment. Electronic equipment used in the automotive railway and airline industry.

transportation management. The planning, analysis, and control of activities for transporting or being transported.

TTL. See **transistor-transistor logic.**

two-year college. A postsecondary school that offers general or liberal arts education usually leading to an associate degree or courses that are creditable toward a baccalaureate degree.

two-year institution. An institution legally authorized to offer and offering at least a two-year program of college-level studies that terminates in an associate degree or is principally creditable toward a baccalaureate degree.

typewriter. A machine for writing in characters by means of a keyboard operated by striking through an inked ribbon. Usually refers to the standard office typewriter (mechanical, electrical, or electronic).

U

UART/USART. See **universal asynchronous receiver/transmitter/universal synchronous asynchronous receiver/transmitter.**

ultrasonic cleaners, drills. 1: An instrument used to clean debris and swarf from surfaces by immersion in a solvent in which ultrasonic vibrations are excited. 2: A drill in which ultrasonic vibrations are generated by the compression and extension of a core electrostrictive or magnetostrictive material.

ultrasonic generator. A generator consisting of an oscillator driving an electracoustic transducer used to produce acoustic waves.

ultrasonic scanner, medical. A device that produces a picture display of ultrasonic frequency waves sent through the sample to be inspected or examined.

ultraviolet electrically programmable ROM. An EPROM that is erasable with an ultraviolet light source.

unit. A single quantity.

universal asynchronous receiver/transmitter/ universal synchronous asynchronous receiver/ transmitter (UART/USART). An electronic circuit that converts data between the parallel format and the serial format transmitted sequentially over a communication line.

UNIX. An operating system designed to be used with microprocessors and with the C programming language.

useful life. The economic life of a product. Typically used to determine depreciation and leasing schedules.

user interface. 1: The point at which a user interacts with a computer. 2: An interactive computer program that sends messages to and receives instructions from a terminal user.

users per system. The typical number of simultaneous users that a computer system will support.

utilities. An environment or industry that includes establishments providing electricity, gas, steam, water, or sanitary services to the general public or to other business enterprises.

UV EPROM. See **ultraviolet electrically programmable ROM.**

V

vacuum column tape drive. A 1/2-inch reel-to-reel tape drive with start-stop capability that uses vacuum columns to provide tape tension and buffing.

value-added network (VAN). A data communication network that provides enhanced services such as protocol conversion.

value-added reseller (VAR) systems integrator. A product reseller that integrates hardware, software, and/or services; it does not apply its label to the product. Systems integrators are a type of VAR and may or may not own the hardware or software.

VAN. See **value-added network.**

VAR. See **value-added reseller systems integrator.**

VAX/VMS. A Digital Equipment Corporation standard multiuser operating system.

VCR. See **videocassette recorder and player.**

vertical-turning programmable machine tool. The tool of a machine that holds a workpiece along the vertical axis for a certain function to be performed such as boring, drilling, and cutting.

vibrational. The effects of vibration and shock on the system.

video. 1: Relates to the bandwidth (megahertz) and spectrum position of the signal arising from television scanning. 2: The reception or recording of electronic signals that create images on a screen or display.

video camera. A camera that records visual images and sounds on magnetic tape.

videocassette recorder and player (VCRs or VTRs). A complete system that has a tape format such as beta, VHS, or 8mm.

videodisc player. A complete video system that has a disc format.

video equipment. Equipment includes amplifiers, television cameras, and other equipment such as synchronization equipment, live cameras, and control consoles.

video home system (VHS) helical scan tape drive. A 13mm helical scan tape drive commonly used for recording television broadcasts.

videotex. An information delivery system that uses information from a database that allows the user to interact with the service, selecting information to be displayed on the user's CRT providing financial services, electronic mail, and teleshopping.

virtual private network (VPN). Similar in function to a leased circuit with the exception that the circuit is not dedicated to one customer.

VLSI. Very large scale integration.

VMS. See **voice-messaging system.**

voice-messaging system (VMS). A computer-based system that enables flexible, nonsimultaneous voice communications. This definition does not include personal-computer-board-level products.

voice-recognition computer device. The capability of a computer to recognize spoken commands. Each user must first "train" the computer by speaking a series of words that the computer can analyze and match with stored information.

voice response unit (VRU). A computer-connected device that selectively links sentences of stored words, creating a spoken word.

voice synthesizer. A device that simulates speech by assembling a language's elements under digital control.

voice terminal. See **telephone.**

voltage regulator and reference IC. 1: A device that provides power to other circuits at a specified DC voltage. 2: A device that provides a specified constant DC voltage to a load over a wide range of variations in input voltage and output current.

VPN. See **virtual private network.**

VRU. See **voice response unit.**

VTR. See **videocassette recorder and player.**

W

wafer. A thin (10 to 20 mils) disk of semiconductor material from which semiconductors are fabricated.

wafer fab. The integrated circuit production process—from raw wafers through a series of diffusion, etching, photolithographic, and other steps to finished wafers.

wafer fabrication equipment. Machinery used to produce wafers in the semiconductor industry. (See also **e-beam, etch-and-clean equipment, stepper.**)

wafer inspection. Inspection of patterned wafers for process defects by visual and image-processing techniques.

water quality and sewage control. A real-time software application that monitors and controls water quality and sewage.

WATS. See **wide area telephone service.**

web ribbon. Web or towel ribbons are wide ribbons used on line, dot matrix, and line, fully formed printers. They are as wide as the print line is long—usually approximately 15 inches.

wet chemical. A chemical used in semiconductor wafer fabrication. Examples are acids and solvents.

wet etch. Immersing method for wafers in an etching solution. Chemical removal of a material by bathing the wafer in acid.

white-collar worker. A person working in an occupation classified by the Bureau of Labor Statistics under the following category headings: managerial and professional specialty and technical, sales, and administrative support.

wholesale trade. An environment or industry that includes establishments or places of business primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, farm, construction contractors, or professional business users; or to other wholesalers; or acting as agents or brokers in buying merchandise for or selling merchandise to such persons or companies.

wide area telephone service. An enhanced telephone company service allowing reduced costs of certain telephone call arrangements. This service can be in-wats or 800-number service (calls can be placed to a location from anywhere at no cost to the calling party) or out-wats (calls can be placed out from a central location).

word processing. A software application with the principal function of editing, entering, and formatting text.

word processor (WP). A standalone word processor capable of functioning independently from a central controller or storage device, although they may communicate with each other. These products generally have removable magnetic media. Products that have evolved from electronic typewriters generally are not included in this category. The ability to share a printer among workstations does not disqualify a product from being a standalone word processor; shared-system word processors are connected to an external file server or controller; word-processor file servers are centralized data storage devices that are accessible and dedicated to shared word processing units.

work force. All persons of either sex who furnish the supply of labor for the production of economic goods and services during a specified time period.

workstation computer. A single-user computer that is distinguished from a personal computer by its features and by the user's potential migration path within the platform. A technical workstation is a system designed with integrated networking; high-performance graphics; floating point; coprocessor; and a virtual, multiuser/multitasking operating system (DOMAIN, UNIX, VMS).

WORM. See **write-once/read-many.**

WP. See **word processor.**

write-once/read-many (WORM). 1: The WORM optical disk market includes drives that can read and write data using various optical diskette media. 2: A data storage device using laser technology that uses a removable disk ranging in size from 3.5 to 14 inches.

X

X-ray (lithography). A machine that uses an X ray for generating a mask plate of direct image transfer to a semiconductor wafer.

X-ray, medical. Equipment used to detect, examine, treat, or analyze body systems through photographic X-rays.

X.25. A CCITT standard that defines the interface between a public data network and a pocket-mode user device; also defines the services that these user devices can expect from the X.25 public data network.

Y

year-average population. The installed base of a product computed at the midyear between the beginning installed base and the ending installed base of the same year.

Z

zener diode. 1: A diode that has a controlled, reverse-voltage/current relationship. 2: A two-layer device that has a sudden rise in current above a certain reverse voltage.

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• Market Statistics

Dataquest

Semiconductor Consumption and Shipment Forecast

May 1991

Source: Dataquest

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Semiconductor Consumption and Shipment Forecast

Introduction

Semiconductor consumption and shipment data comprise a set of detailed tables that estimate the size of the semiconductor total available market (TAM) worldwide and for four major geographical regions for the years 1985 through 1995 and 2000. Semiconductor consumption and shipment tables contain both historical data and forecasts. Historical data begin with 1985 and end with 1990, while forecast data provide annual market size estimates for 1991 through 1995, with additional estimates for 2000. Below is a list of tables detailing the type of data, region, time period, and units of measure.

Each table gives estimates of semiconductor revenue or shipments listed by the major semiconductor device product categories. In these tables, semiconductor components are divided into three major product groups: integrated circuits, discrete devices, and optoelectronic devices. These groups are divided into a number of subgroups, some of which are segmented further.

Definitions and Conventions

Dataquest uses a common manufacturer base for all data tables. This base includes all suppliers to the merchant semiconductor market. It includes aggregate revenue estimates for North American companies that manufacture devices solely for the benefit of the parent company, such as Delco, IBM, and Unisys. Also included are companies that actively market semiconductor devices to the merchant market as well as to other divisions of their own companies. For such companies, both external and internal shipments are included. Devices that are used internally are valued at current market prices.

List of Tables

Table	Region Covered	Years	Units
0	Japan and Western Europe Exchange Rates	1970-1989	Various
1a	Worldwide Market	1985-1990	Dollars
1b	Worldwide Market	1985-1990	Percent
1c	Worldwide Market	1991-1995; 2000	Dollars
1d	Worldwide Market	1991-1995; 2000	Percent
2a	North American Market	1985-1990	Dollars
2b	North American Market	1985-1990	Percent
2c	North American Market	1991-1995; 2000	Dollars
2d	North American Market	1991-1995; 2000	Percent
3a	Japanese Market	1985-1990	Dollars
3b	Japanese Market	1985-1990	Percent
3c	Japanese Market	1991-1995; 2000	Dollars
3d	Japanese Market	1991-1995; 2000	Percent
4a	Japanese Market	1985-1990	Yen
4b	Japanese Market	1985-1990	Percent
4c	Japanese Market	1991-1995; 2000	Yen
4d	Japanese Market	1991-1995; 2000	Percent

(Continued)

List of Tables (Continued)

Consumption—Dataquest defines consumption as the purchase of a semiconductor device or devices. This definition must be differentiated from actual use of the device in a final product. A regional market size includes all devices sold to or shipped to that region, i.e., the TAM in that region.

Hybrids—In earlier consumption data, hybrid devices were included as a separate segment of integrated circuits. Hybrid devices manufactured by semiconductor companies are now included in the most appropriate product segment, usually the analog segment.

The manufacturer base, product group definitions, and guidelines for including value of output that we have used in our tables may differ from those used in other studies of this type. Our base is nearly the same as that used by the World Semiconductor Trade Statistics (WSTS) program, with the following exceptions:

- Dataquest includes all of AT&T's semiconductor revenue, both merchant and captive.
- Dataquest includes—and has included all along—nonrecurring engineering (NRE) charges associated with application-specific integrated circuit (ASIC) revenue. (This applies to both the bipolar digital and MOS digital logic categories.)
- Dataquest includes the revenue generated by sales of standalone circuit design software, sold by certain U.S. manufacturers of ASIC logic devices.
- Dataquest includes Signetics revenue with that of its parent company, Netherlands-based N.V. Philips.
- Dataquest includes revenue for Taiwanese semiconductor manufacturers.
- Dataquest includes revenue for three Japanese companies not included by WSTS until 1990: NMB Semiconductor, Seiko-Epson, and Yamaha.
- As noted herein, Dataquest includes hybrid revenue in the analog category.

Further information on the above points is available through Dataquest's Client Inquiry Center at (408) 437-8099.

Regions—North America is defined as including both the United States and Canada. Latin America, including Mexico, is considered part of the Asia/Pacific-ROW category. Asia/Pacific includes South Korea, Taiwan, Hong Kong, Singapore, and China. Western Europe includes Austria, Belgium, Germany, France, Italy, Luxembourg, the Netherlands, the Scandinavian countries (Denmark, Finland, Norway, Sweden), Spain, the United Kingdom, and the rest of Europe. Japan, the fourth region, is the only single-country region.

Data Sources

The historical information presented in the consumption and shipment data has been consolidated from a variety of sources, each of which focuses on a specific part of the market. These sources include the following:

- World Semiconductor Trade Statistics (WSTS) data, and Dataquest's estimates of regional company sales are used to determine shipments to North America.
- Japanese trade statistics compiled and published by the Ministry of Finance (MOF) and the Ministry of International Trade and Industry (MITI), WSTS data, and Dataquest's estimates of regional company sales are used to determine shipments to Japan.
- For Western European markets, marketing statistics from WSTS data and Dataquest's estimates of regional company sales are used to determine market size.
- In Asia/Pacific-ROW, the major published sources used to estimate market size are WSTS data and Dataquest's estimates of company shipments into the region.

Dataquest believes that the estimates presented here are the most accurate and meaningful generally available today. The sources of the data and the guidelines for the forecasts presented in the tables are as follows:

- Dataquest's own forecasts of electronic equipment production and semiconductor I/O ratios
- Unit shipments or revenue (or both) published by major industry participants, both in the United States and abroad
- Estimates presented by knowledgeable and reliable industry spokespersons
- Government data or trade association data such as those from the Electronics Industry Association (EIA), MITI, WSTS, and the U.S. Department of Commerce
- Published product literature and price lists
- Interviews with knowledgeable manufacturers, distributors, and users
- Relevant projected world economic data

Accuracy

The tables presented here represent Dataquest estimates that we believe are reasonably accurate. Where we have no reasonable estimate, none is given. A zero in a table represents an estimate.

Valuation of Consumption

Regional market size is expressed in U.S. dollars (with the Japanese market also expressed in yen). To make the tables in this study useful in comparing different regions, it is necessary to express all values in a common currency, and we chose the U.S. dollar for convenience. However, the choice of the U.S. dollar (or any single currency, for that matter) as the currency basis for the tables brings with it some problems that require the readers' careful consideration in interpreting the data.

Inflation

All countries that participate significantly in international semiconductor markets suffered from an overall price inflation in the 1980s, continuing into the 1990s. As a consequence, the dollar in a given year is not truly comparable with the dollar in any preceding year. Consumer and wholesale price indices and GNP deflators all measure price changes in various composite "market baskets" of goods. However, there is no price index that measures price changes of material, equipment, and labor inputs to the semiconductor industry. Indeed, the "mix" is changing so rapidly that what is used this year was sometimes unavailable last year, at any price. Nor is there a composite price index that measures price changes in aggregate semiconductor product. In an industry noted for its deflationary trends, this latter effect would tend to make the component purchaser's dollar worth more as time passed, in terms of purchasing ability.

We have made no adjustments in the historical data to account for these inflationary and deflationary effects. The data are expressed in current dollars (dollars that include the inflation rate and exchange rates of the given year) for all historical data; comparisons between different years must be interpreted accordingly.

Average Selling Prices

When considering the worldwide average selling prices (ASPs) for semiconductor components, one must look at the price per function of a circuit, the complexity of the circuit, and the product mix according to this increasing complexity. It is true that one characteristic of the semiconductor industry is that the price per function for integrated circuits has been dropping an average of 30 percent per year for the last 15 years. At the same time, circuits have become denser, resulting in an overall increase in the price of a device with a decreasing cost per function. Thus, Tables 7a through 7d show the worldwide ASPs increasing after many years of decreasing, due to the move toward higher-complexity devices. There are also regional differences in ASPs due to regional competition differences and the varying regional product consumption mix. The worldwide ASP is truly an aggregate measure and may differ significantly from ASPs in any specific market at any point in time.

Exchange Rates

Construction of the West European tables involves combining data from many countries, each of which has different and changing exchange rates. Dataquest uses Annual Foreign Exchange Rates for each year as published by The International Monetary Fund and the *Wall Street Journal*. As far as possible, we prepare our estimates in terms of local currencies before conversion to U.S. dollars. The exchange rates for major currencies can be found in Table 0 at the end of this introduction.

Japanese market size is originally expressed in yen. The Japanese data published in this study are expressed in both dollars (Tables 3a, 3b, 3c, and 3d) and in yen (Tables 4a, 4b, 4c, and 4d). The yen/dollar exchange rate used for each year can be found in Table 0. Because of the fluctuations in the exchange rate for the yen, the dollar values given tend to distort the growth rate of the Japanese market, but they do provide a useful basis for regional market size comparisons. However, the data in yen give a better picture of the real growth in the Japanese market.

Forecast

As mentioned previously, historical data are expressed in current dollars or dollars that include the given year's inflation rate and exchange rates. However, the revenue forecasts use constant dollars and exchange rates, with no allowance for inflation or variations in the rates of exchange between countries. All estimates for 1991 and beyond are made as if 1991 monetary conditions will continue through 2000 and, therefore, show the absolute year-to-year growth during this period.

Table 0
Foreign Exchange Rates

Year	Yrly/Qtrly	Japan (Yen per US$)	France (US$ per Franc)	Germany (US$ per Deutsche Mark)	United Kingdom (US$ per Pound Sterling)
1970	YR	358	0.18	0.27	2.38
1971	YR	343	0.18	0.29	2.44
1972	YR	302	0.20	0.31	2.50
1973	YR	269	0.22	0.37	2.44
1974	YR	292	0.21	0.39	2.33
1975	YR	297	0.23	0.41	2.22
1976	YR	296	0.21	0.40	1.82
1977	YR	269	0.20	0.43	1.75
1978	YR	210	0.22	0.50	1.92
1979	YR	219	0.24	0.55	2.13
1980	YR	227	0.24	0.55	2.33
1981	YR	221	0.18	0.44	2.04
1982	YR	248	0.15	0.41	1.75
1983	YR	235	0.13	0.39	1.52
1984	YR	237	0.11	0.35	1.33
1985	YR	238	0.11	0.34	1.30
1986	YR	167	0.14	0.46	1.47
1987	YR	144	0.17	0.56	1.64
1988	YR	130	0.17	0.57	1.79
1989	YR	138	0.16	0.53	1.50
1990	YR	144	0.18	0.62	1.79
Q191	QTR	134	0.19	0.65	1.91

Source: The International Monetary Fund Financial Times, Dataquest (May 1991)

Table 1a
Worldwide Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990
Total Including Captives	27,116	33,729	41,478	54,521	61,454	62,772
North American Captives	2,773	2,895	3,227	3,662	4,241	4,547
Total Semiconductor	24,343	30,834	38,251	50,859	57,213	58,225
Total IC	18,552	23,618	29,887	41,068	46,924	47,303
Bipolar Digital	3,684	4,325	4,760	5,200	4,510	4,440
Memory	589	606	621	689	540	459
Logic	3,095	3,719	4,139	4,511	3,970	3,981
MOS Digital	10,103	12,815	17,473	26,988	33,024	32,292
Memory	3,817	4,511	6,056	11,692	16,361	13,091
Micro	2,745	3,489	5,108	7,144	8,202	10,068
Logic	3,541	4,815	6,309	8,152	8,461	9,133
Analog	4,765	6,478	7,654	8,880	9,390	10,571
Total Discrete	4,578	5,730	6,655	7,612	7,662	8,235
Total Optoelectronic	1,213	1,486	1,709	2,179	2,627	2,687

Source: Dataquest (May 1991)

Table 1b
Worldwide Semiconductor Consumption
(Percent Change)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990	CAGR 85-90
Total Including Captives	-13.4	24.4	23.0	31.4	12.7	2.1	18.3
North American Captives	10.9	4.4	11.5	13.5	15.8	7.2	10.4
Total Semiconductor	-15.5	26.7	24.1	33.0	12.5	1.8	19.1
Total IC	-18.0	27.3	26.5	37.4	14.3	.8	20.6
Bipolar Digital	-23.0	17.4	10.1	9.2	-13.3	-1.6	3.8
Memory	-23.9	2.9	2.5	11.0	-21.6	-15.0	-4.9
Logic	-22.8	20.2	11.3	9.0	-12.0	.3	5.2
MOS Digital	-22.0	26.8	36.3	54.5	22.4	-2.2	26.2
Memory	-38.7	18.2	34.2	93.1	39.9	-20.0	28.0
Micro	-15.0	27.1	46.4	39.9	14.8	22.8	29.7
Logic	1.4	36.0	31.0	29.2	3.8	7.9	20.9
Analog	-2.5	35.9	18.2	16.0	5.7	12.6	17.3
Total Discrete	-8.2	25.2	16.1	14.4	.7	7.5	12.5
Total Optoelectronic	-.7	22.5	15.0	27.5	20.6	2.3	17.2

Source: Dataquest (May 1991)

Table 1c
Worldwide Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	2000
Total Including Captives	71,807	83,745	97,321	107,632	114,222	199,971
North American Captives	5,584	6,556	7,518	8,407	8,691	14,610
Total Semiconductor	66,223	77,189	89,803	99,225	105,531	185,361
Total IC	54,103	64,232	75,522	83,934	89,840	164,196
Bipolar Digital	4,624	4,679	4,683	4,480	4,256	3,272
Memory	440	434	433	402	375	248
Logic	4,184	4,245	4,250	4,078	3,881	3,024
MOS Digital	37,709	46,294	55,628	62,243	66,906	130,228
Memory	14,974	18,798	23,001	26,078	28,283	56,891
Micro	12,118	14,907	17,917	20,076	21,604	44,069
Logic	10,617	12,589	14,710	16,089	17,019	29,268
Analog	11,770	13,259	15,211	17,211	18,678	30,696
Total Discrete	9,112	9,703	10,721	11,342	11,513	15,046
Total Optoelectronic	3,008	3,254	3,560	3,949	4,178	6,119

Source: Dataquest (May 1991)

Table 1d
Worldwide Semiconductor Consumption
(Percent Change)

Company: All
Product: Each
Region of Consumption: Worldwide
Distribution Channel: All
Application: All
Specification: All

	1991	1992	1993	1994	1995	CAGR 90-95	CAGR 95-00
Total Including Captives	14.4	16.6	16.2	10.6	6.1	12.7	11.9
North American Captives	22.8	17.4	14.7	11.8	3.4	13.8	10.9
Total Semiconductor	13.7	16.6	16.3	10.5	6.4	12.6	11.9
Total IC	14.4	18.7	17.6	11.1	7.0	13.7	12.8
Bipolar Digital	4.1	1.2	.1	-4.3	-5.0	-.8	-5.1
Memory	-4.1	-1.4	-.2	-7.2	-6.7	-4.0	-7.9
Logic	5.1	1.5	.1	-4.0	-4.8	-.5	-4.9
MOS Digital	16.8	22.8	20.2	11.9	7.5	15.7	14.2
Memory	14.4	25.5	22.4	13.4	8.5	16.7	15.0
Micro	20.4	23.0	20.2	12.1	7.6	16.5	15.3
Logic	16.2	18.6	16.8	9.4	5.8	13.3	11.5
Analog	11.3	12.7	14.7	13.1	8.5	12.1	10.4
Total Discrete	10.6	6.5	10.4	5.8	1.5	6.9	5.5
Total Optoelectronic	11.9	8.2	9.4	10.9	5.8	9.2	7.9

Source: Dataquest (May 1991)

Table 2a
North American Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	North America
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990
Total Including Captives	11,663	13,171	15,454	18,789	21,348	20,844
North American Captives	2,243	2,327	2,596	2,945	3,411	3,458
Total Semiconductor	9,420	10,844	12,858	15,844	17,937	17,386
Total IC	7,757	8,986	10,886	13,815	15,909	15,387
Bipolar Digital	1,926	2,030	2,099	2,012	1,701	1,652
Memory	288	267	271	235	203	170
Logic	1,638	1,763	1,828	1,777	1,498	1,482
MOS Digital	4,322	4,912	6,738	9,606	11,682	11,025
Memory	1,753	1,775	2,497	4,298	6,163	4,655
Micro	1,258	1,362	2,012	2,707	2,972	3,563
Logic	1,311	1,775	2,229	2,601	2,547	2,807
Analog	1,509	2,044	2,049	2,197	2,526	2,710
Total Discrete	1,295	1,542	1,642	1,676	1,683	1,669
Total Optoelectronic	368	316	330	353	345	330

Source: Dataquest (May 1991)

Table 2b
North American Semiconductor Consumption
(Percent Change)

Company: All
Product: Each
Region of Consumption: North America
Distribution Channel: All
Application: All
Specification: All

	1985	1986	1987	1988	1989	1990	CAGR 85-90
Total Including Captives	-22.4	12.9	17.3	21.6	13.6	-2.4	12.3
North American Captives	10.7	3.7	11.6	13.4	15.8	1.4	9.0
Total Semiconductor	-27.6	15.1	18.6	23.2	13.2	-3.1	13.0
Total IC	-30.0	15.8	21.1	26.9	15.2	-3.3	14.7
Bipolar Digital	-31.7	5.4	3.4	-4.1	-15.5	-2.9	-3.0
Memory	-34.7	-7.3	1.5	-13.3	-13.6	-16.3	-10.0
Logic	-31.1	7.6	3.7	-2.8	-15.7	-1.1	-2.0
MOS Digital	-33.5	13.7	37.2	42.6	21.6	-5.6	20.6
Memory	-48.8	1.3	40.7	72.1	43.4	-24.5	21.6
Micro	-23.0	8.3	47.7	34.5	9.8	19.9	23.1
Logic	-9.1	35.4	25.6	16.7	-2.1	10.2	16.4
Analog	-14.6	35.5	.2	7.2	15.0	7.3	12.4
Total Discrete	-13.8	19.1	6.5	2.1	.4	-.8	5.2
Total Optoelectronic	-11.1	-14.1	4.4	7.0	-2.3	-4.3	-2.2

Source: Dataquest (May 1991)

Table 2c
North American Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	North America
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	2000
Total Including Captives	22,918	26,235	30,343	33,112	34,448	53,614
North American Captives	4,157	4,849	5,533	6,217	6,447	10,837
Total Semiconductor	18,761	21,386	24,810	26,895	28,001	42,777
Total IC	16,692	19,198	22,404	24,394	25,557	40,005
Bipolar Digital	1,621	1,588	1,649	1,509	1,381	987
Memory	149	138	134	118	104	50
Logic	1,472	1,450	1,515	1,391	1,277	937
MOS Digital	12,102	14,242	16,899	18,580	19,495	31,615
Memory	4,989	5,808	6,963	8,106	8,681	14,827
Micro	4,003	4,784	5,613	5,960	6,254	10,026
Logic	3,110	3,650	4,323	4,514	4,560	6,762
Analog	2,969	3,368	3,856	4,305	4,681	7,403
Total Discrete	1,733	1,823	2,014	2,089	2,039	2,307
Total Optoelectronic	336	365	392	412	405	465

Source: Dataquest (May 1991)

Table 2d
North American Semiconductor Consumption
(Percent Change)

Company:	All
Product:	Each
Region of Consumption:	North America
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	CAGR 90-95	CAGR 95-00
Total Including Captives	10.0	14.5	15.7	9.1	4.0	10.6	9.3
North American Captives	20.2	16.6	14.1	12.4	3.7	13.3	10.9
Total Semiconductor	7.9	14.0	16.0	8.4	4.1	10.0	8.8
Total IC	8.5	15.0	16.7	8.9	4.8	10.7	9.4
Bipolar Digital	-1.9	-2.0	3.8	-8.5	-8.5	-3.5	-6.5
Memory	-12.4	-7.4	-2.9	-11.9	-11.9	-9.4	-13.6
Logic	-.7	-1.5	4.5	-8.2	-8.2	-2.9	-6.0
MOS Digital	9.8	17.7	18.7	9.9	4.9	12.1	10.2
Memory	7.2	16.4	19.9	16.4	7.1	13.3	11.3
Micro	12.3	19.5	17.3	6.2	4.9	11.9	9.9
Logic	10.8	17.4	18.4	4.4	1.0	10.2	8.2
Analog	9.6	13.4	14.5	11.6	8.7	11.6	9.6
Total Discrete	3.8	5.2	10.5	3.7	-2.4	4.1	2.5
Total Optoelectronic	1.8	8.6	7.4	5.1	-1.7	4.2	2.8

Source: Dataquest (May 1991)

Table 3a
Japanese Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Japan
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990
Total Including Captives	8,300	12,018	15,107	20,977	23,234	23,031
North American Captives	151	163	180	205	237	523
Total Semiconductor	8,149	11,855	14,927	20,772	22,997	22,508
Total IC	5,985	8,802	11,263	16,127	17,946	17,387
Bipolar Digital	824	1,295	1,523	1,906	1,750	1,800
Memory	136	169	227	348	246	209
Logic	688	1,126	1,296	1,558	1,504	1,591
MOS Digital	3,232	4,762	6,424	10,501	12,497	11,799
Memory	1,185	1,738	2,268	4,424	5,992	4,612
Micro	884	1,368	1,902	2,573	2,828	3,210
Logic	1,163	1,656	2,254	3,504	3,677	3,977
Analog	1,929	2,745	3,316	3,720	3,699	3,788
Total Discrete	1,621	2,242	2,693	3,282	3,321	3,392
Total Optoelectronic	543	811	971	1,363	1,730	1,729

Source: Dataquest (May 1991)

Table 3b
Japanese Semiconductor Consumption
(Millions of Dollars)

Company:	All
Product:	Each
Region of Consumption:	Japan
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990	CAGR (%) 85-90
Total Including Captives	-6.8	44.8	25.7	38.9	10.8	-.9	22.6
North American Captives	11.9	7.9	10.4	13.9	15.6	120.7	28.2
Total Semiconductor	-7.1	45.5	25.9	39.2	10.7	-2.1	22.5
Total IC	-8.2	47.1	28.0	43.2	11.3	-3.1	23.8
Bipolar Digital	-13.7	57.2	17.6	25.1	-8.2	2.9	16.9
Memory	-16.6	24.3	34.3	53.3	-29.3	-15.0	9.0
Logic	-13.1	63.7	15.1	20.2	-3.5	5.8	18.3
MOS Digital	-10.7	47.3	34.9	63.5	19.0	-5.6	29.6
Memory	-25.0	46.7	30.5	95.1	35.4	-23.0	31.2
Micro	-9.7	54.8	39.0	35.3	9.9	13.5	29.4
Logic	9.4	42.4	36.1	55.5	4.9	8.2	27.9
Analog	-.6	42.3	20.8	12.2	-.6	2.4	14.4
Total Discrete	-7.7	38.3	20.1	21.9	1.2	2.1	15.9
Total Optoelectronic	8.4	49.4	19.7	40.4	26.9	-.1	26.1

Source: Dataquest (May 1991)

Table 3c
Japanese Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Japan
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	2000
Total Including Captives	27,025	31,580	35,586	39,208	41,787	72,290
North American Captives	671	818	931	1,008	1,025	1,723
Total Semiconductor	26,354	30,762	34,655	38,200	40,762	70,567
Total IC	20,545	24,608	28,096	31,150	33,407	60,667
Bipolar Digital	2,030	2,158	2,142	2,131	2,098	1,685
Memory	222	233	240	237	233	180
Logic	1,808	1,925	1,902	1,894	1,865	1,505
MOS Digital	14,288	17,799	20,751	23,267	25,236	50,100
Memory	5,698	7,537	9,037	10,212	11,131	24,719
Micro	3,835	4,615	5,293	5,928	6,422	11,780
Logic	4,755	5,647	6,421	7,127	7,683	13,601
Analog	4,227	4,651	5,203	5,752	6,073	8,882
Total Discrete	3,827	4,017	4,242	4,467	4,601	5,816
Total Optoelectronic	1,982	2,137	2,317	2,583	2,754	4,084

Source: Dataquest (May 1991)

Table 3d
Japanese Semiconductor Consumption
(Percent Change)

Company:	All
Product:	Each
Region of Consumption:	Japan
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	CAGR 90-95	CAGR 95-00
Total Including Captives	17.3	16.9	12.7	10.2	6.6	12.7	11.6
North American Captives	28.3	21.9	13.8	8.3	1.7	14.4	10.9
Total Semiconductor	17.1	16.7	12.7	10.2	6.7	12.6	11.6
Total IC	18.2	19.8	14.2	10.9	7.2	14.0	12.7
Bipolar Digital	12.8	6.3	-.7	-.5	-1.5	3.1	-4.3
Memory	6.2	5.0	3.0	-1.3	-1.7	2.2	-5.0
Logic	13.6	6.5	-1.2	-.4	-1.5	3.2	-4.2
MOS Digital	21.1	24.6	16.6	12.1	8.5	16.4	14.7
Memory	23.5	32.3	19.9	13.0	9.0	19.3	17.3
Micro	19.5	20.3	14.7	12.0	8.3	14.9	12.9
Logic	19.6	18.8	13.7	11.0	7.8	14.1	12.1
Analog	11.6	10.0	11.9	10.6	5.6	9.9	7.9
Total Discrete	12.8	5.0	5.6	5.3	3.0	6.3	4.8
Total Optoelectronic	14.6	7.8	8.4	11.5	6.6	9.8	8.2

Source: Dataquest (May 1991)

Table 4a
Japanese Semiconductor Consumption
(Factory Revenue in Billions of Japanese Yen)

Company:	All
Product:	Each
Region of Consumption:	Japan
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990
Total Including Captives	1,975.3	2,006.9	2,175.4	2,727.0	3,206.3	3,316.4
North American Captives	35.9	27.2	25.9	26.7	32.7	75.3
Total Semiconductor	1,939.4	1,979.7	2,149.5	2,700.3	3,173.6	3,241.1
Total IC	1,424.4	1,469.9	1,621.9	2,096.4	2,476.6	2,503.7
Bipolar Digital	196.1	216.2	219.3	247.7	241.5	259.2
Memory	32.4	28.2	32.7	45.2	33.9	30.1
Logic	163.7	188.0	186.6	202.5	207.6	229.1
MOS Digital	769.2	795.3	925.1	1,365.1	1,724.6	1,699.0
Memory	282.0	290.2	326.6	575.1	826.9	664.1
Micro	210.4	228.5	273.9	334.5	390.3	462.2
Logic	276.8	276.6	324.6	455.5	507.4	572.7
Analog	459.1	458.4	477.5	483.6	510.5	545.5
Total Discrete	385.8	374.4	387.8	426.7	458.3	488.4
Total Optoelectronic	129.2	135.4	139.8	177.2	238.7	249.0
Exchange Rate (Yen/US$)	238	167	144	130	138	144

Source: Dataquest (May 1991)

Table 4b
Japanese Semiconductor Consumption
(Percent Change in Yen)

Company:	All
Product:	Each
Region of Consumption:	Japan
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990	CAGR 85-90
Total Including Captives	-6.4	1.6	8.4	25.4	17.6	3.4	10.9
North American Captives	.0	.0	.0	.0	.0	.0	.0
Total Semiconductor	-6.7	2.1	8.6	25.6	17.5	2.1	10.8
Total IC	-7.8	3.2	10.3	29.3	18.1	1.1	11.9
Bipolar.Digital	-13.3	10.2	1.4	13.0	-2.5	7.3	5.7
Memory	-16.1	-13.0	16.0	38.2	-25.0	-11.2	-1.5
Logic	-12.8	14.8	-.7	8.5	2.5	10.4	7.0
MOS Digital	-10.4	3.4	16.3	47.6	26.3	-1.5	17.2
Memory	-24.6	2.9	12.5	76.1	43.8	-19.7	18.7
Micro	-9.3	8.6	19.9	22.1	16.7	18.4	17.0
Logic	9.9	-.1	17.4	40.3	11.4	12.9	15.7
Analog	-.2	-.2	4.2	1.3	5.6	6.9	3.5
Total Discrete	-7.3	-3.0	3.6	10.0	7.4	6.6	4.8
Total Optoelectronic	8.8	4.8	3.2	26.8	34.7	4.3	14.0

NA = Not available

Source: Dataquest (May 1991)

Table 4c
Japanese Semiconductor Consumption
(Factory Revenue in Billions of Japanese Yen)

Company:	All
Product:	Each
Region of Consumption:	Japan
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	2000
Total Including Captives	3,618.6	4,228.5	4,765.0	5,250.0	5,595.3	9,679.6
North American Captives	89.8	109.5	124.7	135.0	137.2	230.7
Total Semiconductor	3,528.8	4,119.0	4,640.3	5,115.0	5,458.1	9,448.9
Total IC	2,751.0	3,295.0	3,762.1	4,171.0	4,473.2	8,123.3
Bipolar Digital	271.8	289.0	286.8	285.3	280.9	225.6
Memory	29.7	31.2	32.1	31.7	31.2	24.1
Logic	242.1	257.8	254.7	253.6	249.7	201.5
MOS Digital	1,913.2	2,383.2	2,778.6	3,115.5	3,379.1	6,708.4
Memory	763.0	1,009.2	1,210.1	1,367.4	1,490.4	3,309.9
Micro	513.5	617.9	708.7	793.8	859.9	1,577.3
Logic	636.7	756.1	859.8	954.3	1,028.8	1,821.2
Analog	566.0	622.8	696.7	770.2	813.2	1,189.3
Total Discrete	512.4	537.9	568.0	598.1	616.1	778.8
Total Optoelectronic	265.4	286.1	310.2	345.9	368.8	546.8
Exchange Rate (Yen/US$)	133.9	133.9	133.9	133.9	133.9	133.9

Source: Dataquest (May 1991)

Table 4d
Japanese Semiconductor Consumption
(Percent Change in Yen)

Company: All
Product: Each
Region of Consumption: Japan
Distribution Channel: All
Application: All
Specification: All

	1991	1992	1993	1994	1995	CAGR 90-95	CAGR 95-00
Total Including Captives	9.1	16.9	12.7	10.2	6.6	11.0	11.6
North American Captives	.0	.0	.0	.0	.0	.0	.0
Total Semiconductor	8.9	16.7	12.7	10.2	6.7	11.0	11.6
Total IC	9.9	19.8	14.2	10.9	7.2	12.3	12.7
Bipolar Digital	4.9	6.3	-.8	-.5	-1.5	1.6	-4.3
Memory	-1.3	5.1	2.9	-1.2	-1.6	.7	-5.0
Logic	5.7	6.5	-1.2	-.4	-1.5	1.7	-4.2
MOS Digital	12.6	24.6	16.6	12.1	8.5	14.7	14.7
Memory	14.9	32.3	19.9	13.0	9.0	17.5	17.3
Micro	11.1	20.3	14.7	12.0	8.3	13.2	12.9
Logic	11.2	18.8	13.7	11.0	7.8	12.4	12.1
Analog	3.8	10.0	11.9	10.5	5.6	8.3	7.9
Total Discrete	4.9	5.0	5.6	5.3	3.0	4.8	4.8
Total Optoelectronic	6.6	7.8	8.4	11.5	6.6	8.2	8.2

NA = Not available

Source: Dataquest (May 1991)

Table 5a
European Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Europe
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990
Total Including Captives	5,174	5,992	6,949	9,003	10,348	11,227
North American Captives	379	405	451	512	593	566
Total Semiconductor	4,795	5,587	6,498	8,491	9,755	10,661
Total IC	3,615	4,116	4,840	6,669	7,794	8,326
Bipolar Digital	719	719	727	772	640	577
Memory	150	147	88	74	72	58
Logic	569	572	639	698	568	519
MOS Digital	1,933	2,270	2,761	4,364	5,458	5,403
Memory	745	813	854	1,797	2,548	2,154
Micro	486	574	805	1,212	1,469	1,836
Logic	702	883	1,102	1,355	1,441	1,413
Analog	963	1,127	1,352	1,533	1,696	2,346
Total Discrete	969	1,207	1,377	1,516	1,594	1,915
Total Optoelectronic	211	264	281	306	367	420

Source: Dataquest (May 1991)

Table 5b
European Semiconductor Consumption
(Millions of Dollars)

Company:	All
Product:	Each
Region of Consumption:	Europe
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990	CAGR (%) 85-90
Total Including Captives	-.5	15.8	16.0	29.6	14.9	8.5	16.8
North American Captives	12.1	6.9	11.4	13.5	15.8	-4.6	8.4
Total Semiconductor	-1.4	16.5	16.3	30.7	14.9	9.3	17.3
Total IC	-3.1	13.9	17.6	37.8	16.9	6.8	18.2
Bipolar Digital	-3.0	.0	1.1	6.2	-17.1	-9.8	-4.3
Memory	4.2	-2.0	-40.1	-15.9	-2.7	-19.4	-17.3
Logic	-4.7	.5	11.7	9.2	-18.6	-8.6	-1.8
MOS Digital	-8.9	17.4	21.6	58.1	25.1	-1.0	22.8
Memory	-24.4	9.1	5.0	110.4	41.8	-15.5	23.7
Micro	3.2	18.1	40.2	50.6	21.2	25.0	30.5
Logic	5.4	25.8	24.8	23.0	6.3	-1.9	15.0
Analog	11.1	17.0	20.0	13.4	10.6	38.3	19.5
Total Discrete	2.9	24.6	14.1	10.1	5.1	20.1	14.6
Total Optoelectronic	10.5	25.1	6.4	8.9	19.9	14.4	14.8

Source: Dataquest (May 1991)

Table 5c
European Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Europe
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	2000
Total Including Captives	13,030	15,305	18,367	20,508	21,983	41,690
North American Captives	756	889	1,054	1,182	1,219	2,050
Total Semiconductor	12,274	14,416	17,313	19,326	20,764	39,640
Total IC	9,634	11,542	14,002	15,818	17,138	34,417
Bipolar Digital	571	540	500	458	403	268
Memory	57	52	50	40	32	17
Logic	514	488	450	418	371	251
MOS Digital	6,462	8,155	10,264	11,703	12,757	28,000
Memory	2,570	3,346	4,293	4,667	5,140	11,269
Micro	2,225	2,873	3,706	4,447	4,847	11,762
Logic	1,667	1,936	2,265	2,589	2,770	4,969
Analog	2,601	2,847	3,238	3,657	3,978	6,149
Total Discrete	2,178	2,370	2,755	2,894	2,981	4,280
Total Optoelectronic	462	504	556	614	645	943

Source: Dataquest (May 1991)

Table 5d
European Semiconductor Consumption
(Percent Change)

Company:	All
Product:	Each
Region of Consumption:	Europe
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	CAGR 90-95	CAGR 95-00
Total Including Captives	16.1	17.5	20.0	11.7	7.2	14.4	13.7
North American Captives	33.6	17.6	18.6	12.1	3.1	16.6	11.0
Total Semiconductor	15.1	17.5	20.1	11.6	7.4	14.3	13.8
Total IC	15.7	19.8	21.3	13.0	8.3	15.5	15.0
Bipolar Digital	-1.0	-5.4	-7.4	-8.4	-12.0	-6.9	-7.8
Memory	-1.7	-8.8	-3.8	-20.0	-20.0	-11.2	-11.9
Logic	-1.0	-5.1	-7.8	-7.1	-11.2	-6.5	-7.5
MOS Digital	19.6	26.2	25.9	14.0	9.0	18.7	17.0
Memory	19.3	30.2	28.3	8.7	10.1	19.0	17.0
Micro	21.2	29.1	29.0	20.0	9.0	21.4	19.4
Logic	18.0	16.1	17.0	14.3	7.0	14.4	12.4
Analog	10.9	9.5	13.7	12.9	8.8	11.1	9.1
Total Discrete	13.7	8.8	16.2	5.0	3.0	9.3	7.5
Total Optoelectronic	10.0	9.1	10.3	10.4	5.0	9.0	7.9

Source: Dataquest (May 1991)

Table 6a
Asia/Pacific-Rest of World Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Asia/ROW
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990
Total Including Captives	1,979	2,548	3,968	5,752	6,524	7,670
North American Captives	0	0	0	0	0	0
Total Semiconductor	1,979	2,548	3,968	5,752	6,524	7,670
Total IC	1,195	1,714	2,898	4,457	5,275	6,203
Bipolar Digital	215	281	411	510	419	411
Memory	15	23	35	32	19	22
Logic	200	258	376	478	400	389
MOS Digital	616	871	1,550	2,517	3,387	4,065
Memory	134	185	437	1,173	1,658	1,670
Micro	117	185	389	652	933	1,459
Logic	365	501	724	692	796	936
Analog	364	562	937	1,430	1,469	1,727
Total Discrete	693	739	943	1,138	1,064	1,259
Total Optoelectronic	91	95	127	157	185	208

Source: Dataquest (May 1991)

Table 6b
Asia/Pacific-Rest of World Semiconductor Consumption
(Millions of Dollars)

Company:	All
Product:	Each
Region of Consumption:	Asia/ROW
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990	CAGR (%) 85-90
Total Including Captives	-9.3	28.8	55.7	45.0	13.4	17.6	31.1
North American Captives	NM	NM	NM	NM	NM	NM	NM
Total Semiconductor	-9.3	28.8	55.7	45.0	13.4	17.6	31.1
Total IC	-6.7	43.4	69.1	53.8	18.4	17.6	39.0
Bipolar Digital	-20.1	30.7	46.3	24.1	-17.8	-1.9	13.8
Memory	-42.3	53.3	52.2	-8.6	-40.6	15.8	8.0
Logic	-17.7	29.0	45.7	27.1	-16.3	-2.8	14.2
MOS Digital	-12.0	41.4	78.0	62.4	34.6	20.0	45.8
Memory	-42.7	38.1	136.2	168.4	41.3	.7	65.6
Micro	-19.3	58.1	110.3	67.6	43.1	56.4	65.6
Logic	13.7	37.3	44.5	-4.4	15.0	17.6	20.7
Analog	16.7	54.4	66.7	52.6	2.7	17.6	36.5
Total Discrete	-11.7	6.6	27.6	20.7	-6.5	18.3	12.7
Total Optoelectronic	-20.9	4.4	33.7	23.6	17.8	12.4	18.0

NM = Not meaningful

Source: Dataquest (May 1991)

Table 6c
Asia/Pacific-Rest of World Semiconductor Consumption
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Asia/ROW
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	2000
Total Including Captives	8,834	10,625	13,025	14,804	16,004	32,377
North American Captives	0	0	0	0	0	0
Total Semiconductor	8,834	10,625	13,025	14,804	16,004	32,377
Total IC	7,232	8,884	11,020	12,572	13,738	29,107
Bipolar Digital	402	393	392	382	374	332
Memory	12	11	9	7	6	1
Logic	390	382	383	375	368	331
MOS Digital	4,857	6,098	7,714	8,693	9,418	20,513
Memory	1,717	2,107	2,708	3,093	3,331	6,076
Micro	2,055	2,635	3,305	3,741	4,081	10,501
Logic	1,085	1,356	1,701	1,859	2,006	3,936
Analog	1,973	2,393	2,914	3,497	3,946	8,262
Total Discrete	1,374	1,493	1,710	1,892	1,892	2,643
Total Optoelectronic	228	248	295	340	374	627

Source: Dataquest (May 1991)

Table 6d
Asia/Pacific-Rest of World Semiconductor Consumption
(Percent Change)

Company:	All
Product:	Each
Region of Consumption:	Asia/ROW
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	CAGR 90-95	CAGR 95-00
Total Including Captives	15.2	20.3	22.6	13.7	8.1	15.8	15.1
North American Captives	NM	NM	NM	NM	NM	NM	NM
Total Semiconductor	15.2	20.3	22.6	13.7	8.1	15.8	15.1
Total IC	16.6	22.8	24.0	14.1	9.3	17.2	16.2
Bipolar Digital	-2.2	-2.2	-.3	-2.6	-2.1	-1.9	-2.4
Memory	-45.5	-8.3	-18.2	-22.2	-14.3	-22.9	-30.1
Logic	.3	-2.1	.3	-2.1	-1.9	-1.1	-2.1
MOS Digital	19.5	25.6	26.5	12.7	8.3	18.3	16.8
Memory	2.8	22.7	28.5	14.2	7.7	14.8	12.8
Micro	40.8	28.2	25.4	13.2	9.1	22.8	20.8
Logic	15.9	25.0	25.4	9.3	7.9	16.5	14.4
Analog	14.2	21.3	21.8	20.0	12.8	18.0	15.9
Total Discrete	9.1	8.7	14.5	10.6	.0	8.5	6.9
Total Optoelectronic	9.6	8.8	19.0	15.3	10.0	12.5	10.9

NM = Not meaningful

Source: Dataquest (May 1991)

Table 7a
Worldwide Semiconductor Average Selling Prices
(Factory ASP in U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990
Total Semiconductor	.30	.34	.33	.42	.42	.39
Total IC	1.05	1.09	1.18	1.32	1.45	1.33
Bipolar Digital	.71	.71	.69	.70	.70	.68
Memory						
Logic						
MOS Digital	1.64	1.63	1.94	2.38	2.65	2.32
Memory	2.59	2.41	3.09	4.87	5.88	4.43
Micro	3.14	3.13	3.56	4.15	3.77	4.28
Logic	.93	.99	1.12	1.13	1.13	1.06
Analog	.76	.84	.82	.72	.70	.70
Total Discrete	.08	.09	.08	.09	.08	.08
Total Optoelectronic	.22	.25	.28	.34	.27	.29

Source: Dataquest (May 1991)

Table 7b
Worldwide Semiconductor Average Selling Prices
(Percent Change in Dollars)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990	CAGR 85-90
Total Semiconductor	-15.7	13.2	-2.7	24.8	-.3	-5.1	5.4
Total IC	-4.4	3.5	8.5	11.6	10.0	-8.4	4.8
Bipolar Digital	9.2	.0	-2.8	1.4	.0	-2.9	-.9
Memory							
Logic							
MOS Digital	-16.0	-.5	18.6	23.0	11.5	-12.6	7.2
Memory	-33.6	-6.9	28.2	57.6	20.7	-24.7	11.3
Micro	-11.0	-.3	13.7	16.6	-9.2	13.5	6.4
Logic	9.4	6.5	13.1	.9	.0	-6.2	2.7
Analog	1.3	10.5	-2.4	-12.2	-2.8	.0	-1.6
Total Discrete	-11.1	15.0	-13.0	12.5	-11.1	.0	.0
Total Optoelectronic	-21.4	13.6	12.0	21.4	-20.6	7.4	5.7

Source: Dataquest (May 1991)

Table 7c
Worldwide Semiconductor Average Selling Prices
(Factory ASP in U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	2000
Total Semiconductor	.41	.44	.47	.48	.49	.64
Total IC	1.40	1.53	1.65	1.62	1.63	2.00
Bipolar Digital	.70	.71	.72	.70	.69	.69
Memory						
Logic						
MOS Digital	2.46	2.79	3.17	3.08	3.18	4.02
Memory	4.86	6.07	7.34	8.10	9.00	17.56
Micro	4.36	4.43	4.49	4.35	4.29	4.34
Logic	1.12	1.24	1.41	1.30	1.32	1.54
Analog	.71	.71	.70	.68	.67	.68
Total Discrete	.08	.08	.08	.08	.08	.08
Total Optoelectronic	.29	.29	.29	.29	.29	.29

Source: Dataquest (May 1991)

Table 7d
Worldwide Semiconductor Average Selling Prices
(Percent Change in Dollars)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	CAGR 90-95	CAGR 95-00
Total Semiconductor	3.2	8.7	5.7	2.4	3.3	4.6	5.2
Total IC	5.6	9.2	7.5	-2.0	.8	4.1	4.1
Bipolar Digital	2.9	1.4	1.4	-2.8	-1.4	.3	.0
Memory							
Logic							
MOS Digital	6.0	13.3	13.7	-2.8	3.1	6.5	4.8
Memory	9.7	24.9	20.9	10.4	11.1	15.2	14.3
Micro	1.9	1.6	1.4	-3.1	-1.4	.0	.2
Logic	5.7	10.7	13.7	-7.8	1.5	4.5	3.1
Analog	1.4	.0	-1.4	-2.9	-1.5	-.9	.3
Total Discrete	.0	.0	.0	.0	.0	.0	.0
Total Optoelectronic	.0	.0	.0	.0	.0	.0	.0

Source: Dataquest (May 1991)

Table 8a
Worldwide Semiconductor Unit Shipments
(Millions of Units)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990
Total Semiconductor	80,380	89,881	114,551	122,085	137,808	147,757
Total IC	17,607	21,654	25,260	31,098	32,303	35,553
Bipolar Digital	5,172	6,092	6,899	7,429	6,443	6,529
Memory						
Logic						
MOS Digital	6,171	7,850	9,028	11,336	12,446	13,923
Memory	1,475	1,872	1,960	2,401	2,782	2,955
Micro	875	1,115	1,435	1,721	2,176	2,352
Logic	3,820	4,864	5,633	7,214	7,488	8,616
Analog	6,264	7,712	9,334	12,333	13,414	15,101
Total Discrete	57,200	62,283	83,188	84,578	95,775	102,938
Total Optoelectronic	5,573	5,944	6,104	6,409	9,730	9,266

Source: Dataquest (May 1991)

Table 8b
Worldwide Semiconductor Unit Shipments
(Percent Change)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1985	1986	1987	1988	1989	1990	CAGR 85-90
Total Semiconductor	.0	11.8	27.4	6.6	12.9	7.2	12.9
Total IC	-14.4	23.0	16.7	23.1	3.9	10.1	15.1
Bipolar Digital	-29.5	17.8	13.2	7.7	-13.3	1.3	4.8
Memory							
Logic							
MOS Digital	-7.1	27.2	15.0	25.6	9.8	11.9	17.7
Memory	-7.6	26.9	4.7	22.5	15.9	6.2	14.9
Micro	-4.5	27.4	28.7	20.0	26.4	8.1	21.9
Logic	-7.4	27.3	15.8	28.1	3.8	15.1	17.7
Analog	-5.0	23.1	21.0	32.1	8.8	12.6	19.2
Total Discrete	3.2	8.9	33.6	1.7	13.2	7.5	12.5
Total Optoelectronic	26.9	6.7	2.7	5.0	51.8	-4.8	10.7

Source: Dataquest (May 1991)

Table 8c
Worldwide Semiconductor Unit Shipments
(Millions of Units)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	2000
Total Semiconductor	162,794	174,510	192,080	207,313	213,438	291,457
Total IC	38,522	41,864	45,791	51,921	55,118	82,282
Bipolar Digital	6,606	6,575	6,504	6,400	6,168	4,742
Memory						
Logic						
MOS Digital	15,339	16,614	17,557	20,211	21,072	32,399
Memory	3,081	3,097	3,134	3,220	3,143	3,240
Micro	2,779	3,365	3,990	4,615	5,036	10,154
Logic	9,479	10,152	10,433	12,376	12,893	19,005
Analog	16,577	18,675	21,730	25,310	27,878	45,141
Total Discrete	113,900	121,425	134,013	141,775	143,913	188,075
Total Optoelectronic	10,372	11,221	12,276	13,617	14,407	21,100

Source: Dataquest (May 1991)

Table 8d
Worldwide Semiconductor Unit Shipments
(Percent Change)

Company:	All
Product:	Each
Region of Consumption:	Worldwide
Distribution Channel:	All
Application:	All
Specification:	All

	1991	1992	1993	1994	1995	CAGR 90-95	CAGR 95-00
Total Semiconductor	10.2	7.2	10.1	7.9	3.0	7.6	6.4
Total IC	8.4	8.7	9.4	13.4	6.2	9.2	8.3
Bipolar Digital	1.2	-.5	-1.1	-1.6	-3.6	-1.1	-5.1
Memory							
Logic							
MOS Digital	10.2	8.3	5.7	15.1	4.3	8.6	9.0
Memory	4.3	.5	1.2	2.7	-2.4	1.2	.6
Micro	18.2	21.1	18.6	15.7	9.1	16.4	15.1
Logic	10.0	7.1	2.8	18.6	4.2	8.4	8.1
Analog	9.8	12.7	16.4	16.5	10.1	13.0	10.1
Total Discrete	10.6	6.6	10.4	5.8	1.5	6.9	5.5
Total Optoelectronic	11.9	8.2	9.4	10.9	5.8	9.2	7.9

Source: Dataquest (May 1991)

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Final Japanese Semiconductor Market Share Estimates

1990

Source: Dataquest

Semiconductors *Japan*

Dataquest

Final Japanese Semiconductor Market Share Estimates 1990

Source: Dataquest

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Semiconductors *Japan*

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Final Japanese Semiconductor Market Share Estimates 1990

Introduction

An integral part of Dataquest's Japanese Semiconductor Industry Service (JSIS) database is the analysis of semiconductor markets through estimation of market share by manufacturer. This analysis provides insights into semiconductor markets and reinforces estimates of consumption, shipments, and company revenue that were made using other data.

The totals given for the companies reflect worldwide production. For example, Texas Instruments manufactures semiconductors in many parts of the world, but its entire production is included under the U.S. companies' market share section. In contrast, some, but not all, foreign-owned subsidiaries are included in the U.S. totals and not in the total of the parent company location. A U.S. subsidiary to a foreign company is included in U.S. companies if it maintains its own identity; for example, it carries its own name rather than that of its parent company. On the other hand, a U.S. subsidiary of a foreign company that does not maintain its own identity is included in the total of the parent company.

Definitions and Conventions

Dataquest uses a common manufacturer base for all data tables. This base includes all noncaptive suppliers to the semiconductor market. It excludes totally captive suppliers, such as IBM, that manufacture devices solely for the benefit of the parent company, but it includes companies that actively market their semiconductor devices to industry as well as to other divisions of their own companies. For these companies, both external shipments and internal consumption are included. Devices that are used internally are valued at current market prices.

All estimates given in these tables have been converted to U.S. dollars to make the tables useful in comparing companies based in different countries. Each table is also presented in yen, in order to provide a more accurate presentation of actual growth rates for the Japanese companies.

Construction of the tables involves combining data from many countries, each of which has different and changing exchange rates. Dataquest uses average exchange rates for each year and, as far as possible, the estimates are prepared in terms of local currencies before conversion to U.S. dollars or yen.

Need for Careful Interpretation

Despite the care taken in gathering and analyzing the available data and in attempting to categorize those data in a meaningful way, careful attention must be paid to the definitions and assumptions used herein when interpreting the estimates presented in these tables. Various companies, government agencies, and trade associations may use slightly different definitions of product categories and regional groupings, or they may include different companies in their summaries. These differences should be kept in mind when making comparisons between these data and data provided by others.

Final Estimated 1990 Market Share in Japan

Table 1 is provided as a summary of our market share estimates. Regional data given here refer to regional company bases, such that "Japanese Companies" represent the sum of all companies worldwide with Japanese origins. All tables are reported in millions of dollars and percentages of market share. For detail by company, please refer to Tables 2 through 37.

Index of Tables

Notes to Market Share Tables

1. ABB-HAFO was formerly known as ASEA Brown Boveri.
2. ABB-IXYS was formerly the West German-based power semiconductor division of ASEA Brown Boveri.
3. Allegro Micro Systems was formerly known as Sprague.
4. Appian Technology was formerly known as ZyMOS.
5. Ericsson was known as Rifa prior to March 1, 1988.
6. GEC Plessey revenue includes MEDL revenue and Plessey revenue.
7. Harris revenue includes GE Solid State revenue from 1989 onward.
8. Inmos revenue is included in SGS-Thomson revenue from 1989 onward.
9. Matra MHS was formerly known as Matra-Harris Semiconducteurs.
10. Philips revenue includes Signetics revenue.
11. Plessey revenue includes Ferranti revenue from 1987 onward.
12. SGS-Thomson revenue includes Inmos revenue from 1989 onward.
13. Thomson Composants Militaires et Spatiaux (TMS) revenue was formerly included in SGS-Thomson (30 percent) and the Other European Companies category (70 percent).
14. VQSI was formerly known as Varo.
15. Micro Quality Semiconductor was formerly known as VQSI.
16. In 1989, AT&T revenue previously classified as MOS logic has been reclassified as microcomponent.
17. In 1989, Rockwell revenue previously classified as MOS logic has been reclassified as analog.
18. Prior to 1989, Sanyo revenue was understated.
19. Collection of BiCMOS revenue data began in 1987.
20. Vertex was formerly known as Integrated CMOS Systems.

Table 1
Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	All
Product:	Each
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Semiconductor						
North American Companies	1,965	2,162	2,402	9.5	9.4	10.7
Japanese Companies	18,630	20,628	19,825	89.7	89.7	88.1
European Companies	115	130	164	.6	.6	.7
Asia/Pacific Companies	62	77	117	.3	.3	.5
Total Market	20,772	22,997	22,508	100.0	100.0	100.0
Total Integrated Circuit						
North American Companies	1,868	2,082	2,283	11.6	11.6	13.1
Japanese Companies	14,096	15,686	14,848	87.4	87.4	85.4
European Companies	105	112	150	.7	.6	.9
Asia/Pacific Companies	58	66	106	.4	.4	.6
Total Market	16,127	17,946	17,387	100.0	100.0	100.0
Bipolar Digital						
North American Companies	476	377	349	25.0	21.5	19.4
Japanese Companies	1,397	1,338	1,424	73.3	76.5	79.1
European Companies	32	34	26	1.7	1.9	1.4
Asia/Pacific Companies	1	1	1	.1	.1	.1
Total Market	1,906	1,750	1,800	100.0	100.0	100.0
Bipolar Digital Memory						
North American Companies	26	21	16	7.5	8.5	7.7
Japanese Companies	319	223	192	91.7	90.7	91.9
European Companies	3	2	1	.9	.8	.5
Asia/Pacific Companies	0	0	0	.0	.0	.0
Total Market	348	246	209	100.0	100.0	100.0
Bipolar Digital Logic						
North American Companies	450	356	333	28.9	23.7	20.9
Japanese Companies	1,078	1,115	1,232	69.2	74.1	77.4
European Companies	29	32	25	1.9	2.1	1.6
Asia/Pacific Companies	1	1	1	.1	.1	.1
Total Market	1,558	1,504	1,591	100.0	100.0	100.0

(Continued)

Table 1 (Continued)
Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
MOS Digital						
North American Companies	950	1,191	1,405	9.0	9.5	11.9
Japanese Companies	9,462	11,197	10,250	90.1	89.6	86.9
European Companies	38	53	67	.4	.4	.6
Asia/Pacific Companies	51	56	77	.5	.4	.7
Total Market	10,501	12,497	11,799	100.0	100.0	100.0
MOS Memory						
North American Companies	222	429	407	5.0	7.2	8.8
Japanese Companies	4,147	5,494	4,108	93.7	91.7	89.1
European Companies	13	17	25	.3	.3	.5
Asia/Pacific Companies	42	52	72	.9	.9	1.6
Total Market	4,424	5,992	4,612	100.0	100.0	100.0
MOS Microcomponents						
North American Companies	444	496	633	17.3	17.5	19.7
Japanese Companies	2,116	2,309	2,562	82.2	81.6	79.8
European Companies	13	23	15	.5	.8	.5
Asia/Pacific Companies	0	0	0	.0	.0	.0
Total Market	2,573	2,828	3,210	100.0	100.0	100.0
MOS Logic						
North American Companies	284	266	365	8.1	7.2	9.2
Japanese Companies	3,199	3,394	3,580	91.3	92.3	90.0
European Companies	12	13	27	.3	.4	.7
Asia/Pacific Companies	9	4	5	.3	.1	.1
Total Market	3,504	3,677	3,977	100.0	100.0	100.0
Analog						
North American Companies	442	514	529	11.9	13.9	14.0
Japanese Companies	3,237	3,151	3,174	87.0	85.2	83.8
European Companies	35	25	57	.9	.7	1.5
Asia/Pacific Companies	6	9	28	.2	.2	.7
Total Market	3,720	3,699	3,788	100.0	100.0	100.0
Total Discrete						
North American Companies	72	57	80	2.2	1.7	2.4
Japanese Companies	3,199	3,242	3,293	97.5	97.6	97.1
European Companies	7	12	11	.2	.4	.3
Asia/Pacific Companies	4	10	8	.1	.3	.2
Total Market	3,282	3,321	3,392	100.0	100.0	100.0

(Continued)

Table 1 (Continued)
Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Optoelectronic						
North American Companies	25	23	39	1.8	1.3	2.3
Japanese Companies	1,335	1,700	1,684	97.9	98.3	97.9
European Companies	3	6	3	.2	.3	.2
Asia/Pacific Companies	0	1	3	.0	.1	.2
Total Market	1,363	1,730	1,697	100.0	100.0	100.0

NM = Not meaningful

Source: Dataquest (May 1991)

Table 2
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	Total Semiconductor
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	20,772	22,997	22,508	100.0	100.0	100.0
North American Companies	1,965	2,162	2,402	9.5	9.4	10.7
Acrian	2	2	0	.0	.0	.0
Actel	NA	1	1	NA	.0	.0
Advanced Micro Devices	133	143	139	.6	.6	.6
Allegro MicroSystems	4	5	4	.0	.0	.0
Altera	5	7	10	.0	.0	.0
Analog Devices	63	59	42	.3	.3	.2
Appian Technology	0	0	1	.0	.0	.0
AT&T	0	0	7	.0	.0	.0
Atmel	NA	13	7	NA	.1	.0
Brooktree	NA	4	7	NA	.0	.0
Burr-Brown	53	50	49	.3	.2	.2
Catalyst	1	10	9	.0	.0	.0
Cherry Semiconductor	2	0	0	.0	.0	.0
Chips & Technologies	12	18	19	.1	.1	.1
Cirrus Logic	NA	2	23	NA	.0	.1
Crystal	NA	1	0	NA	.0	.0
Cypress Semiconductor	4	9	11	.0	.0	.0
Dallas Semiconductor	NA	1	1	NA	.0	.0
Elantec	NA	2	3	NA	.0	.0
Exar	3	5	19	.0	.0	.1
General Electric	8	0	0	.0	.0	.0
General Instrument	27	16	23	.1	.1	.1
Gennum	NA	2	2	NA	.0	.0
Gould AMI	2	6	4	.0	.0	.0
Harris	15	36	41	.1	.2	.2
Hewlett Packard	29	25	24	.1	.1	.1
Honeywell	7	0	4	.0	.0	.0
Inova	NA	0	1	NA	.0	.0
Integrated Device Technology	11	15	20	.1	.1	.1
Intel	285	301	367	1.4	1.3	1.6
International CMOS Technology	NA	4	7	NA	.0	.0
Int'l. Microelectronic Prod.	0	1	0	.0	.0	.0
International Rectifier	5	5	14	.0	.0	.1

(Continued)

Table 2 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
ITT	33	25	25	.2	.1	.1
Lattice	2	4	9	.0	.0	.0
Linear Technology	6	8	10	.0	.0	.0
LSI Logic	20	51	58	.1	.2	.3
Macronix	NA	8	1	NA	.0	.0
Maxim	7	9	12	.0	.0	.1
Micro Linear	0	1	1	.0	.0	.0
Micro Power Systems	2	3	4	.0	.0	.0
Microchip Technology	8	9	4	.0	.0	.0
Micron Technology	8	2	2	.0	.0	.0
Mitel	7	0	10	.0	.0	.0
MOSel	1	1	9	.0	.0	.0
Motorola	290	353	438	1.4	1.5	1.9
National Semiconductor	140	145	143	.7	.6	.6
NCR	1	0	3	.0	.0	.0
Optek	NA	0	7	NA	.0	.0
Performance Semiconductor	NA	1	1	NA	.0	.0
Precision Monolithics	10	5	6	.0	.0	.0
Quality Technologies	1	0	0	.0	.0	.0
Raytheon	0	0	4	.0	.0	.0
Rockwell	88	100	80	.4	.4	.4
SEEQ Technology	4	4	5	.0	.0	.0
Sierra Semiconductor	0	0	2	.0	.0	.0
Signal Processing Technology	NA	NA	1	NA	NA	.0
Silicon Systems	18	15	23	.1	.1	.1
Siliconix	8	6	5	.0	.0	.0
Sipex	NA	1	1	NA	.0	.0
Standard Microsystems	1	1	1	.0	.0	.0
Supertex	3	8	5	.0	.0	.0
Teledyne	3	2	2	.0	.0	.0
Texas Instruments	599	608	614	2.9	2.6	2.7
TRW	0	0	2	.0	.0	.0
Unitrode	3	3	1	.0	.0	.0
Vertex	NA	3	4	.0	.0	.0
Vitelic	0	3	2	.0	.0	.0
VLSI Technology	6	7	8	.0	.0	.0
Weitek	4	4	4	.0	.0	.0
Western Digital	8	11	13	.0	.0	.1
Xicor	5	8	5	.0	.0	.0
Xilinx	4	5	12	.0	.0	.1
Zilog	4	5	6	.0	.0	.0

(Continued)

Table 2 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	18,630	20,628	19,825	89.7	89.7	88.1
Fuji Electric	284	303	313	1.4	1.3	1.4
Fujitsu	1,987	2,098	2,041	9.6	9.1	9.1
Hitachi	2,470	2,719	2,717	11.9	11.8	12.1
Matsushita	1,622	1,521	1,572	7.8	6.6	7.0
Mitsubishi	1,596	1,769	1,583	7.7	7.7	7.0
NEC	3,287	3,600	3,614	15.8	15.7	16.1
New JRC	146	146	149	.7	.6	.7
NMB Semiconductor	27	29	1	.1	.1	.0
Oki	527	645	620	2.5	2.8	2.8
Ricoh	80	88	96	.4	.4	.4
Rohm	592	600	633	2.8	2.6	2.8
Sanken	268	266	281	1.3	1.2	1.2
Sanyo	868	1,118	1,033	4.2	4.9	4.6
Seiko Epson	226	284	172	1.1	1.2	.8
Sharp	859	1,000	1,080	4.1	4.3	4.8
Shindengen Electric	NA	NA	189	NA	NA	.8
Sony	845	872	890	4.1	3.8	4.0
Toko	NA	NA	53	NA	NA	.2
Toshiba	2,496	2,743	2,650	12.0	11.9	11.8
Yamaha	135	129	138	.6	.6	.6
Other Japanese Companies	315	698	0	1.5	3.0	.0
European Companies	115	130	164	.6	.6	.7
ABB-HAFO	3	2	2	.0	.0	.0
Ericsson	2	2	2	.0	.0	.0
Eurosil	1	1	1	.0	.0	.0
GEC Plessey	0	0	16	.0	.0	.1
Inmos	8	0	0	.0	.0	.0
Matra MHS	2	1	1	.0	.0	.0
Philips	62	69	77	.3	.3	.3
Plessey	6	8	0	.0	.0	.0
SGS-Thomson	12	22	40	.1	.1	.2
Siemens	17	22	21	.1	.1	.1
Telefunken Electronic	2	2	4	.0	.0	.0
TMS	0	1	0	.0	.0	.0

(Continued)

Table 2 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	62	77	117	.3	.3	.5
Goldstar	9	5	16	.0	.0	.1
Hi-Sincerity	NA	NA	1	NA	NA	.0
Hyundai	1	3	2	.0	.0	.0
Korean Electronic Co.	1	8	12	.0	.0	.1
Ledtech Electronics	NA	NA	1	NA	NA	.0
Samsung	49	59	60	.2	.3	.3
United Microelectronics	2	2	1	.0	.0	.0
Winbond	NA	NA	3	NA	NA	.0
Other Asia/Pacific Companies	0	0	21	.0	.0	.1

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 3
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	Total Semiconductor
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	2,700.8	3,173.1	3,240.3	100.0	100.0	100.0
North American Companies	255.5	298.3	345.1	9.5	9.4	10.7
Acrian	.3	.3	.0	.0	.0	.0
Actel	NA	.1	.1	NA	.0	.0
Advanced Micro Devices	17.3	19.7	20.0	.6	.6	.6
Allegro MicroSystems	.5	.7	.6	.0	.0	.0
Altera	.7	1.0	1.4	.0	.0	.0
Analog Devices	8.2	8.1	6.0	.3	.3	.2
Appian Technology	.0	.0	.1	.0	.0	.0
AT&T	.0	.0	1.0	.0	.0	.0
Atmel	NA	1.8	1.0	NA	.1	.0
Brooktree	NA	.6	1.0	NA	.0	.0
Burr-Brown	6.9	6.9	7.1	.3	.2	.2
Catalyst	.1	1.4	1.3	.0	.0	.0
Cherry Semiconductor	.3	.0	.0	.0	.0	.0
Chips & Technologies	1.6	2.5	2.7	.1	.1	.1
Cirrus Logic	NA	.3	3.3	NA	.0	.1
Crystal	NA	.1	.0	NA	.0	.0
Cypress Semiconductor	.5	1.2	1.6	.0	.0	.0
Dallas Semiconductor	NA	.1	.1	NA	.0	.0
Elantec	NA	.3	.4	NA	.0	.0
Exar	.4	.7	2.7	.0	.0	.1
General Electric	1.0	.0	.0	.0	.0	.0
General Instrument	3.5	2.2	3.3	.1	.1	.1
Gennum	NA	.3	.3	NA	.0	.0
Gould AMI	.3	.8	.6	.0	.0	.0
Harris	2.0	5.0	5.9	.1	.2	.2
Hewlett Packard	3.8	3.5	3.2	.1	.1	.1
Honeywell	.9	.0	.6	.0	.0	.0
Inova	NA	.0	.1	NA	.0	.0
Integrated Device Technology	1.4	2.1	2.9	.1	.1	.1
Intel	37.1	41.5	52.8	1.4	1.3	1.6
International CMOS Technology	NA	.6	1.0	NA	.0	.0
Int'l. Microelectronic Prod.	.0	.1	.0	.0	.0	.0
International Rectifier	.7	.7	2.0	.0	.0	.1

(Continued)

Table 3 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
ITT	4.3	3.5	3.6	.2	.1	.1
Lattice	.3	.6	1.3	.0	.0	.0
Linear Technology	.8	1.1	1.4	.0	.0	.0
LSI Logic	2.6	7.0	8.4	.1	.2	.3
Macronix	NA	1.1	.1	NA	.0	.0
Maxim	.9	1.2	1.7	.0	.0	.1
Micro Linear	.0	.1	.1	.0	.0	.0
Micro Power Systems	.3	.4	.6	.0	.0	.0
Microchip Technology	1.0	1.2	.6	.0	.0	.0
Micron Technology	1.0	.3	.3	.0	.0	.0
Mitel	.9	.0	1.4	.0	.0	.0
MOSel	.1	.1	1.3	.0	.0	.0
Motorola	37.7	48.7	63.1	1.4	1.5	1.9
National Semiconductor	18.2	20.0	20.6	.7	.6	.6
NCR	.1	.0	.4	.0	.0	.0
Optek	NA	.0	1.0	NA	.0	.0
Performance Semiconductor	NA	.1	.1	NA	.0	.0
Precision Monolithics	1.3	.7	.9	.0	.0	.0
Quality Technologies	.1	.0	.0	.0	.0	.0
Raytheon	.0	.0	.6	.0	.0	.0
Rockwell	11.4	13.8	11.5	.4	.4	.4
SEEQ Technology	.5	.6	.7	.0	.0	.0
Sierra Semiconductor	.0	.0	.3	.0	.0	.0
Signal Processing Technology	NA	NA	.1	NA	NA	.0
Silicon Systems	2.3	2.1	3.3	.1	.1	.1
Siliconix	1.0	.8	.7	.0	.0	.0
Sipex	NA	.1	.1	NA	.0	.0
Standard Microsystems	.1	.1	.1	.0	.0	.0
Supertex	.4	1.1	.7	.0	.0	.0
Teledyne	.4	.3	.3	.0	.0	.0
Texas Instruments	77.9	83.9	88.4	2.9	2.6	2.7
TRW	.0	.0	.3	.0	.0	.0
Unitrode	.4	.4	.1	.0	.0	.0
Vertex	NA	.4	.6	NA	.0	.0
Vitelic	.0	.4	.3	.0	.0	.0
VLSI Technology	.8	1.0	1.2	.0	.0	.0
Weitek	.5	.6	.6	.0	.0	.0
Western Digital	1.0	1.5	1.9	.0	.0	.1
Xicor	.7	1.1	.7	.0	.0	.0
Xilinx	.5	.7	1.7	.0	.0	.1
Zilog	.5	.7	.9	.0	.0	.0

(Continued)

Table 3 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	2,422.1	2,846.4	2,855.0	89.7	89.7	88.1
Fuji Electric	36.9	41.8	45.1	1.4	1.3	1.4
Fujitsu	258.3	289.5	293.9	9.6	9.1	9.1
Hitachi	321.1	375.2	391.2	11.9	11.8	12.1
Matsushita	210.9	209.9	226.4	7.8	6.6	7.0
Mitsubishi	207.5	244.1	228.0	7.7	7.7	7.0
NEC	427.3	496.8	520.4	15.8	15.7	16.1
New JRC	19.0	20.1	21.5	.7	.6	.7
NMB Semiconductor	3.5	4.0	.1	.1	.1	.0
Oki	68.5	89.0	89.3	2.5	2.8	2.8
Ricoh	10.4	12.1	13.8	.4	.4	.4
Rohm	77.0	82.8	91.2	2.9	2.6	2.8
Sanken	34.8	36.7	40.5	1.3	1.2	1.2
Sanyo	112.8	154.3	148.8	4.2	4.9	4.6
Seiko Epson	29.4	39.2	24.8	1.1	1.2	.8
Sharp	111.7	138.0	155.5	4.1	4.3	4.8
Shindengen Electric	NA	NA	27.2	NA	NA	.8
Sony	109.9	120.3	128.2	4.1	3.8	4.0
Toko	NA	NA	7.6	NA	NA	.2
Toshiba	324.5	378.5	381.6	12.0	11.9	11.8
Yamaha	17.6	17.8	19.9	.7	.6	.6
Other Japanese Companies	41.0	96.3	.0	1.5	3.0	.0
European Companies	15.1	17.8	23.6	.6	.6	.7
ABB-HAFO	.4	.3	.3	.0	.0	.0
Ericsson	.3	.3	.3	.0	.0	.0
Eurosil	.1	.1	.1	.0	.0	.0
GEC Plessey	.0	.0	2.3	.0	.0	.1
Inmos	1.0	.0	.0	.0	.0	.0
Matra MHS	.3	.1	.1	.0	.0	.0
Philips	8.1	9.5	11.1	.3	.3	.3
Plessey	.8	1.1	.0	.0	.0	.0
SGS-Thomson	1.6	3.0	5.8	.1	.1	.2
Siemens	2.2	3.0	3.0	.1	.1	.1
Telefunken Electronic	.3	.3	.6	.0	.0	.0
TMS	.0	.1	.0	.0	.0	.0

(Continued)

Table 3 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	8.1	10.6	16.6	.3	.3	.5
Goldstar	1.2	.7	2.3	.0	.0	.1
Hi-Sincerity	NA	NA	.1	NA	NA	.0
Hyundai	.1	.4	.3	.0	.0	.0
Korean Electronic Co.	.1	1.1	1.7	.0	.0	.1
Ledtech Electronics	NA	NA	.1	NA	NA	.0
Samsung	6.4	8.1	8.6	.2	.3	.3
United Microelectronics	.3	.3	.1	.0	.0	.0
Winbond	NA	NA	.4	NA	NA	.0
Other Asia/Pacific Companies	.0	.0	3.0	.0	.0	.1
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 4
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	Total Integrated Circuit
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	16,127	17,946	17,387	100.0	100.0	100.0
North American Companies	1,868	2,082	2,283	11.6	11.6	13.1
Actel	NA	1	1	NA	.0	.0
Advanced Micro Devices	133	143	139	.8	.8	.8
Allegro MicroSystems	4	5	4	.0	.0	.0
Altera	5	7	10	.0	.0	.1
Analog Devices	63	59	42	.4	.3	.2
Appian Technology	0	0	1	.0	.0	.0
AT&T	0	0	7	.0	.0	.0
Atmel	NA	13	7	NA	.1	.0
Brooktree	NA	4	7	NA	.0	.0
Burr-Brown	53	50	49	.3	.3	.3
Catalyst	1	10	9	.0	.1	.1
Cherry Semiconductor	2	0	0	.0	.0	.0
Chips & Technologies	12	18	19	.1	.1	.1
Cirrus Logic	NA	2	23	NA	.0	.1
Crystal	NA	1	0	NA	.0	.0
Cypress Semiconductor	4	9	11	.0	.1	.1
Dallas Semiconductor	NA	1	1	NA	.0	.0
Elantec	NA	2	3	NA	.0	.0
Exar	3	5	19	.0	.0	.1
General Electric	8	0	0	.0	.0	.0
Gennum	NA	2	2	NA	.0	.0
Gould AMI	2	6	4	.0	.0	.0
Harris	15	32	35	.1	.2	.2
Hewlett Packard	0	0	2	.0	.0	.0
Honeywell	7	0	4	.0	.0	.0
Inova	NA	0	1	NA	.0	.0
Integrated Device Technology	11	15	20	.1	.1	.1
Intel	285	301	367	1.8	1.7	2.1
International CMOS Technology	NA	4	7	NA	.0	.0
Int'l. Microelectronic Prod.	0	1	0	.0	.0	.0
ITT	18	15	15	.1	.1	.1
Lattice	2	4	9	.0	.0	.1
Linear Technology	6	8	10	.0	.0	.1

(Continued)

Table 4 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
LSI Logic	20	51	58	.1	.3	.3
Macronix	NA	8	1	NA	.0	.0
Maxim	7	9	12	.0	.1	.1
Micro Linear	0	1	1	.0	.0	.0
Micro Power Systems	2	3	4	.0	.0	.0
Microchip Technology	8	9	4	.0	.1	.0
Micron Technology	8	2	2	.0	.0	.0
Mitel	7	0	10	.0	.0	.1
MOSel	1	1	9	.0	.0	.1
Motorola	280	341	415	1.7	1.9	2.4
National Semiconductor	140	145	143	.9	.8	.8
NCR	1	0	3	.0	.0	.0
Performance Semiconductor	NA	1	1	NA	.0	.0
Precision Monolithics	10	5	6	.1	.0	.0
Raytheon	0	0	4	.0	.0	.0
Rockwell	88	100	80	.5	.6	.5
SEEQ Technology	4	4	5	.0	.0	.0
Sierra Semiconductor	0	0	2	.0	.0	.0
Signal Processing Technology	NA	NA	1	NA	NA	.0
Silicon Systems	18	15	23	.1	.1	.1
Siliconix	4	4	3	.0	.0	.0
Sipex	NA	1	1	NA	.0	.0
Standard Microsystems	1	1	1	.0	.0	.0
Supertex	2	7	4	.0	.0	.0
Teledyne	3	2	2	.0	.0	.0
Texas Instruments	597	606	604	3.7	3.4	3.5
TRW	0	0	2	.0	.0	.0
Unitrode	2	2	0	.0	.0	.0
Vertex	NA	3	4	.0	.0	.0
Vitelic	0	3	2	.0	.0	.0
VLSI Technology	6	7	8	.0	.0	.0
Weitek	4	4	4	.0	.0	.0
Western Digital	8	11	13	.0	.1	.1
Xicor	5	8	5	.0	.0	.0
Xilinx	4	5	12	.0	.0	.1
Zilog	4	5	6	.0	.0	.0

(Continued)

Table 4 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	14,096	15,686	14,848	87.4	87.4	85.4
Fuji Electric	59	65	69	.4	.4	.4
Fujitsu	1,834	1,949	1,880	11.4	10.9	10.8
Hitachi	1,842	2,111	2,148	11.4	11.8	12.4
Matsushita	1,126	949	955	7.0	5.3	5.5
Mitsubishi	1,298	1,447	1,329	8.0	8.1	7.6
NEC	2,762	3,014	3,043	17.1	16.8	17.5
New JRC	126	132	135	.8	.7	.8
NMB Semiconductor	27	29	1	.2	.2	.0
Oki	484	602	577	3.0	3.4	3.3
Ricoh	80	88	96	.5	.5	.6
Rohm	262	275	279	1.6	1.5	1.6
Sanken	111	107	113	.7	.6	.6
Sanyo	671	784	694	4.2	4.4	4.0
Seiko Epson	226	284	172	1.4	1.6	1.0
Sharp	607	720	795	3.8	4.0	4.6
Shindengen Electric	NA	NA	33	NA	NA	.2
Sony	522	537	554	3.2	3.0	3.2
Toko	NA	NA	48	NA	NA	.3
Toshiba	1,724	1,873	1,789	10.7	10.4	10.3
Yamaha	135	129	138	.8	.7	.8
Other Japanese Companies	200	591	0	1.2	3.3	.0
European Companies	105	112	150	.7	.6	.9
ABB-HAFO	1	0	0	.0	.0	.0
Ericsson	2	2	2	.0	.0	.0
Eurosil	1	1	1	.0	.0	.0
GEC Plessey	0	0	16	.0	.0	.1
Inmos	8	0	0	.0	.0	.0
Matra MHS	2	1	1	.0	.0	.0
Philips	60	67	74	.4	.4	.4
Plessey	6	8	0	.0	.0	.0
SGS-Thomson	10	20	35	.1	.1	.2
Siemens	13	11	17	.1	.1	.1
Telefunken Electronic	2	2	4	.0	.0	.0

(Continued)

Table 4 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	58	66	106	.4	.4	.6
Goldstar	9	5	16	.1	.0	.1
Hyundai	1	3	2	.0	.0	.0
Korean Electronic Co.	0	1	5	.0	.0	.0
Samsung	46	55	58	.3	.3	.3
United Microelectronics	2	2	1	.0	.0	.0
Winbond	NA	NA	3	NA	NA	.0
Other Asia/Pacific Companies	0	0	21	.0	.0	.1

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 5
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	Total Integrated Circuit
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	2,096.7	2,476.7	2,502.9	100.0	100.0	100.0
North American Companies	242.8	287.3	328.1	11.6	11.6	13.1
Actel	NA	.1	.1	NA	.0	.0
Advanced Micro Devices	17.3	19.7	20.0	.8	.8	.8
Allegro MicroSystems	.5	.7	.6	.0	.0	.0
Altera	.7	1.0	1.4	.0	.0	.1
Analog Devices	8.2	8.1	6.0	.4	.3	.2
Appian Technology	.0	.0	.1	.0	.0	.0
AT&T	.0	.0	1.0	.0	.0	.0
Atmel	NA	1.8	1.0	NA	.1	.0
Brooktree	NA	.6	1.0	NA	.0	.0
Burr-Brown	6.9	6.9	7.1	.3	.3	.3
Catalyst	.1	1.4	1.3	.0	.1	.1
Cherry Semiconductor	.3	.0	.0	.0	.0	.0
Chips & Technologies	1.6	2.5	2.7	.1	.1	.1
Cirrus Logic	NA	.3	3.3	NA	.0	.1
Crystal	NA	.1	.0	NA	.0	.0
Cypress Semiconductor	.5	1.2	1.6	.0	.0	.1
Dallas Semiconductor	NA	.1	.1	NA	.0	.0
Elantec	NA	.3	.4	NA	.0	.0
Exar	.4	.7	2.7	.0	.0	.1
General Electric	1.0	.0	.0	.0	.0	.0
Gennum	NA	.3	.3	NA	.0	.0
Gould AMI	.3	.8	.6	.0	.0	.0
Harris	2.0	4.4	5.0	.1	.2	.2
Honeywell	.9	.0	.6	.0	.0	.0
Inova	NA	.0	.1	NA	.0	.0
Integrated Device Technology	1.4	2.1	2.9	.1	.1	.1
Intel	37.1	41.5	52.8	1.8	1.7	2.1
International CMOS Technology	NA	.6	1.0	NA	.0	.0
Int'l. Microelectronic Prod.	.0	.1	.0	.0	.0	.0
ITT	2.3	2.1	2.2	.1	.1	.1
Lattice	.3	.6	1.3	.0	.0	.1
Linear Technology	.8	1.1	1.4	.0	.0	.1
LSI Logic	2.6	7.0	8.4	.1	.3	.3

(Continued)

Table 5 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Macronix	NA	1.1	.1	NA	.0	.0
Maxim	.9	1.2	1.7	.0	.0	.1
Micro Linear	.0	.1	.1	.0	.0	.0
Micro Power Systems	.3	.4	.6	.0	.0	.0
Microchip Technology	1.0	1.2	.6	.0	.0	.0
Micron Technology	1.0	.3	.3	.0	.0	.0
Mitel	.9	.0	1.4	.0	.0	.1
MOSel	.1	.1	1.3	.0	.0	.1
Motorola	36.4	47.1	59.8	1.7	1.9	2.4
National Semiconductor	18.2	20.0	20.6	.9	.8	.8
NCR	.1	.0	.4	.0	.0	.0
Performance Semiconductor	NA	.1	.1	NA	.0	.0
Precision Monolithics	1.3	.7	.9	.1	.0	.0
Raytheon	.0	.0	.6	.0	.0	.0
Rockwell	11.4	13.8	11.5	.5	.6	.5
SEEQ Technology	.5	.6	.7	.0	.0	.0
Sierra Semiconductor	.0	.0	.3	.0	.0	.0
Signal Processing Technology	NA	NA	.1	NA	NA	.0
Silicon Systems	2.3	2.1	3.3	.1	.1	.1
Siliconix	.5	.6	.4	.0	.0	.0
Sipex	NA	.1	.1	NA	.0	.0
Standard Microsystems	.1	.1	.1	.0	.0	.0
Supertex	.3	1.0	.6	.0	.0	.0
Teledyne	.4	.3	.3	.0	.0	.0
Texas Instruments	77.6	83.6	87.0	3.7	3.4	3.5
TRW	.0	.0	.3	.0	.0	.0
Unitrode	.3	.3	.0	.0	.0	.0
Vertex	NA	.4	.6	NA	.0	.0
Vitelic	.0	.4	.3	.0	.0	.0
VLSI Technology	.8	1.0	1.2	.0	.0	.0
Weitek	.5	.6	.6	.0	.0	.0
Western Digital	1.0	1.5	1.9	.0	.1	.1
Xicor	.7	1.1	.7	.0	.0	.0
Xilinx	.5	.7	1.7	.0	.0	.1
Zilog	.5	.7	.9	.0	.0	.0

(Continued)

Table 5 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	1,832.6	2,164.9	2,138.1	87.4	87.4	85.4
Fuji Electric	7.7	9.0	9.9	.4	.4	.4
Fujitsu	238.4	269.0	270.7	11.4	10.9	10.8
Hitachi	239.5	291.3	309.3	11.4	11.8	12.4
Matsushita	146.4	131.0	137.5	7.0	5.3	5.5
Mitsubishi	168.7	199.7	191.4	8.0	8.1	7.6
NEC	359.1	415.9	438.2	17.1	16.8	17.5
New JRC	16.4	18.2	19.4	.8	.7	.8
NMB Semiconductor	3.5	4.0	.1	.2	.2	.0
Oki	62.9	83.1	83.1	3.0	3.4	3.3
Ricoh	10.4	12.1	13.8	.5	.5	.6
Rohm	34.1	38.0	40.2	1.6	1.5	1.6
Sanken	14.4	14.8	16.3	.7	.6	.7
Sanyo	87.2	108.2	99.9	4.2	4.4	4.0
Seiko Epson	29.4	39.2	24.8	1.4	1.6	1.0
Sharp	78.9	99.4	114.5	3.8	4.0	4.6
Shindengen Electric	NA	NA	4.8	NA	NA	.2
Sony	67.9	74.1	79.8	3.2	3.0	3.2
Toko	NA	NA	6.9	NA	NA	.3
Toshiba	224.1	258.5	257.6	10.7	10.4	10.3
Yamaha	17.6	17.8	19.9	.8	.7	.8
Other Japanese Companies	26.0	81.6	.0	1.2	3.3	.0
European Companies	13.7	15.4	21.5	.7	.6	.9
ABB-HAFO	.1	.0	.0	.0	.0	.0
Ericsson	.3	.3	.3	.0	.0	.0
Eurosil	.1	.1	.1	.0	.0	.0
GEC Plessey	.0	.0	2.3	.0	.0	.1
Inmos	1.0	.0	.0	.0	.0	.0
Matra MHS	.3	.1	.1	.0	.0	.0
Philips	7.8	9.2	10.7	.4	.4	.4
Plessey	.8	1.1	.0	.0	.0	.0
SGS-Thomson	1.3	2.8	5.0	.1	.1	.2
Siemens	1.7	1.5	2.4	.1	.1	.1
Telefunken Electronic	.3	.3	.6	.0	.0	.0

(Continued)

Table 5 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	7.6	9.1	15.2	.4	.4	.6
Goldstar	1.2	.7	2.3	.1	.0	.1
Hyundai	.1	.4	.3	.0	.0	.0
Korean Electronic Co.	.0	.1	.7	.0	.0	.0
Samsung	6.0	7.6	8.4	.3	.3	.3
United Microelectronics	.3	.3	.1	.0	.0	.0
Winbond	NA	NA	.4	NA	NA	.0
Other Asia/Pacific Companies	.0	.0	3.0	.0	.0	.1
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 6
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	Bipolar Digital
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	1,906	1,750	1,800	100.0	100.0	100.0
North American Companies	476	377	349	25.0	21.5	19.4
Advanced Micro Devices	62	59	47	3.3	3.4	2.6
Chips & Technologies	2	1	1	.1	.1	.1
Intel	3	1	0	.2	.1	.0
Motorola	65	56	55	3.4	3.2	3.1
National Semiconductor	78	67	61	4.1	3.8	3.4
Raytheon	0	0	1	.0	.0	.1
Texas Instruments	266	193	184	14.0	11.0	10.2
Japanese Companies	1,397	1,338	1,424	73.3	76.5	79.1
Fujitsu	479	433	487	25.1	24.7	27.1
Hitachi	369	345	387	19.4	19.7	21.5
Matsushita	27	13	13	1.4	.7	.7
Mitsubishi	116	108	96	6.1	6.2	5.3
NEC	264	242	238	13.9	13.8	13.2
New JRC	1	1	1	.1	.1	.1
Oki	37	48	47	1.9	2.7	2.6
Rohm	0	0	1	.0	.0	.1
Sanyo	38	62	60	2.0	3.5	3.3
Toshiba	66	86	94	3.5	4.9	5.2
European Companies	32	34	26	1.7	1.9	1.4
GEC Plessey	0	0	4	.0	.0	.2
Philips	29	30	22	1.5	1.7	1.2
Plessey	3	4	0	.2	.2	.0
Asia/Pacific Companies	1	1	1	.1	.1	.1
Goldstar	1	1	1	.1	.1	.1

NM = Not meaningful

Source: Dataquest (May 1991)

Table 7
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	Bipolar Digital
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	247.9	241.3	259.0	100.0	100.0	100.0
North American Companies	62.0	51.8	50.2	25.0	21.5	19.4
Advanced Micro Devices	8.1	8.1	6.8	3.3	3.4	2.6
Chips & Technologies	.3	.1	.1	.1	.0	.0
Intel	.4	.1	.0	.2	.0	.0
Motorola	8.5	7.7	7.9	3.4	3.2	3.1
National Semiconductor	10.1	9.2	8.8	4.1	3.8	3.4
Raytheon	.0	.0	.1	.0	.0	.0
Texas Instruments	34.6	26.6	26.5	14.0	11.0	10.2
Japanese Companies	181.6	184.7	204.9	73.3	76.5	79.1
Fujitsu	62.3	59.8	70.1	25.1	24.8	27.1
Hitachi	48.0	47.6	55.7	19.4	19.7	21.5
Matsushita	3.5	1.8	1.9	1.4	.7	.7
Mitsubishi	15.1	14.9	13.8	6.1	6.2	5.3
NEC	34.3	33.4	34.3	13.8	13.8	13.2
New JRC	.1	.1	.1	.0	.0	.0
Oki	4.8	6.6	6.8	1.9	2.7	2.6
Rohm	.0	.0	.1	.0	.0	.0
Sanyo	4.9	8.6	8.6	2.0	3.6	3.3
Toshiba	8.6	11.9	13.5	3.5	4.9	5.2
European Companies	4.2	4.7	3.8	1.7	1.9	1.5
GEC Plessey	.0	.0	.6	.0	.0	.2
Philips	3.8	4.1	3.2	1.5	1.7	1.2
Plessey	.4	.6	.0	.2	.2	.0
Asia/Pacific Companies	.1	.1	.1	.0	.0	.0
Goldstar	.1	.1	.1	.0	.0	.0
Exchange Rate (Yen/US$)	130	138	144			

NM = Not meaningful

Source: Dataquest (May 1991)

Table 8
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	TTL/Other
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	1,399	1,262	1,205	100.0	100.0	100.0
North American Companies	437	332	294	31.2	26.3	24.4
Advanced Micro Devices	62	49	32	4.4	3.9	2.7
Chips & Technologies	2	1	1	.1	.1	.1
Intel	3	1	0	.2	.1	.0
Motorola	32	28	22	2.3	2.2	1.8
National Semiconductor	72	60	55	5.1	4.8	4.6
Texas Instruments	266	193	184	19.0	15.3	15.3
Japanese Companies	933	898	890	66.7	71.2	73.9
Fujitsu	232	208	206	16.6	16.5	17.1
Hitachi	261	244	260	18.7	19.3	21.6
Matsushita	18	9	8	1.3	.7	.7
Mitsubishi	116	108	96	8.3	8.6	8.0
NEC	166	152	150	11.9	12.0	12.4
New JRC	1	1	1	.1	.1	.1
NMB Semiconductor	1	0	0	.1	.0	.0
Oki	34	43	42	2.4	3.4	3.5
Rohm	0	0	1	.0	.0	.1
Sanyo	38	62	60	2.7	4.9	5.0
Toshiba	66	71	66	4.7	5.6	5.5
European Companies	28	31	20	2.0	2.5	1.7
Philips	28	29	20	2.0	2.3	1.7
Plessey	0	2	0	.0	.2	.0
Asia/Pacific Companies	1	1	1	.1	.1	.1
Goldstar	1	1	1	.1	.1	.1

NM = Not meaningful

Source: Dataquest (May 1991)

Table 9
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	TTL/Other
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	181.9	174.1	173.3	100.0	100.0	100.0
North American Companies	57.0	45.8	42.3	31.3	26.3	24.4
Advanced Micro Devices	8.1	6.8	4.6	4.5	3.9	2.7
Chips & Technologies	.3	.1	.1	.2	.1	.1
Intel	.4	.1	.0	.2	.1	.0
Motorola	4.2	3.9	3.2	2.3	2.2	1.8
National Semiconductor	9.4	8.3	7.9	5.2	4.8	4.6
Texas Instruments	34.6	26.6	26.5	19.0	15.3	15.3
Japanese Companies	121.2	123.9	128.0	66.6	71.2	73.9
Fujitsu	30.2	28.7	29.7	16.6	16.5	17.1
Hitachi	33.9	33.7	37.4	18.6	19.4	21.6
Matsushita	2.3	1.2	1.2	1.3	.7	.7
Mitsubishi	15.1	14.9	13.8	8.3	8.6	8.0
NEC	21.6	21.0	21.6	11.9	12.1	12.5
New JRC	.1	.1	.1	.1	.1	.1
NMB Semiconductor	.1	.0	.0	.1	.0	.0
Oki	4.4	5.9	6.0	2.4	3.4	3.5
Rohm	.0	.0	.1	.0	.0	.1
Sanyo	4.9	8.6	8.6	2.7	4.9	5.0
Toshiba	8.6	9.8	9.5	4.7	5.6	5.5
European Companies	3.6	4.3	2.9	2.0	2.5	1.7
Philips	3.6	4.0	2.9	2.0	2.3	1.7
Plessey	.0	.3	.0	.0	.2	.0
Asia/Pacific Companies	.1	.1	.1	.1	.1	.1
Goldstar	.1	.1	.1	.1	.1	.1
Exchange Rate (Yen/US$)	130	138	144			

NM = Not meaningful

Source: Dataquest (May 1991)

Table 10
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	ECL
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	508	488	595	100.0	100.0	100.0
North American Companies	39	45	55	7.7	9.2	9.2
Advanced Micro Devices	0	10	15	.0	2.0	2.5
Motorola	33	28	33	6.5	5.7	5.5
National Semiconductor	6	7	6	1.2	1.4	1.0
Raytheon	0	0	1	.0	.0	.2
Japanese Companies	465	440	534	91.5	90.2	89.7
Fujitsu	247	225	281	48.6	46.1	47.2
Hitachi	108	101	127	21.3	20.7	21.3
Matsushita	9	4	5	1.8	.8	.8
NEC	98	90	88	19.3	18.4	14.8
Oki	3	5	5	.6	1.0	.8
Toshiba	0	15	28	.0	3.1	4.7
European Companies	4	3	6	.8	.6	1.0
GEC Plessey	0	0	4	.0	.0	.7
Philips	1	1	2	.2	.2	.3
Plessey	3	2	0	.6	.4	.0

NM = Not meaningful

Source: Dataquest (May 1991)

Table 11
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	ECL
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	66.0	67.5	85.8	100.0	100.0	100.0
North American Companies	5.1	6.3	8.0	7.7	9.3	9.3
Advanced Micro Devices	.0	1.4	2.2	.0	2.1	2.6
Motorola	4.3	3.9	4.8	6.5	5.8	5.6
National Semiconductor	.8	1.0	.9	1.2	1.5	1.0
Raytheon	.0	.0	.1	.0	.0	.1
Japanese Companies	60.4	60.8	76.9	91.5	90.1	89.6
Fujitsu	32.1	31.1	40.5	48.6	46.1	47.2
Hitachi	14.0	13.9	18.3	21.2	20.6	21.3
Matsushita	1.2	.6	.7	1.8	.9	.8
NEC	12.7	12.4	12.7	19.2	18.4	14.8
Oki	.4	.7	.7	.6	1.0	.8
Toshiba	.0	2.1	4.0	.0	3.1	4.7
European Companies	.5	.4	.9	.8	.6	1.0
GEC Plessey	.0	.0	.6	.0	.0	.7
Philips	.1	.1	.3	.2	.1	.3
Plessey	.4	.3	.0	.6	.4	.0
Exchange Rate (Yen/US$)	130	138	144			

NM = Not meaningful

Source: Dataquest (May 1991)

Table 12
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	Bipolar Digital Memory
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	348	246	209	100.0	100.0	100.0
North American Companies	26	21	16	7.5	8.5	7.7
Advanced Micro Devices	8	9	5	2.3	3.7	2.4
Motorola	1	1	0	.3	.4	.0
National Semiconductor	0	7	7	.0	2.8	3.3
Texas Instruments	17	4	4	4.9	1.6	1.9
Japanese Companies	319	223	192	91.7	90.7	91.9
Fujitsu	190	124	101	54.6	50.4	48.3
Hitachi	90	82	76	25.9	33.3	36.4
NEC	39	17	15	11.2	6.9	7.2
European Companies	3	2	1	.9	.8	.5
Philips	3	2	1	.9	.8	.5

NM = Not meaningful

Source: Dataquest (May 1991)

Table 13
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	Bipolar Digital Memory
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	45.2	33.9	30.0	100.0	100.0	100.0
North American Companies	3.3	2.9	2.3	7.3	8.6	7.7
Advanced Micro Devices	1.0	1.2	.7	2.2	3.5	2.3
Motorola	.1	.1	.0	.2	.3	.0
National Semiconductor	.0	1.0	1.0	.0	2.9	3.3
Texas Instruments	2.2	.6	.6	4.9	1.8	2.0
Japanese Companies	41.5	30.7	27.6	91.8	90.6	92.0
Fujitsu	24.7	17.1	14.5	54.6	50.4	48.3
Hitachi	11.7	11.3	10.9	25.9	33.3	36.3
NEC	5.1	2.3	2.2	11.3	6.8	7.3
European Companies	.4	.3	.1	.9	.9	.3
Philips	.4	.3	.1	.9	.9	.3
Exchange Rate (Yen/US$)	130	138	144			

NM = Not meaningful

Source: Dataquest (May 1991)

Table 14
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	Bipolar Logic & Microcomponent
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	1,558	1,504	1,591	100.0	100.0	100.0
North American Companies	450	356	333	28.9	23.7	20.9
Advanced Micro Devices	54	50	42	3.5	3.3	2.6
Chips & Technologies	2	1	1	.1	.1	.1
Intel	3	1	0	.2	.1	.0
Motorola	64	55	55	4.1	3.7	3.5
National Semiconductor	78	60	54	5.0	4.0	3.4
Raytheon	0	0	1	.0	.0	.1
Texas Instruments	249	189	180	16.0	12.6	11.3
Japanese Companies	1,078	1,115	1,232	69.2	74.1	77.4
Fujitsu	289	309	386	18.5	20.5	24.3
Hitachi	279	263	311	17.9	17.5	19.5
Matsushita	27	13	13	1.7	.9	.8
Mitsubishi	116	108	96	7.4	7.2	6.0
NEC	225	225	223	14.4	15.0	14.0
New JRC	1	1	1	.1	.1	.1
Oki	37	48	47	2.4	3.2	3.0
Rohm	0	0	1	.0	.0	.1
Sanyo	38	62	60	2.4	4.1	3.8
Toshiba	66	86	94	4.2	5.7	5.9
European Companies	29	32	25	1.9	2.1	1.6
GEC Plessey	0	0	4	.0	.0	.3
Philips	26	28	21	1.7	1.9	1.3
Plessey	3	4	0	.2	.3	.0
Asia/Pacific Companies	1	1	1	.1	.1	.1
Goldstar	1	1	1	.1	.1	.1

NM = Not meaningful

Source: Dataquest (May 1991)

Table 15
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	Bipolar Logic & Microcomponent
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	202.6	207.6	228.8	100.0	100.0	100.0
North American Companies	58.5	49.1	47.8	28.9	23.7	20.9
Advanced Micro Devices	7.0	6.9	6.0	3.5	3.3	2.6
Chips & Technologies	.3	.1	.1	.1	.0	.0
Intel	.4	.1	.0	.2	.0	.0
Motorola	8.3	7.6	7.9	4.1	3.7	3.5
National Semiconductor	10.1	8.3	7.8	5.0	4.0	3.4
Raytheon	.0	.0	.1	.0	.0	.0
Texas Instruments	32.4	26.1	25.9	16.0	12.6	11.3
Japanese Companies	140.2	153.9	177.3	69.2	74.1	77.5
Fujitsu	37.6	42.6	55.6	18.6	20.5	24.3
Hitachi	36.3	36.3	44.8	17.9	17.5	19.6
Matsushita	3.5	1.8	1.9	1.7	.9	.8
Mitsubishi	15.1	14.9	13.8	7.5	7.2	6.0
NEC	29.3	31.1	32.1	14.5	15.0	14.0
New JRC	.1	.1	.1	.0	.0	.0
Oki	4.8	6.6	6.8	2.4	3.2	3.0
Rohm	.0	.0	.1	.0	.0	.0
Sanyo	4.9	8.6	8.6	2.4	4.1	3.8
Toshiba	8.6	11.9	13.5	4.2	5.7	5.9
European Companies	3.8	4.5	3.6	1.9	2.2	1.6
GEC Plessey	.0	.0	.6	.0	.0	.3
Philips	3.4	3.9	3.0	1.7	1.9	1.3
Plessey	.4	.6	.0	.2	.3	.0
Asia/Pacific Companies	.1	.1	.1	.0	.0	.0
Goldstar	.1	.1	.1	.0	.0	.0
Exchange Rate (Yen/US$)	130	138	144			

NM = Not meaningful

Source: Dataquest (May 1991)

Table 16
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	MOS Digital
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	10,501	12,497	11,799	100.0	100.0	100.0
North American Companies	950	1,191	1,405	9.0	9.5	11.9
Actel	NA	1	1	NA	.0	.0
Advanced Micro Devices	60	72	80	.6	.6	.7
Allegro MicroSystems	0	0	1	.0	.0	.0
Altera	5	7	10	.0	.1	.1
Analog Devices	3	3	3	.0	.0	.0
Appian Technology	0	0	1	.0	.0	.0
AT&T	0	0	6	.0	.0	.1
Atmel	NA	6	7	NA	.0	.1
Catalyst	1	10	9	.0	.1	.1
Chips & Technologies	10	17	18	.1	.1	.2
Cirrus Logic	NA	2	23	NA	.0	.2
Cypress Semiconductor	4	9	11	.0	.1	.1
Dallas Semiconductor	NA	1	1	NA	.0	.0
General Electric	6	0	0	.1	.0	.0
Gould AMI	2	5	3	.0	.0	.0
Harris	2	17	20	.0	.1	.2
Hewlett Packard	0	0	2	.0	.0	.0
Inova	NA	0	1	NA	.0	.0
Integrated Device Technology	11	15	20	.1	.1	.2
Intel	282	300	367	2.7	2.4	3.1
International CMOS Technology	NA	4	7	NA	.0	.1
ITT	10	13	13	.1	.1	.1
Lattice	2	4	9	.0	.0	.1
LSI Logic	20	51	58	.2	.4	.5
Macronix	NA	8	1	NA	.1	.0
Microchip Technology	8	9	4	.1	.1	.0
Micron Technology	8	2	2	.1	.0	.0
MOSel	1	1	9	.0	.0	.1
Motorola	160	236	296	1.5	1.9	2.5
National Semiconductor	24	51	49	.2	.4	.4
NCR	1	0	3	.0	.0	.0
Performance Semiconductor	NA	1	1	NA	.0	.0
Rockwell	88	1	0	.8	.0	.0

(Continued)

Table 16 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
SEEQ Technology	4	4	5	.0	.0	.0
Standard Microsystems	1	1	1	.0	.0	.0
Texas Instruments	206	294	309	2.0	2.4	2.6
Vertex	NA	3	4	.0	.0	.0
Vitelic	0	3	2	.0	.0	.0
VLSI Technology	6	7	8	.1	.1	.1
Weitek	4	4	4	.0	.0	.0
Western Digital	8	11	13	.1	.1	.1
Xicor	5	8	5	.0	.1	.0
Xilinx	4	5	12	.0	.0	.1
Zilog	4	5	6	.0	.0	.1
Japanese Companies	9,462	11,197	10,250	90.1	89.6	86.9
Fuji Electric	31	29	26	.3	.2	.2
Fujitsu	1,212	1,370	1,243	11.5	11.0	10.5
Hitachi	1,172	1,477	1,473	11.2	11.8	12.5
Matsushita	745	653	628	7.1	5.2	5.3
Mitsubishi	958	1,007	844	9.1	8.1	7.2
NEC	2,090	2,433	2,461	19.9	19.5	20.9
New JRC	23	30	31	.2	.2	.3
NMB Semiconductor	27	29	1	.3	.2	.0
Oki	424	519	495	4.0	4.2	4.2
Ricoh	80	88	96	.8	.7	.8
Rohm	47	59	57	.4	.5	.5
Sanyo	246	321	264	2.3	2.6	2.2
Seiko Epson	216	274	162	2.1	2.2	1.4
Sharp	541	658	726	5.2	5.3	6.2
Sony	224	270	279	2.1	2.2	2.4
Toshiba	1,288	1,455	1,333	12.3	11.6	11.3
Yamaha	135	118	131	1.3	.9	1.1
Other Japanese Companies	3	407	0	.0	3.3	.0
European Companies	38	53	67	.4	.4	.6
ABB-HAFO	1	0	0	.0	.0	.0
Eurosil	1	1	1	.0	.0	.0
GEC Plessey	0	0	1	.0	.0	.0
Inmos	8	0	0	.1	.0	.0
Matra MHS	2	1	1	.0	.0	.0
Philips	7	24	24	.1	.2	.2
Plessey	1	2	0	.0	.0	.0
SGS-Thomson	5	14	23	.0	.1	.2
Siemens	13	11	17	.1	.1	.1

(Continued)

Table 16 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	51	56	77	.5	.4	.7
Goldstar	8	4	15	.1	.0	.1
Hyundai	1	3	2	.0	.0	.0
Samsung	40	47	57	.4	.4	.5
United Microelectronics	2	2	1	.0	.0	.0
Winbond	NA	NA	2	NA	NA	.0

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 17
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	MOS Digital
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	1,365.0	1,724.4	1,698.3	100.0	100.0	100.0
North American Companies	123.4	164.2	201.8	9.0	9.5	11.9
Actel	NA	.1	.1	NA	.0	.0
Advanced Micro Devices	7.8	9.9	11.5	.6	.6	.7
Allegro MicroSystems	.0	.0	.1	.0	.0	.0
Altera	.7	1.0	1.4	.1	.1	.1
Analog Devices	.4	.4	.4	.0	.0	.0
Appian Technology	.0	.0	.1	.0	.0	.0
AT&T	.0	.0	.9	.0	.0	.1
Atmel	NA	.8	1.0	NA	.0	.1
Catalyst	.1	1.4	1.3	.0	.1	.1
Chips & Technologies	1.3	2.3	2.6	.1	.1	.2
Cirrus Logic	NA	.3	3.3	NA	.0	.2
Cypress Semiconductor	.5	1.2	1.6	.0	.1	.1
Dallas Semiconductor	NA	.1	.1	NA	.0	.0
General Electric	.8	.0	.0	.1	.0	.0
Gould AMI	.3	.7	.4	.0	.0	.0
Harris	.3	2.3	2.9	.0	.1	.2
Inova	NA	.0	.1	NA	.0	.0
Integrated Device Technology	1.4	2.1	2.9	.1	.1	.2
Intel	36.7	41.4	52.8	2.7	2.4	3.1
International CMOS Technology	NA	.6	1.0	NA	.0	.1
ITT	1.3	1.8	1.9	.1	.1	.1
Lattice	.3	.6	1.3	.0	.0	.1
LSI Logic	2.6	7.0	8.4	.2	.4	.5
Macronix	NA	1.1	.1	NA	.1	.0
Microchip Technology	1.0	1.2	.6	.1	.1	.0
Micron Technology	1.0	.3	.3	.1	.0	.0
MOSel	.1	.1	1.3	.0	.0	.1
Motorola	20.8	32.6	42.6	1.5	1.9	2.5
National Semiconductor	3.1	7.0	7.1	.2	.4	.4
NCR	.1	.0	.4	.0	.0	.0
Performance Semiconductor	NA	.1	.1	NA	.0	.0
Rockwell	11.4	.1	.0	.8	.0	.0
SEEQ Technology	.5	.6	.7	.0	.0	.0

(Continued)

Table 17 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Standard Microsystems	.1	.1	.1	.0	.0	.0
Texas Instruments	26.8	40.6	44.5	2.0	2.4	2.6
Vertex	NA	.4	.6	NA	.0	.0
Vitelic	.0	.4	.3	.0	.0	.0
VLSI Technology	.8	1.0	1.2	.1	.1	.1
Weitek	.5	.6	.6	.0	.0	.0
Western Digital	1.0	1.5	1.9	.1	.1	.1
Xicor	.7	1.1	.7	.1	.1	.0
Xilinx	.5	.7	1.7	.0	.0	.1
Zilog	.5	.7	.9	.0	.0	.1
Japanese Companies	1,230.1	1,545.2	1,475.9	90.1	89.6	86.9
Fuji Electric	4.0	4.0	3.7	.3	.2	.2
Fujitsu	157.6	189.1	179.0	11.5	11.0	10.5
Hitachi	152.4	203.8	212.1	11.2	11.8	12.5
Matsushita	96.9	90.1	90.4	7.1	5.2	5.3
Mitsubishi	124.5	139.0	121.5	9.1	8.1	7.2
NEC	271.7	335.8	354.4	19.9	19.5	20.9
New JRC	3.0	4.1	4.5	.2	.2	.3
NMB Semiconductor	3.5	4.0	.1	.3	.2	.0
Oki	55.1	71.6	71.3	4.0	4.2	4.2
Ricoh	10.4	12.1	13.8	.8	.7	.8
Rohm	6.1	8.1	8.2	.4	.5	.5
Sanyo	32.0	44.3	38.0	2.3	2.6	2.2
Seiko Epson	28.1	37.8	23.3	2.1	2.2	1.4
Sharp	70.3	90.8	104.5	5.2	5.3	6.2
Sony	29.1	37.3	40.2	2.1	2.2	2.4
Toshiba	167.4	200.8	192.0	12.3	11.6	11.3
Yamaha	17.6	16.3	18.9	1.3	.9	1.1
Other Japanese Companies	.4	56.2	.0	.0	3.3	.0
European Companies	4.9	7.2	9.5	.4	.4	.6
ABB-HAFO	.1	.0	.0	.0	.0	.0
Eurosil	.1	.1	.1	.0	.0	.0
GEC Plessey	.0	.0	.1	.0	.0	.0
Inmos	1.0	.0	.0	.1	.0	.0
Matra MHS	.3	.1	.1	.0	.0	.0
Philips	.9	3.3	3.5	.1	.2	.2
Plessey	.1	.3	.0	.0	.0	.0
SGS-Thomson	.7	1.9	3.3	.1	.1	.2
Siemens	1.7	1.5	2.4	.1	.1	.1

(Continued)

Table 17 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	6.6	7.8	11.1	.5	.5	.7
Goldstar	1.0	.6	2.2	.1	.0	.1
Hyundai	.1	.4	.3	.0	.0	.0
Samsung	5.2	6.5	8.2	.4	.4	.5
United Microelectronics	.3	.3	.1	.0	.0	.0
Winbond	NA	NA	.3	NA	NA	.0
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 18
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	N/PMOS
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	4,055	4,173	2,814	100.0	100.0	100.0
North American Companies	507	501	294	12.5	12.0	10.4
Advanced Micro Devices	47	43	35	1.2	1.0	1.2
Gould AMI	2	5	1	.0	.1	.0
Intel	142	148	129	3.5	3.5	4.6
ITT	6	4	4	.1	.1	.1
Macronix	NA	8	1	NA	.2	.0
Microchip Technology	2	2	1	.0	.0	.0
Micron Technology	8	2	0	.2	.0	.0
Motorola	38	29	11	.9	.7	.4
National Semiconductor	4	0	0	.1	.0	.0
Rockwell	71	1	0	1.8	.0	.0
SEEQ Technology	2	2	1	.0	.0	.0
Standard Microsystems	1	0	0	.0	.0	.0
Texas Instruments	177	246	102	4.4	5.9	3.6
Xicor	5	8	5	.1	.2	.2
Zilog	2	3	4	.0	.1	.1
Japanese Companies	3,529	3,645	2,504	87.0	87.3	89.0
Fujitsu	383	391	258	9.4	9.4	9.2
Hitachi	459	481	279	11.3	11.5	9.9
Matsushita	344	248	226	8.5	5.9	8.0
Mitsubishi	512	429	325	12.6	10.3	11.5
NEC	786	824	646	19.4	19.7	23.0
Oki	133	149	114	3.3	3.6	4.1
Ricoh	37	36	35	.9	.9	1.2
Rohm	1	1	1	.0	.0	.0
Sanyo	49	25	21	1.2	.6	.7
Sharp	164	197	204	4.0	4.7	7.2
Sony	42	52	51	1.0	1.2	1.8
Toshiba	589	587	344	14.5	14.1	12.2
Yamaha	28	39	0	.7	.9	.0
Other Japanese Companies	2	186	0	.0	4.5	.0

(Continued)

Table 18 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
European Companies	4	7	15	.1	.2	.5
Philips	1	2	7	.0	.0	.2
SGS-Thomson	3	5	8	.1	.1	.3
Asia/Pacific Companies	15	20	1	.4	.5	.0
Goldstar	0	1	0	.0	.0	.0
Samsung	15	19	1	.4	.5	.0

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 19
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	N/PMOS
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	527.4	576.0	404.9	100.0	100.0	100.0
North American Companies	66.0	69.1	42.2	12.5	12.0	10.4
Advanced Micro Devices	6.1	5.9	5.0	1.2	1.0	1.2
Gould AMI	.3	.7	.1	.1	.1	.0
Intel	18.5	20.4	18.6	3.5	3.5	4.6
ITT	.8	.6	.6	.2	.1	.1
Macronix	NA	1.1	.1	NA	.2	.0
Microchip Technology	.3	.3	.1	.1	.1	.0
Micron Technology	1.0	.3	.0	.2	.1	.0
Motorola	4.9	4.0	1.6	.9	.7	.4
National Semiconductor	.5	.0	.0	.1	.0	.0
Rockwell	9.2	.1	.0	1.7	.0	.0
SEEQ Technology	.3	.3	.1	.1	.1	.0
Standard Microsystems	.1	.0	.0	.0	.0	.0
Texas Instruments	23.0	33.9	14.7	4.4	5.9	3.6
Xicor	.7	1.1	.7	.1	.2	.2
Zilog	.3	.4	.6	.1	.1	.1
Japanese Companies	458.9	503.2	360.4	87.0	87.4	89.0
Fujitsu	49.8	54.0	37.2	9.4	9.4	9.2
Hitachi	59.7	66.4	40.2	11.3	11.5	9.9
Matsushita	44.7	34.2	32.5	8.5	5.9	8.0
Mitsubishi	66.6	59.2	46.8	12.6	10.3	11.6
NEC	102.2	113.7	93.0	19.4	19.7	23.0
Oki	17.3	20.6	16.4	3.3	3.6	4.1
Ricoh	4.8	5.0	5.0	.9	.9	1.2
Rohm	.1	.1	.1	.0	.0	.0
Sanyo	6.4	3.5	3.0	1.2	.6	.7
Sharp	21.3	27.2	29.4	4.0	4.7	7.3
Sony	5.5	7.2	7.3	1.0	1.3	1.8
Toshiba	76.6	81.0	49.5	14.5	14.1	12.2
Yamaha	3.6	5.4	.0	.7	.9	.0
Other Japanese Companies	.3	25.7	.0	.1	4.5	.0

(Continued)

Table 19 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
European Companies	.5	1.0	2.2	.1	.2	.5
Philips	.1	.3	1.0	.0	.1	.2
SGS-Thomson	.4	.7	1.2	.1	.1	.3
Asia/Pacific Companies	2.0	2.7	.1	.4	.5	.0
Goldstar	.0	.1	.0	.0	.0	.0
Samsung	2.0	2.6	.1	.4	.5	.0
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 20
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	CMOS
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	6,434	7,818	8,677	100.0	100.0	100.0
North American Companies	432	668	1,094	6.7	8.5	12.6
Actel	NA	1	1	NA	.0	.0
Advanced Micro Devices	13	29	45	.2	.4	.5
Allegro MicroSystems	0	0	1	.0	.0	.0
Altera	5	7	10	.1	.1	.1
Analog Devices	3	3	3	.0	.0	.0
Appian Technology	0	0	1	.0	.0	.0
AT&T	0	0	6	.0	.0	.1
Atmel	NA	6	7	NA	.1	.1
Catalyst	1	10	9	.0	.1	.1
Chips & Technologies	10	17	18	.2	.2	.2
Cirrus Logic	NA	2	23	NA	.0	.3
Cypress Semiconductor	4	9	11	.1	.1	.1
General Electric	6	0	0	.1	.0	.0
Gould AMI	0	0	2	.0	.0	.0
Harris	2	17	20	.0	.2	.2
Hewlett Packard	0	0	2	.0	.0	.0
Inova	NA	0	1	NA	.0	.0
Integrated Device Technology	11	15	20	.2	.2	.2
Intel	140	152	238	2.2	1.9	2.7
International CMOS Technology	NA	4	7	NA	.1	.1
ITT	4	9	9	.1	.1	.1
Lattice	2	4	9	.0	.1	.1
LSI Logic	20	49	56	.3	.6	.6
Microchip Technology	0	0	3	.0	.0	.0
Micron Technology	0	0	2	.0	.0	.0
MOSel	1	1	9	.0	.0	.1
Motorola	122	207	281	1.9	2.6	3.2
National Semiconductor	19	45	44	.3	.6	.5
NCR	1	0	3	.0	.0	.0
Performance Semiconductor	NA	1	1	NA	.0	.0
Rockwell	17	0	0	.3	.0	.0
SEEQ Technology	2	2	4	.0	.0	.0
Standard Microsystems	0	1	1	.0	.0	.0

(Continued)

Table 20 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Texas Instruments	25	42	202	.4	.5	2.3
Vertex	NA	3	4	.0	.0	.0
Vitelic	0	3	2	.0	.0	.0
VLSI Technology	6	7	8	.1	.1	.1
Weitek	4	4	4	.1	.1	.0
Western Digital	8	11	13	.1	.1	.1
Xilinx	4	5	12	.1	.1	.1
Zilog	2	2	2	.0	.0	.0
Japanese Companies	5,932	7,068	7,455	92.2	90.4	85.9
Fuji Electric	30	23	24	.5	.3	.3
Fujitsu	829	875	892	12.9	11.2	10.3
Hitachi	713	846	1,112	11.1	10.8	12.8
Matsushita	401	405	402	6.2	5.2	4.6
Mitsubishi	446	578	519	6.9	7.4	6.0
NEC	1,304	1,522	1,728	20.3	19.5	19.9
New JRC	23	30	31	.4	.4	.4
NMB Semiconductor	27	29	1	.4	.4	.0
Oki	291	306	355	4.5	3.9	4.1
Ricoh	43	51	60	.7	.7	.7
Rohm	46	58	56	.7	.7	.6
Sanyo	197	296	243	3.1	3.8	2.8
Seiko Epson	216	274	162	3.4	3.5	1.9
Sharp	377	461	522	5.9	5.9	6.0
Sony	182	218	228	2.8	2.8	2.6
Toshiba	699	796	989	10.9	10.2	11.4
Yamaha	107	79	131	1.7	1.0	1.5
Other Japanese Companies	1	221	0	.0	2.8	.0
European Companies	34	46	52	.5	.6	.6
ABB-HAFO	1	0	0	.0	.0	.0
Eurosil	1	1	1	.0	.0	.0
GEC Plessey	0	0	1	.0	.0	.0
Inmos	8	0	0	.1	.0	.0
Matra MHS	2	1	1	.0	.0	.0
Philips	6	22	17	.1	.3	.2
Plessey	1	2	0	.0	.0	.0
SGS-Thomson	2	9	15	.0	.1	.2
Siemens	13	11	17	.2	.1	.2

(Continued)

Table 20 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	36	36	76	.6	.5	.9
Goldstar	8	3	15	.1	.0	.2
Hyundai	1	3	2	.0	.0	.0
Samsung	25	28	56	.4	.4	.6
United Microelectronics	2	2	1	.0	.0	.0
Winbond	NA	NA	2	NA	NA	.0

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 21
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	CMOS
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	836.6	1,078.6	1,248.9	100.0	100.0	100.0
North American Companies	56.3	92.2	157.2	6.7	8.5	12.6
Actel	NA	.1	.1	NA	.0	.0
Advanced Micro Devices	1.7	4.0	6.5	.2	.4	.5
Allegro MicroSystems	.0	.0	.1	.0	.0	.0
Altera	.7	1.0	1.4	.1	.1	.1
Analog Devices	.4	.4	.4	.0	.0	.0
Appian Technology	.0	.0	.1	.0	.0	.0
AT&T	.0	.0	.9	.0	.0	.1
Atmel	NA	.8	1.0	NA	.1	.1
Catalyst	.1	1.4	1.3	.0	.1	.1
Chips & Technologies	1.3	2.3	2.6	.2	.2	.2
Cirrus Logic	NA	.3	3.3	NA	.0	.3
Cypress Semiconductor	.5	1.2	1.6	.1	.1	.1
General Electric	.8	.0	.0	.1	.0	.0
Gould AMI	.0	.0	.3	.0	.0	.0
Harris	.3	2.3	2.9	.0	.2	.2
Inova	NA	.0	.1	NA	.0	.0
Integrated Device Technology	1.4	2.1	2.9	.2	.2	.2
Intel	18.2	21.0	34.3	2.2	1.9	2.7
International CMOS Technology	NA	.6	1.0	NA	.1	.1
ITT	.5	1.2	1.3	.1	.1	.1
Lattice	.3	.6	1.3	.0	.1	.1
LSI Logic	2.6	6.8	8.1	.3	.6	.6
Microchip Technology	.0	.0	.4	.0	.0	.0
Micron Technology	.0	.0	.3	.0	.0	.0
MOSel	.1	.1	1.3	.0	.0	.1
Motorola	15.9	28.6	40.5	1.9	2.7	3.2
National Semiconductor	2.5	6.2	6.3	.3	.6	.5
NCR	.1	.0	.4	.0	.0	.0
Performance Semiconductor	NA	.1	.1	NA	.0	.0
Rockwell	2.2	.0	.0	.3	.0	.0
SEEQ Technology	.3	.3	.6	.0	.0	.0
Standard Microsystems	.0	.1	.1	.0	.0	.0
Texas Instruments	3.3	5.8	29.1	.4	.5	2.3

(Continued)

Table 21 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Vertex	NA	.4	.6	NA	.0	.0
Vitelic	.0	.4	.3	.0	.0	.0
VLSI Technology	.8	1.0	1.2	.1	.1	.1
Weitek	.5	.6	.6	.1	.1	.0
Western Digital	1.0	1.5	1.9	.1	.1	.2
Xilinx	.5	.7	1.7	.1	.1	.1
Zilog	.3	.3	.3	.0	.0	.0
Japanese Companies	771.2	975.2	1,073.4	92.2	90.4	85.9
Fuji Electric	3.9	3.2	3.5	.5	.3	.3
Fujitsu	107.8	120.8	128.4	12.9	11.2	10.3
Hitachi	92.7	116.7	160.1	11.1	10.8	12.8
Matsushita	52.1	55.9	57.9	6.2	5.2	4.6
Mitsubishi	58.0	79.8	74.7	6.9	7.4	6.0
NEC	169.5	210.0	248.8	20.3	19.5	19.9
New JRC	3.0	4.1	4.5	.4	.4	.4
NMB Semiconductor	3.5	4.0	.1	.4	.4	.0
Oki	37.8	42.2	51.1	4.5	3.9	4.1
Ricoh	5.6	7.0	8.6	.7	.6	.7
Rohm	6.0	8.0	8.1	.7	.7	.6
Sanyo	25.6	40.8	35.0	3.1	3.8	2.8
Seiko Epson	28.1	37.8	23.3	3.4	3.5	1.9
Sharp	49.0	63.6	75.2	5.9	5.9	6.0
Sony	23.7	30.1	32.8	2.8	2.8	2.6
Toshiba	90.9	109.8	142.4	10.9	10.2	11.4
Yamaha	13.9	10.9	18.9	1.7	1.0	1.5
Other Japanese Companies	.1	30.5	.0	.0	2.8	.0
European Companies	4.4	6.2	7.3	.5	.6	.6
ABB-HAFO	.1	.0	.0	.0	.0	.0
Eurosil	.1	.1	.1	.0	.0	.0
GEC Plessey	.0	.0	.1	.0	.0	.0
Inmos	1.0	.0	.0	.1	.0	.0
Matra MHS	.3	.1	.1	.0	.0	.0
Philips	.8	3.0	2.4	.1	.3	.2
Plessey	.1	.3	.0	.0	.0	.0
SGS-Thomson	.3	1.2	2.2	.0	.1	.2
Siemens	1.7	1.5	2.4	.2	.1	.2

(Continued)

Table 21 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	4.7	5.0	11.0	.6	.5	.9
Goldstar	1.0	.4	2.2	.1	.0	.2
Hyundai	.1	.4	.3	.0	.0	.0
Samsung	3.3	3.9	8.1	.4	.4	.6
United Microelectronics	.3	.3	.1	.0	.0	.0
Winbond	NA	NA	.3	NA	NA	.0
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 22
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	BiCMOS
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	12	506	308	100.0	100.0	100.0
North American Companies	11	22	17	91.7	4.3	5.5
Dallas Semiconductor	NA	1	1	NA	.2	.3
LSI Logic	0	2	2	.0	.4	.6
Microchip Technology	6	7	0	50.0	1.4	.0
Motorola	0	0	4	.0	.0	1.3
National Semiconductor	1	6	5	8.3	1.2	1.6
Texas Instruments	4	6	5	33.3	1.2	1.6
Japanese Companies	1	484	291	8.3	95.7	94.5
Fuji Electric	1	6	2	8.3	1.2	.6
Fujitsu	0	104	93	.0	20.6	30.2
Hitachi	0	150	82	.0	29.6	26.6
NEC	0	87	87	.0	17.2	28.2
Oki	0	64	26	.0	12.6	8.4
Ricoh	0	1	1	.0	.2	.3
Toshiba	0	72	0	.0	14.2	.0

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 23
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	BiCMOS
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	1.5	69.7	44.2	100.0	100.0	100.0
North American Companies	1.4	3.0	2.4	93.3	4.3	5.4
Dallas Semiconductor	NA	.1	.1	NA	.1	.2
LSI Logic	.0	.3	.3	.0	.4	.7
Microchip Technology	.8	1.0	.0	53.3	1.4	.0
Motorola	.0	.0	.6	.0	.0	1.4
National Semiconductor	.1	.8	.7	6.7	1.1	1.6
Texas Instruments	.5	.8	.7	33.3	1.1	1.6
Japanese Companies	.1	66.7	41.8	6.7	95.7	94.6
Fuji Electric	.1	.8	.3	6.7	1.1	.7
Fujitsu	.0	14.4	13.4	.0	20.7	30.3
Hitachi	.0	20.7	11.8	.0	29.7	26.7
NEC	.0	12.0	12.5	.0	17.2	28.3
Oki	.0	8.8	3.7	.0	12.6	8.4
Ricoh	.0	.1	.1	.0	.1	.2
Toshiba	.0	9.9	.0	.0	14.2	.0
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 24
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	MOS Memory
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	4,424	5,992	4,612	100.0	100.0	100.0
North American Companies	222	429	407	5.0	7.2	8.8
Advanced Micro Devices	20	41	47	.5	.7	1.0
Atmel	NA	3	3	NA	.1	.1
Catalyst	1	10	9	.0	.2	.2
Cypress Semiconductor	2	7	8	.0	.1	.2
Dallas Semiconductor	NA	1	1	NA	.0	.0
Gould AMI	2	1	1	.0	.0	.0
Harris	0	8	7	.0	.1	.2
Inova	NA	0	1	NA	.0	.0
Integrated Device Technology	8	10	12	.2	.2	.3
Intel	42	45	30	.9	.8	.7
International CMOS Technology	NA	4	5	NA	.1	.1
Macronix	NA	8	1	NA	.1	.0
Microchip Technology	7	8	3	.2	.1	.1
Micron Technology	8	2	2	.2	.0	.0
MOSel	1	1	9	.0	.0	.2
Motorola	28	98	103	.6	1.6	2.2
National Semiconductor	5	4	3	.1	.1	.1
Performance Semiconductor	NA	1	0	NA	.0	.0
SEEQ Technology	3	3	3	.1	.1	.1
Texas Instruments	90	163	152	2.0	2.7	3.3
Vitelic	0	3	2	.0	.1	.0
Xicor	5	8	5	.1	.1	.1

(Continued)

Table 24 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	4,147	5,494	4,108	93.7	91.7	89.1
Fujitsu	754	784	587	17.0	13.1	12.7
Hitachi	621	850	776	14.0	14.2	16.8
Matsushita	151	218	158	3.4	3.6	3.4
Mitsubishi	518	607	417	11.7	10.1	9.0
NEC	859	924	750	19.4	15.4	16.3
NMB Semiconductor	27	29	1	.6	.5	.0
Oki	110	162	133	2.5	2.7	2.9
Ricoh	24	28	29	.5	.5	.6
Rohm	8	10	7	.2	.2	.2
Sanyo	84	119	80	1.9	2.0	1.7
Seiko Epson	58	109	47	1.3	1.8	1.0
Sharp	265	368	392	6.0	6.1	8.5
Sony	92	127	120	2.1	2.1	2.6
Toshiba	576	757	611	13.0	12.6	13.2
Other Japanese Companies	0	402	0	.0	6.7	.0
European Companies	13	17	25	.3	.3	.5
Inmos	4	0	0	.1	.0	.0
Matra MHS	1	1	1	.0	.0	.0
Philips	3	13	7	.1	.2	.2
SGS-Thomson	5	3	17	.1	.1	.4
Asia/Pacific Companies	42	52	72	.9	.9	1.6
Goldstar	6	3	14	.1	.1	.3
Hyundai	1	3	2	.0	.1	.0
Samsung	35	46	55	.8	.8	1.2
Winbond	NA	NA	1	NA	NA	.0

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 25
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	MOS Memory
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	575.1	826.9	663.6	100.0	100.0	100.0
North American Companies	28.9	59.2	58.3	5.0	7.2	8.8
Advanced Micro Devices	2.6	5.7	6.8	.5	.7	1.0
Atmel	NA	.4	.4	NA	.0	.1
Catalyst	.1	1.4	1.3	.0	.2	.2
Cypress Semiconductor	.3	1.0	1.2	.1	.1	.2
Dallas Semiconductor	NA	.1	.1	NA	.0	.0
Gould AMI	.3	.1	.1	.1	.0	.0
Harris	.0	1.1	1.0	.0	.1	.2
Inova	NA	.0	.1	NA	.0	.0
Integrated Device Technology	1.0	1.4	1.7	.2	.2	.3
Intel	5.5	6.2	4.3	1.0	.7	.6
International CMOS Technology	NA	.6	.7	NA	.1	.1
Macronix	NA	1.1	.1	NA	.1	.0
Microchip Technology	.9	1.1	.4	.2	.1	.1
Micron Technology	1.0	.3	.3	.2	.0	.0
MOSel	.1	.1	1.3	.0	.0	.2
Motorola	3.6	13.5	14.8	.6	1.6	2.2
National Semiconductor	.7	.6	.4	.1	.1	.1
Performance Semiconductor	NA	.1	.0	NA	.0	.0
SEEQ Technology	.4	.4	.4	.1	.0	.1
Texas Instruments	11.7	22.5	21.9	2.0	2.7	3.3
Vitelic	.0	.4	.3	.0	.0	.0
Xicor	.7	1.1	.7	.1	.1	.1

(Continued)

Table 25 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	539.0	758.3	591.5	93.7	91.7	89.1
Fujitsu	98.0	108.2	84.5	17.0	13.1	12.7
Hitachi	80.7	117.3	111.7	14.0	14.2	16.8
Matsushita	19.6	30.1	22.8	3.4	3.6	3.4
Mitsubishi	67.3	83.8	60.0	11.7	10.1	9.0
NEC	111.7	127.5	108.0	19.4	15.4	16.3
NMB Semiconductor	3.5	4.0	.1	.6	.5	.0
Oki	14.3	22.4	19.2	2.5	2.7	2.9
Ricoh	3.1	3.9	4.2	.5	.5	.6
Rohm	1.0	1.4	1.0	.2	.2	.2
Sanyo	10.9	16.4	11.5	1.9	2.0	1.7
Seiko Epson	7.5	15.0	6.8	1.3	1.8	1.0
Sharp	34.5	50.8	56.4	6.0	6.1	8.5
Sony	12.0	17.5	17.3	2.1	2.1	2.6
Toshiba	74.9	104.5	88.0	13.0	12.6	13.3
Other Japanese Companies	.0	55.5	.0	.0	6.7	.0
European Companies	1.7	2.3	3.5	.3	.3	.5
Inmos	.5	.0	.0	.1	.0	.0
Matra MHS	.1	.1	.1	.0	.0	.0
Philips	.4	1.8	1.0	.1	.2	.2
SGS-Thomson	.7	.4	2.4	.1	.0	.4
Asia/Pacific Companies	5.5	7.1	10.3	1.0	.9	1.6
Goldstar	.8	.4	2.0	.1	.0	.3
Hyundai	.1	.4	.3	.0	.0	.0
Samsung	4.6	6.3	7.9	.8	.8	1.2
Winbond	NA	NA	.1	NA	NA	.0
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 26
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	MOS Microcomponent
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	2,573	2,828	3,210	100.0	100.0	100.0
North American Companies	444	496	633	17.3	17.5	19.7
Advanced Micro Devices	35	23	18	1.4	.8	.6
Analog Devices	3	3	3	.1	.1	.1
Appian Technology	0	0	1	.0	.0	.0
Chips & Technologies	10	17	18	.4	.6	.6
Cirrus Logic	NA	2	23	NA	.1	.7
Harris	2	7	9	.1	.2	.3
Integrated Device Technology	0	1	2	.0	.0	.1
Intel	235	250	332	9.1	8.8	10.3
ITT	2	0	0	.1	.0	.0
LSI Logic	0	0	2	.0	.0	.1
Motorola	73	82	124	2.8	2.9	3.9
National Semiconductor	6	28	27	.2	1.0	.8
Performance Semiconductor	NA	0	1	NA	.0	.0
Rockwell	0	1	0	.0	.0	.0
SEEQ Technology	0	0	2	.0	.0	.1
Standard Microsystems	1	1	1	.0	.0	.0
Texas Instruments	60	59	45	2.3	2.1	1.4
VLSI Technology	1	2	2	.0	.1	.1
Weitek	4	4	4	.2	.1	.1
Western Digital	8	11	13	.3	.4	.4
Zilog	4	5	6	.2	.2	.2

(Continued)

Table 26 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	2,116	2,309	2,562	82.2	81.6	79.8
Fuji Electric	0	0	1	.0	.0	.0
Fujitsu	169	172	190	6.6	6.1	5.9
Hitachi	350	365	408	13.6	12.9	12.7
Matsushita	215	202	233	8.4	7.1	7.3
Mitsubishi	350	328	360	13.6	11.6	11.2
NEC	533	669	770	20.7	23.7	24.0
Oki	70	78	77	2.7	2.8	2.4
Ricoh	19	22	23	.7	.8	.7
Rohm	16	16	17	.6	.6	.5
Sanyo	55	48	39	2.1	1.7	1.2
Seiko Epson	12	12	11	.5	.4	.3
Sharp	45	94	117	1.7	3.3	3.6
Sony	37	47	49	1.4	1.7	1.5
Toshiba	244	255	267	9.5	9.0	8.3
Other Japanese Companies	1	1	0	.0	.0	.0
European Companies	13	23	15	.5	.8	.5
Inmos	4	0	0	.2	.0	.0
Matra MHS	1	0	0	.0	.0	.0
Philips	1	11	4	.0	.4	.1
SGS-Thomson	0	7	5	.0	.2	.2
Siemens	7	5	6	.3	.2	.2

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 27
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	MOS Microcomponent
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	334.7	390.3	462.3	100.0	100.0	100.0
North American Companies	57.8	68.4	91.2	17.3	17.5	19.7
Advanced Micro Devices	4.6	3.2	2.6	1.4	.8	.6
Analog Devices	.4	.4	.4	.1	.1	.1
Appian Technology	.0	.0	.1	.0	.0	.0
Chips & Technologies	1.3	2.3	2.6	.4	.6	.6
Cirrus Logic	NA	.3	3.3	NA	.1	.7
Harris	.3	1.0	1.3	.1	.3	.3
Integrated Device Technology	.0	.1	.3	.0	.0	.1
Intel	30.6	34.5	47.8	9.1	8.8	10.3
ITT	.3	.0	.0	.1	.0	.0
LSI Logic	.0	.0	.3	.0	.0	.1
Motorola	9.5	11.3	17.9	2.8	2.9	3.9
National Semiconductor	.8	3.9	3.9	.2	1.0	.8
Performance Semiconductor	NA	.0	.1	NA	.0	.0
Rockwell	.0	.1	.0	.0	.0	.0
SEEQ Technology	.0	.0	.3	.0	.0	.1
Standard Microsystems	.1	.1	.1	.0	.0	.0
Texas Instruments	7.8	8.1	6.5	2.3	2.1	1.4
VLSI Technology	.1	.3	.3	.0	.1	.1
Weitek	.5	.6	.6	.1	.2	.1
Western Digital	1.0	1.5	1.9	.3	.4	.4
Zilog	.5	.7	.9	.1	.2	.2

(Continued)

Table 27 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	275.3	318.7	368.9	82.3	81.7	79.8
Fuji Electric	.0	.0	.1	.0	.0	.0
Fujitsu	22.0	23.7	27.4	6.6	6.1	5.9
Hitachi	45.5	50.4	58.8	13.6	12.9	12.7
Matsushita	28.0	27.9	33.6	8.4	7.1	7.3
Mitsubishi	45.5	45.3	51.8	13.6	11.6	11.2
NEC	69.3	92.3	110.9	20.7	23.6	24.0
Oki	9.1	10.8	11.1	2.7	2.8	2.4
Ricoh	2.5	3.0	3.3	.7	.8	.7
Rohm	2.1	2.2	2.4	.6	.6	.5
Sanyo	7.2	6.6	5.6	2.2	1.7	1.2
Seiko Epson	1.6	1.7	1.6	.5	.4	.3
Sharp	5.9	13.0	16.8	1.8	3.3	3.6
Sony	4.8	6.5	7.1	1.4	1.7	1.5
Toshiba	31.7	35.2	38.4	9.5	9.0	8.3
Other Japanese Companies	.1	.1	.0	.0	.0	.0
European Companies	1.6	3.2	2.2	.5	.8	.5
Inmos	.5	.0	.0	.1	.0	.0
Matra MHS	.1	.0	.0	.0	.0	.0
Philips	.1	1.5	.6	.0	.4	.1
SGS-Thomson	.0	1.0	.7	.0	.3	.2
Siemens	.9	.7	.9	.3	.2	.2
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 28
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	MOS Logic
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	3,504	3,677	3,977	100.0	100.0	100.0
North American Companies	284	266	365	8.1	7.2	9.2
Actel	NA	1	1	NA	.0	.0
Advanced Micro Devices	5	8	15	.1	.2	.4
Allegro MicroSystems	0	0	1	.0	.0	.0
Altera	5	7	10	.1	.2	.3
AT&T	0	0	6	.0	.0	.2
Atmel	NA	3	4	NA	.1	.1
Cypress Semiconductor	2	2	3	.1	.1	.1
General Electric	6	0	0	.2	.0	.0
Gould AMI	0	4	2	.0	.1	.1
Harris	0	2	4	.0	.1	.1
Hewlett Packard	0	0	2	.0	.0	.1
Integrated Device Technology	3	4	6	.1	.1	.2
Intel	5	5	5	.1	.1	.1
International CMOS Technology	NA	0	2	NA	.0	.1
ITT	8	13	13	.2	.4	.3
Lattice	2	4	9	.1	.1	.2
LSI Logic	20	51	56	.6	1.4	1.4
Microchip Technology	1	1	1	.0	.0	.0
Motorola	59	56	69	1.7	1.5	1.7
National Semiconductor	13	19	19	.4	.5	.5
NCR	1	0	3	.0	.0	.1
Rockwell	88	0	0	2.5	.0	.0
SEEQ Technology	1	1	0	.0	.0	.0
Texas Instruments	56	72	112	1.6	2.0	2.8
Vertex	NA	3	4	.0	.1	.1
VLSI Technology	5	5	6	.1	.1	.2
Xilinx	4	5	12	.1	.1	.3

(Continued)

Table 28 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	3,199	3,394	3,580	91.3	92.3	90.0
Fuji Electric	31	29	25	.9	.8	.6
Fujitsu	289	414	466	8.2	11.3	11.7
Hitachi	201	262	289	5.7	7.1	7.3
Matsushita	379	233	237	10.8	6.3	6.0
Mitsubishi	90	72	67	2.6	2.0	1.7
NEC	698	840	941	19.9	22.8	23.7
New JRC	23	30	31	.7	.8	.8
Oki	244	279	285	7.0	7.6	7.2
Ricoh	37	38	44	1.1	1.0	1.1
Rohm	23	33	33	.7	.9	.8
Sanyo	107	154	145	3.1	4.2	3.6
Seiko Epson	146	153	104	4.2	4.2	2.6
Sharp	231	196	217	6.6	5.3	5.5
Sony	95	96	110	2.7	2.6	2.8
Toshiba	468	443	455	13.4	12.0	11.4
Yamaha	135	118	131	3.9	3.2	3.3
Other Japanese Companies	2	4	0	.1	.1	.0
European Companies	12	13	27	.3	.4	.7
ABB-HAFO	1	0	0	.0	.0	.0
Eurosil	1	1	1	.0	.0	.0
GEC Plessey	0	0	1	.0	.0	.0
Philips	3	0	13	.1	.0	.3
Plessey	1	2	0	.0	.1	.0
SGS-Thomson	0	4	1	.0	.1	.0
Siemens	6	6	11	.2	.2	.3
Asia/Pacific Companies	9	4	5	.3	.1	.1
Goldstar	2	1	1	.1	.0	.0
Samsung	5	1	2	.1	.0	.1
United Microelectronics	2	2	1	.1	.1	.0
Winbond	NA	NA	1	NA	NA	.0

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 29
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	MOS Logic
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	455.8	507.3	572.0	100.0	100.0	100.0
North American Companies	37.1	36.7	52.2	8.1	7.2	9.1
Actel	NA	.1	.1	NA	.0	.0
Advanced Micro Devices	.7	1.1	2.2	.2	.2	.4
Allegro MicroSystems	.0	.0	.1	.0	.0	.0
Altera	.7	1.0	1.4	.2	.2	.2
AT&T	.0	.0	.9	.0	.0	.2
Atmel	NA	.4	.6	NA	.1	.1
Cypress Semiconductor	.3	.3	.4	.1	.1	.1
General Electric	.8	.0	.0	.2	.0	.0
Gould AMI	.0	.6	.3	.0	.1	.1
Harris	.0	.3	.6	.0	.1	.1
Integrated Device Technology	.4	.6	.9	.1	.1	.2
Intel	.7	.7	.7	.2	.1	.1
International CMOS Technology	NA	.0	.3	NA	.0	.1
ITT	1.0	1.8	1.9	.2	.4	.3
Lattice	.3	.6	1.3	.1	.1	.2
LSI Logic	2.6	7.0	8.1	.6	1.4	1.4
Microchip Technology	.1	.1	.1	.0	.0	.0
Motorola	7.7	7.7	9.9	1.7	1.5	1.7
National Semiconductor	1.7	2.6	2.7	.4	.5	.5
NCR	.1	.0	.4	.0	.0	.1
Rockwell	11.4	.0	.0	2.5	.0	.0
SEEQ Technology	.1	.1	.0	.0	.0	.0
Texas Instruments	7.3	9.9	16.1	1.6	2.0	2.8
Vertex	NA	.4	.6	NA	.1	.1
VLSI Technology	.7	.7	.9	.2	.1	.2
Xilinx	.5	.7	1.7	.1	.1	.3

(Continued)

Table 29 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Japanese Companies	415.9	468.3	515.4	91.2	92.3	90.1
Fuji Electric	4.0	4.0	3.6	.9	.8	.6
Fujitsu	37.6	57.1	67.1	8.2	11.3	11.7
Hitachi	26.1	36.2	41.6	5.7	7.1	7.3
Matsushita	49.3	32.2	34.1	10.8	6.3	6.0
Mitsubishi	11.7	9.9	9.6	2.6	2.0	1.7
NEC	90.7	115.9	135.5	19.9	22.8	23.7
New JRC	3.0	4.1	4.5	.7	.8	.8
Oki	31.7	38.5	41.0	7.0	7.6	7.2
Ricoh	4.8	5.2	6.3	1.1	1.0	1.1
Rohm	3.0	4.6	4.8	.7	.9	.8
Sanyo	13.9	21.3	20.9	3.0	4.2	3.7
Seiko Epson	19.0	21.1	15.0	4.2	4.2	2.6
Sharp	30.0	27.0	31.2	6.6	5.3	5.5
Sony	12.4	13.2	15.8	2.7	2.6	2.8
Toshiba	60.8	61.1	65.5	13.3	12.0	11.5
Yamaha	17.6	16.3	18.9	3.9	3.2	3.3
Other Japanese Companies	.3	.6	.0	.1	.1	.0
European Companies	1.5	1.8	3.8	.3	.4	.7
ABB-HAFO	.1	.0	.0	.0	.0	.0
Eurosil	.1	.1	.1	.0	.0	.0
GEC Plessey	.0	.0	.1	.0	.0	.0
Philips	.4	.0	1.9	.1	.0	.3
Plessey	.1	.3	.0	.0	.1	.0
SGS-Thomson	.0	.6	.1	.0	.1	.0
Siemens	.8	.8	1.6	.2	.2	.3
Asia/Pacific Companies	1.3	.5	.6	.3	.1	.1
Goldstar	.3	.1	.1	.1	.0	.0
Samsung	.7	.1	.3	.2	.0	.1
United Microelectronics	.3	.3	.1	.1	.1	.0
Winbond	NA	NA	.1	NA	NA	.0
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 30
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	Analog
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	3,720	3,699	3,788	100.0	100.0	100.0
North American Companies	442	514	529	11.9	13.9	14.0
Advanced Micro Devices	11	12	12	.3	.3	.3
Allegro MicroSystems	4	5	3	.1	.1	.1
Analog Devices	60	56	39	1.6	1.5	1.0
AT&T	0	0	1	.0	.0	.0
Atmel	NA	7	0	NA	.2	.0
Brooktree	NA	4	7	NA	.1	.2
Burr-Brown	53	50	49	1.4	1.4	1.3
Cherry Semiconductor	2	0	0	.1	.0	.0
Crystal	NA	1	0	NA	.0	.0
Elantec	NA	2	3	NA	.1	.1
Exar	3	5	19	.1	.1	.5
General Electric	2	0	0	.1	.0	.0
Gennum	NA	2	2	NA	.1	.1
Gould AMI	0	1	1	.0	.0	.0
Harris	13	15	15	.3	.4	.4
Honeywell	7	0	4	.2	.0	.1
Int'l. Microelectronic Prod.	0	1	0	.0	.0	.0
ITT	8	2	2	.2	.1	.1
Linear Technology	6	8	10	.2	.2	.3
Maxim	7	9	12	.2	.2	.3
Micro Linear	0	1	1	.0	.0	.0
Micro Power Systems	2	3	4	.1	.1	.1
Mitel	7	0	10	.2	.0	.3
Motorola	55	49	64	1.5	1.3	1.7
National Semiconductor	38	27	33	1.0	.7	.9
Precision Monolithics	10	5	6	.3	.1	.2
Raytheon	0	0	3	.0	.0	.1
Rockwell	0	99	80	.0	2.7	2.1
Sierra Semiconductor	0	0	2	.0	.0	.1
Signal Processing Technology	NA	NA	1	NA	NA	.0
Silicon Systems	18	15	23	.5	.4	.6
Siliconix	4	4	3	.1	.1	.1

(Continued)

Table 30 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Sipex	NA	1	1	NA	.0	.0
Supertex	2	7	4	.1	.2	.1
Teledyne	3	2	2	.1	.1	.1
Texas Instruments	125	119	111	3.4	3.2	2.9
TRW	0	0	2	.0	.0	.1
Unitrode	2	2	0	.1	.1	.0
Japanese Companies	3,237	3,151	3,174	87.0	85.2	83.8
Fuji Electric	28	36	43	.8	1.0	1.1
Fujitsu	143	146	150	3.8	3.9	4.0
Hitachi	301	289	288	8.1	7.8	7.6
Matsushita	354	283	314	9.5	7.7	8.3
Mitsubishi	224	332	389	6.0	9.0	10.3
NEC	408	339	344	11.0	9.2	9.1
New JRC	102	101	103	2.7	2.7	2.7
Oki	23	35	35	.6	.9	.9
Rohm	215	216	221	5.8	5.8	5.8
Sanken	111	107	113	3.0	2.9	3.0
Sanyo	387	401	370	10.4	10.8	9.8
Seiko Epson	10	10	10	.3	.3	.3
Sharp	66	62	69	1.8	1.7	1.8
Shindengen Electric	NA	NA	33	NA	NA	.9
Sony	298	267	275	8.0	7.2	7.3
Toko	NA	NA	48	NA	NA	1.3
Toshiba	370	332	362	9.9	9.0	9.6
Yamaha	0	11	7	.0	.3	.2
Other Japanese Companies	197	184	0	5.3	5.0	.0
European Companies	35	25	57	.9	.7	1.5
Ericsson	2	2	2	.1	.1	.1
GEC Plessey	0	0	11	.0	.0	.3
Philips	24	13	28	.6	.4	.7
Plessey	2	2	0	.1	.1	.0
SGS-Thomson	5	6	12	.1	.2	.3
Telefunken Electronic	2	2	4	.1	.1	.1

(Continued)

Table 30 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	6	9	28	.2	.2	.7
Korean Electronic Co.	0	1	5	.0	.0	.1
Samsung	6	8	1	.2	.2	.0
Winbond	NA	NA	1	NA	NA	.0
Other Asia/Pacific Companies	0	0	21	.0	.0	.6

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 31
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	Analog
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	483.8	510.6	544.9	100.0	100.0	100.0
North American Companies	57.6	71.1	75.9	11.9	13.9	13.9
Advanced Micro Devices	1.4	1.7	1.7	.3	.3	.3
Allegro MicroSystems	.5	.7	.4	.1	.1	.1
Analog Devices	7.8	7.7	5.6	1.6	1.5	1.0
AT&T	.0	.0	.1	.0	.0	.0
Atmel	NA	1.0	.0	NA	.2	.0
Brooktree	NA	.6	1.0	NA	.1	.2
Burr-Brown	6.9	6.9	7.1	1.4	1.4	1.3
Cherry Semiconductor	.3	.0	.0	.1	.0	.0
Crystal	NA	.1	.0	NA	.0	.0
Elantec	NA	.3	.4	NA	.1	.1
Exar	.4	.7	2.7	.1	.1	.5
General Electric	.3	.0	.0	.1	.0	.0
Gennum	NA	.3	.3	NA	.1	.1
Gould AMI	.0	.1	.1	.0	.0	.0
Harris	1.7	2.1	2.2	.4	.4	.4
Honeywell	.9	.0	.6	.2	.0	.1
Int'l. Microelectronic Prod.	.0	.1	.0	.0	.0	.0
ITT	1.0	.3	.3	.2	.1	.1
Linear Technology	.8	1.1	1.4	.2	.2	.3
Maxim	.9	1.2	1.7	.2	.2	.3
Micro Linear	.0	.1	.1	.0	.0	.0
Micro Power Systems	.3	.4	.6	.1	.1	.1
Mitel	.9	.0	1.4	.2	.0	.3
Motorola	7.2	6.8	9.2	1.5	1.3	1.7
National Semiconductor	4.9	3.7	4.8	1.0	.7	.9
Precision Monolithics	1.3	.7	.9	.3	.1	.2
Raytheon	.0	.0	.4	.0	.0	.1
Rockwell	.0	13.7	11.5	.0	2.7	2.1
Sierra Semiconductor	.0	.0	.3	.0	.0	.1
Signal Processing Technology	NA	NA	.1	NA	NA	.0
Silicon Systems	2.3	2.1	3.3	.5	.4	.6
Siliconix	.5	.6	.4	.1	.1	.1

(Continued)

Table 31 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Sipex	NA	.1	.1	NA	.0	.0
Supertex	.3	1.0	.6	.1	.2	.1
Teledyne	.4	.3	.3	.1	.1	.1
Texas Instruments	16.3	16.4	16.0	3.4	3.2	2.9
TRW	.0	.0	.3	.0	.0	.1
Unitrode	.3	.3	.0	.1	.1	.0
Japanese Companies	420.7	434.8	456.9	87.0	85.2	83.9
Fuji Electric	3.6	5.0	6.2	.7	1.0	1.1
Fujitsu	18.6	20.1	21.6	3.8	3.9	4.0
Hitachi	39.1	39.9	41.5	8.1	7.8	7.6
Matsushita	46.0	39.1	45.2	9.5	7.7	8.3
Mitsubishi	29.1	45.8	56.0	6.0	9.0	10.3
NEC	53.0	46.8	49.5	11.0	9.2	9.1
New JRC	13.3	13.9	14.8	2.7	2.7	2.7
Oki	3.0	4.8	5.0	.6	.9	.9
Rohm	28.0	29.8	31.8	5.8	5.8	5.8
Sanken	14.4	14.8	16.3	3.0	2.9	3.0
Sanyo	50.3	55.3	53.3	10.4	10.8	9.8
Seiko Epson	1.3	1.4	1.4	.3	.3	.3
Sharp	8.6	8.6	9.9	1.8	1.7	1.8
Shindengen Electric	NA	NA	4.8	NA	NA	.9
Sony	38.7	36.8	39.6	8.0	7.2	7.3
Toko	NA	NA	6.9	NA	NA	1.3
Toshiba	48.1	45.8	52.1	9.9	9.0	9.6
Yamaha	.0	1.5	1.0	.0	.3	.2
Other Japanese Companies	25.6	25.4	.0	5.3	5.0	.0
European Companies	4.7	3.5	8.2	1.0	.7	1.5
Ericsson	.3	.3	.3	.1	.1	.1
GEC Plessey	.0	.0	1.6	.0	.0	.3
Philips	3.1	1.8	4.0	.6	.4	.7
Plessey	.3	.3	.0	.1	.1	.0
SGS-Thomson	.7	.8	1.7	.1	.2	.3
Telefunken Electronic	.3	.3	.6	.1	.1	.1

(Continued)

Table 31 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	.8	1.2	3.9	.2	.2	.7
Korean Electronic Co.	.0	.1	.7	.0	.0	.1
Samsung	.8	1.1	.1	.2	.2	.0
Winbond	NA	NA	.1	NA	NA	.0
Other Asia/Pacific Companies	.0	.0	3.0	.0	.0	.6
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 32
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Each
Product:	Total Discrete
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	3,282	3,321	3,392	100.0	100.0	100.0
North American Companies	72	57	80	2.2	1.7	2.4
Acrian	2	2	0	.1	.1	.0
General Instrument	27	16	23	.8	.5	.7
Harris	0	3	5	.0	.1	.1
Hewlett Packard	5	3	1	.2	.1	.0
International Rectifier	5	5	14	.2	.2	.4
ITT	15	10	10	.5	.3	.3
Motorola	10	12	23	.3	.4	.7
Siliconix	4	2	2	.1	.1	.1
Supertex	1	1	1	.0	.0	.0
Texas Instruments	2	2	0	.1	.1	.0
Unitrode	1	1	1	.0	.0	.0
Japanese Companies	3,199	3,242	3,293	97.5	97.6	97.1
Fuji Electric	222	237	243	6.8	7.1	7.2
Fujitsu	65	58	62	2.0	1.7	1.8
Hitachi	580	564	522	17.7	17.0	15.4
Matsushita	320	268	314	9.8	8.1	9.3
Mitsubishi	274	293	224	8.3	8.8	6.6
NEC	447	478	461	13.6	14.4	13.6
New JRC	7	3	3	.2	.1	.1
Oki	9	10	10	.3	.3	.3
Rohm	230	238	258	7.0	7.2	7.6
Sanken	138	141	149	4.2	4.2	4.4
Sanyo	138	191	185	4.2	5.8	5.5
Shindengen Electric	NA	NA	156	NA	NA	4.6
Sony	106	86	76	3.2	2.6	2.2
Toko	NA	NA	5	NA	NA	.1
Toshiba	630	642	625	19.2	19.3	18.4
Other Japanese Companies	33	33	0	1.0	1.0	.0

(Continued)

Table 32 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
European Companies	7	12	11	.2	.4	.3
Philips	2	2	3	.1	.1	.1
SGS-Thomson	2	2	5	.1	.1	.1
Siemens	3	8	3	.1	.2	.1
Asia/Pacific Companies	4	10	8	.1	.3	.2
Hi-Sincerity	NA	NA	1	NA	NA	.0
Korean Electronic Co.	1	6	5	.0	.2	.1
Samsung	3	4	2	.1	.1	.1

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 33
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	Total Discrete
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	426.9	458.5	488.1	100.0	100.0	100.0
North American Companies	9.5	7.9	11.3	2.2	1.7	2.3
Acrian	.3	.3	.0	.1	.1	.0
General Instrument	3.5	2.2	3.3	.8	.5	.7
Harris	.0	.4	.7	.0	.1	.1
Hewlett Packard	.7	.4	.1	.2	.1	.0
International Rectifier	.7	.7	2.0	.2	.2	.4
ITT	2.0	1.4	1.4	.5	.3	.3
Motorola	1.3	1.7	3.3	.3	.4	.7
Siliconix	.5	.3	.3	.1	.1	.1
Supertex	.1	.1	.1	.0	.0	.0
Texas Instruments	.3	.3	.0	.1	.1	.0
Unitrode	.1	.1	.1	.0	.0	.0
Japanese Companies	415.9	447.5	474.2	97.4	97.6	97.2
Fuji Electric	28.9	32.7	35.0	6.8	7.1	7.2
Fujitsu	8.5	8.0	8.9	2.0	1.7	1.8
Hitachi	75.4	77.8	75.2	17.7	17.0	15.4
Matsushita	41.6	37.0	45.2	9.7	8.1	9.3
Mitsubishi	35.6	40.4	32.3	8.3	8.8	6.6
NEC	58.1	66.0	66.4	13.6	14.4	13.6
New JRC	.9	.4	.4	.2	.1	.1
Oki	1.2	1.4	1.4	.3	.3	.3
Rohm	29.9	32.8	37.2	7.0	7.2	7.6
Sanken	17.9	19.5	21.5	4.2	4.3	4.4
Sanyo	17.9	26.4	26.6	4.2	5.8	5.4
Shindengen Electric	NA	NA	22.5	NA	NA	4.6
Sony	13.8	11.9	10.9	3.2	2.6	2.2
Toko	NA	NA	.7	NA	NA	.1
Toshiba	81.9	88.6	90.0	19.2	19.3	18.4
Other Japanese Companies	4.3	4.6	.0	1.0	1.0	.0

(Continued)

Table 33 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
European Companies	1.0	1.7	1.5	.2	.4	.3
Philips	.3	.3	.4	.1	.1	.1
SGS-Thomson	.3	.3	.7	.1	.1	.1
Siemens	.4	1.1	.4	.1	.2	.1
Asia/Pacific Companies	.5	1.4	1.1	.1	.3	.2
Hi-Sincerity	NA	NA	.1	NA	NA	.0
Korean Electronic Co.	.1	.8	.7	.0	.2	.1
Samsung	.4	.6	.3	.1	.1	.1
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 34
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company: Each
Product: Total Optoelectronic
Region of Consumption: Japan
Distribution Channel: NM
Application: All
Specification: All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	1,363	1,730	1,729	100.0	100.0	100.0
North American Companies	25	23	39	1.8	1.3	2.3
Harris	0	1	1	.0	.1	.1
Hewlett Packard	24	22	21	1.8	1.3	1.2
Optek	NA	0	7	NA	.0	.4
Quality Technologies	1	0	0	.1	.0	.0
Texas Instruments	0	0	10	.0	.0	.6
Japanese Companies	1,335	1,700	1,684	97.9	98.3	97.4
Fuji Electric	3	1	1	.2	.1	.1
Fujitsu	88	91	99	6.5	5.3	5.7
Hitachi	48	44	47	3.5	2.5	2.7
Matsushita	176	304	303	12.9	17.6	17.5
Mitsubishi	24	29	30	1.8	1.7	1.7
NEC	78	108	110	5.7	6.2	6.4
New JRC	13	11	11	1.0	.6	.6
Oki	34	33	33	2.5	1.9	1.9
Rohm	100	87	96	7.3	5.0	5.6
Sanken	19	18	19	1.4	1.0	1.1
Sanyo	59	143	154	4.3	8.3	8.9
Sharp	252	280	285	18.5	16.2	16.5
Sony	217	249	260	15.9	14.4	15.0
Toshiba	142	228	236	10.4	13.2	13.6
Other Japanese Companies	82	74	0	6.0	4.3	.0
European Companies	3	6	3	.2	.3	.2
ABB-HAFO	2	2	2	.1	.1	.1
Siemens	1	3	1	.1	.2	.1
TMS	0	1	0	.0	.1	.0

(Continued)

Table 34 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	0	1	3	.0	.1	.2
Korean Electronic Co.	0	1	2	.0	.1	.1
Ledtech Electronics	NA	NA	1	NA	NA	.1

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 35
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Each
Product:	Total Optoelectronic
Region of Consumption:	Japan
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	177.2	238.7	248.7	100.0	100.0	100.0
North American Companies	3.2	3.1	5.5	1.8	1.3	2.2
Harris	.0	.1	.1	.0	.0	.0
Hewlett Packard	3.1	3.0	3.0	1.7	1.3	1.2
Optek	NA	.0	1.0	NA	.0	.4
Quality Technologies	.1	.0	.0	.1	.0	.0
Texas Instruments	.0	.0	1.4	.0	.0	.6
Japanese Companies	173.6	234.7	242.4	98.0	98.3	97.5
Fuji Electric	.4	.1	.1	.2	.0	.0
Fujitsu	11.4	12.6	14.3	6.4	5.3	5.7
Hitachi	6.2	6.1	6.8	3.5	2.6	2.7
Matsushita	22.9	42.0	43.6	12.9	17.6	17.5
Mitsubishi	3.1	4.0	4.3	1.7	1.7	1.7
NEC	10.1	14.9	15.8	5.7	6.2	6.4
New JRC	1.7	1.5	1.6	1.0	.6	.6
Oki	4.4	4.6	4.8	2.5	1.9	1.9
Rohm	13.0	12.0	13.8	7.3	5.0	5.5
Sanken	2.5	2.5	2.7	1.4	1.0	1.1
Sanyo	7.7	19.7	22.2	4.3	8.3	8.9
Sharp	32.8	38.6	41.0	18.5	16.2	16.5
Sony	28.2	34.4	37.4	15.9	14.4	15.0
Toshiba	18.5	31.5	34.0	10.4	13.2	13.7
Other Japanese Companies	10.7	10.2	.0	6.0	4.3	.0
European Companies	.4	.8	.4	.2	.3	.2
ABB-HAFO	.3	.3	.3	.2	.1	.1
Siemens	.1	.4	.1	.1	.2	.0
TMS	.0	.1	.0	.0	.0	.0

(Continued)

Table 35 (Continued)
Semiconductor Market Share Estimates
(Factory Revenue in Billions of Yen)

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Asia/Pacific Companies	.0	.1	.4	.0	.0	.2
Korean Electronic Co.	.0	.1	.3	.0	.0	.1
Ledtech Electronics	NA	NA	.1	NA	NA	.0
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 36
Market Share Estimates
(Factory Revenue in Millions of U.S. Dollars)

Company:	Japanese Companies
Product:	Total Semiconductor
Region of Consumption:	Worldwide
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	50,859	57,213	58,225	100.0	100.0	100.0
Japanese Companies	25,942	29,809	28,377	51.0	52.1	48.7
Fuji Electric	346	362	385	.7	.6	.7
Fujitsu	2,607	2,963	2,880	5.1	5.2	4.9
Hitachi	3,506	3,974	3,893	6.9	6.9	6.7
Matsushita	1,883	1,882	1,942	3.7	3.3	3.3
Mitsubishi	2,312	2,579	2,319	4.5	4.5	4.0
NEC	4,543	5,015	4,898	8.9	8.8	8.4
New JRC	169	171	178	.3	.3	.3
NMB Semiconductor	199	247	201	.4	.4	.3
Oki	947	1,154	1,074	1.9	2.0	1.8
Ricoh	85	91	96	.2	.2	.2
Rohm	721	740	774	1.4	1.3	1.3
Sanken	383	387	407	.8	.7	.7
Sanyo	1,083	1,365	1,381	2.1	2.4	2.4
Seiko Epson	311	368	213	.6	.6	.4
Sharp	1,036	1,230	1,325	2.0	2.1	2.3
Shindengen Electric	NA	NA	209	NA	NA	.4
Sony	950	1,077	1,146	1.9	1.9	2.0
Toko	NA	NA	60	NA	NA	.1
Toshiba	4,395	4,930	4,843	8.6	8.6	8.3
Yamaha	151	143	153	.3	.2	.3
Other Japanese Companies	315	1,131	0	.6	2.0	.0

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

Table 37
Market Share Estimates
(Factory Revenue in Billions of Yen)

Company:	Japanese Companies
Product:	Total Semiconductor
Region of Consumption:	Worldwide
Distribution Channel:	NM
Application:	All
Specification:	All

	Revenue			Market Share (%)		
	1988	1989	1990	1988	1989	1990
Total Market	6,611.7	7,895.4	8,384.4	100.0	100.0	100.0
Japanese Companies	3,372.7	4,113.7	4,086.1	51.0	52.1	48.7
Fuji Electric	45.0	50.0	55.4	.7	.6	.7
Fujitsu	338.9	408.9	414.7	5.1	5.2	4.9
Hitachi	455.8	548.4	560.6	6.9	6.9	6.7
Matsushita	244.8	259.7	279.6	3.7	3.3	3.3
Mitsubishi	300.6	355.9	333.9	4.5	4.5	4.0
NEC	590.6	692.1	705.3	8.9	8.8	8.4
New JRC	22.0	23.6	25.6	.3	.3	.3
NMB Semiconductor	25.9	34.1	28.9	.4	.4	.3
Oki	123.1	159.3	154.7	1.9	2.0	1.8
Ricoh	11.1	12.6	13.8	.2	.2	.2
Rohm	93.7	102.1	111.5	1.4	1.3	1.3
Sanken	49.8	53.4	58.6	.8	.7	.7
Sanyo	140.8	188.4	198.9	2.1	2.4	2.4
Seiko Epson	40.4	50.8	30.7	.6	.6	.4
Sharp	134.7	169.7	190.8	2.0	2.1	2.3
Shindengen	NA	NA	30.1	NA	NA	.4
Sony	123.5	148.6	165.0	1.9	1.9	2.0
Toko	NA	NA	8.6	NA	NA	.1
Toshiba	571.4	680.3	697.4	8.6	8.6	8.3
Yamaha	19.6	19.7	22.0	.3	.2	.3
Other Japanese Companies	41.0	156.1	.0	.6	2.0	.0
Exchange Rate (Yen/US$)	130	138	144			

NA = Not available

NM = Not meaningful

Source: Dataquest (May 1991)

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Japanese Fab Database

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Semiconductors *Japan*

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October 1991

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Japanese Fab Database

Background

The material in this booklet applies to the Japanese portion of Dataquest's Semiconductor Equipment, Manufacturing, and Materials Service Wafer Fab Database. The Wafer Fab Database is updated on an ongoing basis, employing both primary and secondary research methodologies. The tables included in this booklet highlight both production and pilot line wafer fabs.

General Definitions

A *fab line* is a processing line in a clean room that is equipped to do all front-end wafer processing. Occasionally there are two separate product-specific fab lines or two different wafer sizes in a clean room. In this situation, a clean room will be documented as two fab lines if the equipment is dedicated to each wafer size or product line. There can be many fab lines at one location.

Front-end wafer processing is defined as all steps involved with semiconductor processing, beginning with initial oxide and ending at wafer probe.

A *production fab* is defined as a wafer fab capable of front-end processing more than 1,250 wafers per week (type = F).

A *pilot fab* is defined as a wafer fab capable of front-end processing 1,250 wafers or less per week (type = P).

Definitions of Table Columns

The *Products Produced* column contains product information for seven product categories. The information in this column can be very detailed, depending on the information's availability. The nomenclature used within the seven product groups of the fab database is as follows, with definitions where warranted:

- Analog
  - LIN—Linear/analog devices
  - A/D D/A—Analog-to-digital, digital-to-analog converters
  - AUTOMOTIVE—Dedicated to automobile applications
  - CODEC—Coder/decoder
  - INTERFACE—Interface IC
  - MESFET (GaAs)—Metal Schottky field-effect transistor
  - MODFET (GaAs)
  - MDIODE (GaAs)—Microwave diode
  - MFET (GaAs)—Microwave field-effect transistor
  - MODEM—Modulator/demodulator
  - MMIC—Monolithic microwave IC
  - OP AMP—Operational amplifier
  - PWR IC—Power IC
  - REG—Voltage regulator
  - SMART PWR—Smart power
  - SWITCHES—Switching device
  - TELECOM—Telecommunications chips
- Memory
  - MEM—Memory
  - RAM—Random-access memory
  - DRAM—Dynamic RAM
  - SRAM 4 TR.—Static RAM uses a 4-transistor cell design
  - SRAM 6 TR.—Static RAM uses a 6-transistor cell design
  - VRAM—Video RAM
  - ROM—Read-only memory
  - PROM—Programmable ROM
  - EPROM—Ultraviolet erasable PROM
  - EEPROM or E2—Electrically erasable PROM
  - FERRAM—Ferroelectric RAM
  - NVMEM—Nonvolatile memory (ROM, PROM, EPROM, EEPROM, FERRAM)
  - FIFO—First-in, first-out memory
  - SPMEM—Other specialty memory (dual port, shift-register, color look-up, etc.)
- Micrologic
  - ASSP—Application-specific standard product
  - BIT—Bit slice (subset of MPU functions)
  - DSP—Digital signal processor
  - MCU—Microcontroller unit

- MPR—Microperipheral
- MPRCOM—MPR digital communications (ISDN, LAN, UART, modem)
- MPU—Microprocessor unit
- LISP—32-bit list instruction set processor for AI applications
- RISC—Reduced-instruction-set computation 32-bit MPU

• Standard logic

- LOG—Standard logic

• ASIC logic

- ASIC—Application-specific IC
- ARRAYS—Gate arrays
- CBIC—Cell-based IC
- CUSTOM—Full-custom IC (single user)
- PLD—Programmable logic device

• Discrete

- DIS—Discrete
- DIODE
- FET—Field-effect transistor
- GTO—Gate turn-off thyristor
- HEMT (GaAs)—High-electron-mobility transistor
- MOSFET—MOS-based field-effect transistor
- PWR TRAN—Power transistor
- RECTIFIER
- RF—Radio frequency
- SCR—Schottky rectifier
- SENSORS
- SST—Small-signal transistor
- THYRISTOR
- TRAN—Transistor
- ZENER DIODE

• Optoelectronic

- OPTO—Optoelectronic
- CCD—Charge-coupled device (imaging)
- COUPLERS—Photocouplers
- IED—Infrared-emitting diode
- IMAGE SENSOR
- LASER (GaP)—Semiconductor laser or laser IC
- LED—Light-emitting diode
- PDIODE—Photo diode
- PTRAN—Photo transistor
- SAW—Surface acoustic wave device
- SIT IMAGE SENSOR—Static induction transistor image sensor

The *Process Technology* column lists four major types of technologies. This column also lists a few uncommon technologies along with information on levels of metal, type of well, and logic structure, when available. Definitions of the nomenclature used in the Process Technology column are as follows:

• MOS (silicon-based)

- CMOS—Complementary metal-oxide semiconductor
- MOS—n-channel metal-oxide semiconductor (NMOS) and p-channel metal-oxide semiconductor (PMOS) (More than 90 percent of the MOS fabs use n-channel MOS.)
- M1—Single-level metal
- M2—Double-level metal
- M3—Triple-level metal
- N-WELL
- P-WELL
- POLY1—Single-level polysilicon
- POLY2—Double-level polysilicon
- POLY3—Triple-level polysilicon

• BiCMOS (silicon-based)

- BICMOS—Bipolar and CMOS combined on a chip
- BIMOS—Bipolar and MOS combined on a chip
- ECL I/O—ECL input/output
- TTL I/O—TTL input/output

• Bipolar (silicon-based)

- BIP—Bipolar
- ECL—Emitter-coupled logic
- TTL—Transistor-transistor logic
- STTL—Schottky TTL

• Gallium arsenide and other compound semiconductor materials

- GaAs—Gallium arsenide
- GaAlAs—Gallium aluminum arsenide

- GaAs on Si—Gallium arsenide on silicon
- GaP—Gallium phosphide
- HgCdTe—Mercuric cadmium telluride
- InAs—Indium arsenide
- InP—Indium phosphide
- InSb—Indium antimony
- LiNbO3—Lithium niobate
- SOS—Silicon on sapphire

The number in the *Minimum Linewidth* column represents the minimum linewidth at the critical mask layers as drawn. This number is stated in microns and is defined in Dataquest's fab survey as being available in production volumes.

The *Wafer Size* column represents the wafer diameter expressed colloquially in inches. However, for wafers greater than 3 inches in diameter, the colloquial expression is inaccurate. When calculating square inches, the following approximations are used:

Wafer-Start Capacity is defined in the fab survey as the equipment-limited wafer-start capacity per four-week period. Start capacity is not limited by current staffing or the number of shifts operating; it is limited only by the installed equipment in the fab and the complexity of the process it runs. Start capacity in square inches is calculated using the approximate diameter and the wafer-start capacity.

The *Clean Room Class* column represents the level of cleanliness in the cleanest part of the clean room. This area represents the true environment to which the wafer is exposed.

The *Origin of Owner* column represents the country where the parent company is headquartered.

The *Merchant or Captive* column categorizes each fab line on the tables as one of these two types. Definitions of the various categories are as follows:

- A *Merchant* fab line is a fab line that produces devices that end up available on the merchant market.
- A *Captive* fab line does not sell any of its devices on the merchant market. All production is consumed by the owner of the fab line.

Table 1
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
CANON	KANAGAWA	R&D CENTER	N/A	AMORPHOUS IMAGE SENSORS	GaAs	0.00	3	0	0	0	N/A	JAPAN	C
CANON	SHIGA	NAGAHAMA WORKS	N/A	AMORPHOUS IMAGE SENSORS	GaAs	0.00	3	0	0	0	N/A	JAPAN	C
CANON DENSHI	SAITAMA	N/A	N/A	CCD	MOS	3.00	5	5,000	95,100	0	N/A	JAPAN	C
CASIO	TOKYO	N/A	N/A	ASIC	N/A	0.00	4	11,000	133,870	0	N/A	JAPAN	C
CLARION	FUKUSHIMA	S/C LAB	N/A	SAW CONVOLVER CUSTOM	N/A	0.00	4	5,000	60,850	0	N/A	JAPAN	C
FUJI ELECTRIC	YAMANASHI	YAMANASHI	N/A	LOG ASSP	CMOS	0.00	6	15,000	410,700	0	N/A	JAPAN	C
FUJI ELECTRIC	NAGANO	MATSUMOTO	N/A	DIODE PWR TRAN PWR MOSFET	MOS	2.00	5	20,000	380,400	0	N/A	JAPAN	C
FUJI ELECTRIC	NAGANO	MATSUMOTO	N/A	LOG CUSTOM ASSP	CMOS MOS	2.00	5	10,000	190,200	0	100	JAPAN	C
FUJI ELECTRIC	TOYAMA	MAIN OFFICE	N/A	DIODE	N/A	0.00	4	10,000	121,700	0	N/A	JAPAN	C
FUJI XEROX	MIE	SUZUKA FUJI/XER	N/A	PWR ICs IMAGE SENSOR LOG	CMOS	3.00	5	3,000	57,060	0	N/A	JAPAN	C
FUJITSU	YAMANASHI	YAMANASHI ELECT	N/A	FET LIN OPTO HEMT	GaAs	0.00	3	0	0	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
FUJITSU	IWATE	IWATE	NO. 3	256K DRAM 1Mb DRAM SRAM ROM	CMOS MOS P3	1.00	6	30,000	821,400	0	N/A	JAPAN	M
FUJITSU	FUKUSHIMA	AIZU	VLSI 3	1Mb DRAM SRAM ROM	CMOS MOS	1.00	6	20,000	547,600	0	10	JAPAN	M
FUJITSU	IWATE	IWATE	NO. 4	4Mb DRAM 16Mb DRAM SRAM A	CMOS MOS P3	0.80	6	13,000	355,940	0	1	JAPAN	M
FUJITSU	FUKUSHIMA	WAKAMATSU	BLDG. 1 #2	ARRAYS LOG	CMOS	1.20	6	16,000	438,080	0	N/A	JAPAN	M
FUJITSU	FUKUSHIMA	WAKAMATSU	BLDG. 2 #1	ARRAYS CBIC 32-bit MCU	CMOS	0.70	6	15,000	410,700	5,250	N/A	JAPAN	M
FUJITSU	YAMANASHI	YAMANASHI ELECT	N/A	FET LIN OPTO HEMT	GaAs	0.00	4	0	0	0	10	JAPAN	M
FUJITSU	FUKUSHIMA	AIZU	VLSI 2	256K DRAM SRAM EPROM MPU	MOS CMOS	1.50	5	40,000	760,800	0	N/A	JAPAN	M
FUJITSU	FUKUSHIMA	AIZU	VLSI 1	DIS A/D D/A	BIP	2.00	5	30,000	570,600	0	N/A	JAPAN	M
FUJITSU	FUKUSHIMA	WAKAMATSU	BLDG. 1 #1	ARRAYS LOG	CMOS	1.50	5	38,000	722,760	0	N/A	JAPAN	M
FUJITSU	IWATE	IWATE	NO. 1	ARRAYS	BIP	1.20	6	15,000	410,700	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
FUJITSU	IWATE	IWATE	NO. 2	ROM EPROM	MOS	1.50	5	32,000	608,640	0	N/A	JAPAN	M
FUJITSU	MIE	MIE	NO. 1	ARRAYS	CMOS MOS	1.00	6	10,000	273,800	0	10	JAPAN	M
FUJITSU	MIE	MIE	NO. 3	4Mb DRAM 16Mb DRAM	CMOS	0.80	8	500	24,335	0	N/A	JAPAN	M
FUJITSU	KANAGAWA	N/A	N/A	3D ICs JOSEPHSON JUNCTION	N/A	0.00	5	15,000	285,300	0	N/A	JAPAN	M
FUJITSU	MIYAGI	MIYAGI	N/A	ASIC	CMOS	1.20	6	10,000	273,800	0	N/A	JAPAN	M
FUJITSU	MIE	MIE	NO. 2	LOG ARRAYS 4Mb DRAM PROTO	CMOS BIP	0.80	6	10,000	273,800	0	N/A	JAPAN	M
FUJITSU	GIFU	FUJITSU VLSI	MINOKAMO	PROTOTYPE ICs	CMOS	1.00	6	5,000	136,900	0	10	JAPAN	M
HAMAMATSU PHOTONICS	SHIZUOKA	N/A	N/A	OPTO	N/A	0.00	3	15,000	106,050	0	N/A	JAPAN	C
HITACHI	CHIBA	MOBARA WORKS	D1	ASIC MCU EPROM	MOS CMOS	1.50	5	30,000	570,600	4,180	N/A	JAPAN	M
HITACHI	CHIBA	MOBARA WORKS	D3	1Mb DRAM 4Mb DRAM	CMOS M2	0.80	6	30,000	821,400	4,180	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
HITACHI	IBARAGI	NAKA WORKS	N/A	1Mb DRAM SAMPLE 4Mb DRAM	CMOS	0.80	6	20,000	547,600	1,850	N/A	JAPAN	M
HITACHI	GUNMA	TAKASAKI WORKS	N/A	LIN EPROM PWR MOSFET SRAM	BIP MOS CMOS	2.00	5	20,000	380,400	0	N/A	JAPAN	M
HITACHI	YAMANASHI	KOFU WORKS	NO. K4-1	MEM MPU LOG	MOS	2.00	5	20,000	380,400	0	N/A	JAPAN	M
HITACHI	YAMANASHI	KOFU WORKS	NO. K3	64K SRAM	MOS	1.50	5	15,000	285,300	3,995	N/A	JAPAN	M
HITACHI	HOKKAIDO	HOKKAI S/C	CHITOSE	256K SRAM 1Mb DRAM MPU	CMOS	1.00	6	15,000	410,700	1,850	N/A	JAPAN	M
HITACHI	YAMANASHI	KOFU WORKS	NO. K4-3	4Mb DRAM 1Mb SRAM EPROM	CMOS MOS	0.80	6	10,000	273,800	0	100	JAPAN	M
HITACHI	GUNMA	TAKASAKI WORKS	KOMORO	LASER TELECOM 8-bit MCU	CMOS GaAs	1.50	3	15,000	106,050	1,850	N/A	JAPAN	M
HITACHI	CHIBA	MOBARA WORKS	D2	1Mb DRAM	CMOS MOS	1.20	5	30,000	570,600	4,180	N/A	JAPAN	M
HITACHI	IBARAGI	HITACHI WORKS	N/A	PWR GTO THYRISTERS	BIP STTL	4.00	5	20,000	380,400	0	N/A	JAPAN	M
HITACHI	IBARAGI	NAKA WORKS	N1-1	4Mb DRAM 1Mb SRAM	CMOS	0.80	6	15,000	410,700	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
HITACHI	YAMANASHI	KOFU WORKS	IMASUWA	4Mb DRAM 16Mb PROTO SRAM 4Mb SRAM	CMOS	0.60	6	25,000	684,500	0	N/A	JAPAN	M
HITACHI	TOKYO	MUSASHI WORKS	DDC	LOG LIN	BIP	2.00	4	15,000	182,550	0	N/A	JAPAN	M
HITACHI	TOKYO	MUSASHI WORKS	N/A	4-Bit MPU 8-Bit MCU	MOS	2.00	4	20,000	243,400	0	N/A	JAPAN	M
HITACHI	TOKYO	MUSASHI WORKS	N/A	4-bit 8-bit MCU	MOS	1.50	5	30,000	570,600	0	N/A	JAPAN	M
HITACHI	YAMANASHI	KOFU WORKS	NO. K4-2	1Mb DRAM	CMOS	1.00	6	20,000	547,600	0	N/A	JAPAN	M
HITACHI	YAMANASHI	KOFU WORKS	NO. K2-1	N/A	N/A	2.00	4	15,000	182,550	0	N/A	JAPAN	M
HITACHI	YAMANASHI	KOFU WORKS	NO. K2-2	N/A	MOS	2.00	5	20,000	380,400	0	N/A	JAPAN	M
HITACHI	GUNMA	TAKASAKI WORKS	N/A	256K SRAM 4Mb DRAM MCU	CMOS BICMOS	0.80	6	20,000	547,600	0	N/A	JAPAN	M
HITACHI	HOKKAIDO	HOKKAI S/C	CHITOSE	4Mb DRAM 1Mb SRAM ROM E2	CMOS	0.80	0	0	0	0	N/A	JAPAN	M
HITACHI	YAMANASHI	KOFU WORKS	LSI	N/A	MOS	3.00	4	30,000	365,100	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
HITACHI	TOKYO	MUSASHI WORKS	R&D	MPU SRAM DRAM ARRAYS CBIC	CMOS M2	1.30	6	15,000	410,700	0	N/A	JAPAN	M
HITACHI	TOKYO	MUSASHI WORKS	R&D	MPU MEM CBIC	CMOS M2	1.20	5	15,000	285,300	0	10	JAPAN	M
HITACHI	TOKYO	MUSASHI WORKS	N/A	4Mb DRAM 16Mb PROTO MCU	CMOS	0.80	8	8,000	389,360	0	N/A	JAPAN	M
HITACHI		N/A	N/A	4Mb DRAM 16Mb DRAM	CMOS	0.50	8	8,000	389,360	0	N/A	JAPAN	M
HITACHI	GUNMA	TAKASAKI WORKS	N/A	16Mb DRAM ASIC RISC MPU	CMOS BICMOS	0.50	8	0	0	0	N/A	JAPAN	M
HITACHI		N/A	N/A	4Mb DRAM 16Mb DRAM	CMOS	0.00	8	2,000	97,340	0	N/A	JAPAN	M
HONDA	TOCHIGI	CENTRAL RSCH.	N/A	ENG. CONTROL SENSORS MMIC	GaAs	0.00	3	0	0	0	N/A	JAPAN	C
IBM	SHIGA	YASU WORKS	N/A	1Mb DRAM MPU ROM	MOS CMOS	1.00	5	30,000	570,600	4,645	N/A	U.S.	C
IBM	SHIGA	N/A	N/A	4Mb DRAM SRAM 250K ARRAYS	CMOS	0.80	8	15,000	730,050	3,716	N/A	U.S.	C
IBM	SHIGA	S/C RSRCH CTR	N/A	16Mb DRAM 250K ARRAYS	CMOS	0.60	8	5,000	243,350	1,858	N/A	U.S.	C

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
INTL. RECTIFIER	KANAGAWA	HQ	N/A	MOSFET DIODE RECTIFIER	BIP	0.00	3	20,000	141,400	0	N/A	U.S.	M
INTL. RECTIFIER	AKITA	AKITA	N/A	DIS	N/A	0.00	0	0	0	0	N/A	U.S.	M
IWATSU	TOKYO	HACHIOJI BLDG	N/A	N/A	CMOS	1.50	5	6,000	114,120	0	N/A	JAPAN	M
JVC	KANAGAWA	CENTRAL LAB	N/A	1K ARRAYS DSP CUSTOM	CMOS	3.00	3	9,000	63,630	0	N/A	JAPAN	C
KAWASAKI STEEL	TOCHIGI	PHASE 1	N/A	256K SRAM CBIC ARRAYS	CMOS NTT	0.80	6	10,000	273,800	0	N/A	JAPAN	M
KAWASAKI STEEL	TOCHIGI	LSI RSCH.	PROTOTYPE	SRAM CBIC ARRAYS	CMOS NTT	0.80	5	7,000	133,140	0	N/A	JAPAN	M
KODAK	KANAGAWA	MIDORI-KU	N/A	N/A	N/A	0.00	3	14,000	98,980	0	N/A	U.S.	C
KODENSHI	KYOTO-FU	N/A	PLANT 3	DIS DIODE TRAN	GaAs GaP	0.00	0	0	0	0	N/A	JAPAN	M
KYOTO S/C	KYOTO-FU	N/A	N/A	LED TRAN IMAGE SENSOR	GaAs GaP	0.00	0	0	0	0	10000	JAPAN	M
MATSUSHITA	NIIGATA	ARAI	FAB B-3	64K DRAM SRAM MPU	MOS	2.00	5	45,000	855,900	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
MATSUSHITA	NIIGATA	ARAI	FAB D	LOG LIN CCD	BIP	3.00	5	20,000	380,400	0	100	JAPAN	M
MATSUSHITA	TOYAMA	UOZU	FAB C-1	1Mb DRAM 4Mb DRAM	CMOS	0.80	6	20,000	547,600	0	10	JAPAN	M
MATSUSHITA	TOYAMA	UOZU	FAB B	1Mb DRAM 256K SRAM	CMOS	1.00	6	25,000	684,500	0	10	JAPAN	M
MATSUSHITA	TOYAMA	UOZU	FAB A-1	16-bit MPU ARRAYS CCD	CMOS	2.00	5	15,000	285,300	0	100	JAPAN	M
MATSUSHITA	KYOTO-FU	NAGAOKA	IC	MEM MPU ARRAYS CBIC	MOS	2.00	4	15,000	182,550	0	1000	JAPAN	M
MATSUSHITA	KAGOSHIMA	KAGOSHIMA	N/A	OPTO S/C LASERS LED HEMT	GaP MOS	0.00	0	0	0	0	10000	JAPAN	M
MATSUSHITA	KYOTO-FU	TOYO DENPA LTD.	N/A	PWR TRAN	MOS	0.00	5	18,000	342,360	0	N/A	JAPAN	M
MATSUSHITA	KYOTO-FU	NAGAOKA	LSI	LOG	CMOS	2.00	4	15,000	182,550	0	N/A	JAPAN	M
MATSUSHITA	KYOTO-FU	NAGAOKA	VLSI	CCD FET	MOS GaAs	1.50	4	10,000	121,700	0	N/A	JAPAN	M
MATSUSHITA	TOYAMA	UOZU	FAB A-2	MPU ROM EPROM EEPROM	MOS	1.50	5	15,000	285,300	0	N/A	JAPAN	M
MATSUSHITA	TOYAMA	UOZU	FAB C-2	4Mb DRAM 256K SRAM	CMOS	0.80	6	20,000	547,600	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
MATSUSHITA	NIIGATA	ARAI	FAB D	ROM EPROM EEPROM	MOS	1.50	5	20,000	380,400	0	N/A	JAPAN	M
MATSUSHITA	NIIGATA	ARAI	FAB C-2	256K DRAM SRAM MPU ROM	MOS	1.50	5	35,000	665,700	0	100	JAPAN	M
MATSUSHITA	KYOTO-FU	NAGAOKA	N/A	TTL LOG PWR TRAN CUSTOM	BIP	3.00	4	20,000	243,400	0	10000	JAPAN	M
MATSUSHITA	NIIGATA	ARAI	FAB C-1	MPU	MOS	1.50	4	15,000	182,550	0	N/A	JAPAN	M
MATSUSHITA	KYOTO-FU	NAGAOKA	N/A	CCD	MOS	2.00	4	8,000	97,360	0	1000	JAPAN	M
MATSUSHITA	OSAKA	S/C RSCH. CTR.	PROTOTYPE	16Mb DRAM 64-bit MPU	CMOS	0.60	6	8,000	219,040	0	N/A	JAPAN	M
MATSUSHITA	TOCHIGI	APPL. LAB	N/A	SST VARIABLE CAPAC. DIODE	MOS	0.00	3	8,000	56,560	0	N/A	JAPAN	M
MEIDENSHA	SHIZUOKA	N/A	N/A	GTO THYRISTOR	N/A	0.00	5	7,000	133,140	0	N/A	JAPAN	M
MITSUBISHI	KUMAMOTO	KUMAMOTO WORKS	C-2F	1Mb SRAM 1Mb ROM ARRAYS	MOS CMOS	0.80	5	25,000	475,500	0	N/A	JAPAN	M
MITSUBISHI	FUKUOKA	FUKUOKA	#2	LOG LIN A/D D/A DIS	BIP	3.00	4	25,000	304,250	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
MITSUBISHI	KUMAMOTO	KUMAMOTO WORKS	B-1F	EPROM	CMOS	1.50	5	30,000	570,600	0	N/A	JAPAN	M
MITSUBISHI	KUMAMOTO	KUMAMOTO WORKS	B-2F	ARRAYS	CMOS	2.00	4	42,000	511,140	0	N/A	JAPAN	M
MITSUBISHI	KUMAMOTO	KUMAMOTO WORKS	C-1F	EPROM	CMOS	1.50	5	25,000	475,500	0	N/A	JAPAN	M
MITSUBISHI	KOCHI	KOCHI	TA-1F	4Mb DRAM SRAM ASIC MCU	CMOS	1.00	6	25,000	684,500	0	N/A	JAPAN	M
MITSUBISHI	EHIME	SAIJO A	A-2F	4Mb DRAM SAMPLE 16Mb	CMOS M2	0.50	6	20,000	547,600	5,574	N/A	JAPAN	M
MITSUBISHI	HYOGO	KITAITAMI WORKS	N/A	N/A	N/A	0.00	4	25,000	304,250	0	N/A	JAPAN	M
MITSUBISHI	FUKUOKA	FUKUOKA	#3	100K 200K ARRAYS	CMOS BICMOS	0.80	0	0	0	0	N/A	JAPAN	M
MITSUBISHI	HYOGO	KITAITAMI WORKS	N/A	ARRAYS OPTO LASER	CMOS MOS	2.00	5	28,000	532,560	650	10	JAPAN	M
MITSUBISHI	EHIME	SAIJO C	C	8-BIT MCU	CMOS M2	0.80	5	38,000	722,760	4,000	10	JAPAN	M
MITSUBISHI	FUKUOKA	FUKUOKA	#1	PWR TRN DIODE	BIP	4.00	4	40,000	486,800	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
MITSUBISHI	EHIME	SAIJO B	B	ASIC MCU	CMOS MI	1.20	5	38,000	722,760	4,000	N/A	JAPAN	M
MITSUBISHI	HYOGO	KITAITAMI WORKS	N/A	FET OPTO HEMT	GaAs	0.00	3	0	0	0	N/A	JAPAN	M
MITSUBISHI	KOCHI	KOCHI	N/A	1Mb DRAM 8-bit MCU 16-bit MCU ASIC	CMOS	1.00	6	10,000	273,800	0	10	JAPAN	M
MITSUBISHI	OSAKA	ULSI	N/A	64Mb DRAM 256Mb DRAM	CMOS	0.35	8	0	0	0		JAPAN	M
MITSUMI	KANAGAWA	ATSUGI	N/A	LOG DIS	BIP	0.00	4	30,000	365,100	0	100	JAPAN	M
MORIRICA	KANAGAWA	HEADQUARTER	N/A	OPTO	GaP	0.00	0	0	0	0	N/A	JAPAN	M
MOTOROLA	FUKUSHIMA	AIZU WORKS	N/A	LOG	BIP	3.00	4	30,000	365,100	0	N/A	U.S.	M
MOTOROLA	FUKUSHIMA	AIZU WORKS	MOS-7	CBIC MCU SRAM ROM PWR ICs	CMOS MOS M1	1.80	4	25,000	304,250	2,211	100	U.S.	M
MURATA MFG.	N/A	N/A	N/A	FET MMIC	GaAs	0.80	0	0	0	0	N/A	JAPAN	C
NEC	KUMAMOTO	KYUSHU	FAB 3	CCD	MOS	3.00	4	60,000	730,200	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
NEC	YAMAGUCHI	YAMAGUCHI LTD	PHASE 1	1Mb DRAM SRAM MPU	CMOS MOS	1.00	6	25,000	684,500	0	10	JAPAN	M
NEC	SHIGA	KANSAI LTD	NO. 3	ARRAYS SRAM 8-bit MPU	CMOS MOS	2.00	4	20,000	243,400	0	N/A	JAPAN	M
NEC	KUMAMOTO	KYUSHU	FAB 6	1Mb DRAM MPU ARRAYS	MOS POLY2	1.00	6	45,000	1,232,100	4,645	100	JAPAN	M
NEC	SHIGA	KANSAI LTD	YOKAICHI P	ZENER DIODE	BIP	5.00	4	20,000	243,400	0	1000	JAPAN	M
NEC	YAMANASHI	OTSUKI WORKS	N/A	N/A	N/A	2.00	5	30,000	570,600	0	100	JAPAN	M
NEC	KUMAMOTO	KYUSHU	FAB 7	MCU 1Mb DRAM ARRAYS EPROM	CMOS BICMOS	1.00	6	30,000	821,400	2,787	10	JAPAN	M
NEC	KUMAMOTO	KYUSHU	FAB 4	ASIC EPROM MCU MPU	CMOS MOS	1.40	5	20,000	380,400	4,180	100	JAPAN	M
NEC	SHIGA	KANSAI LTD	NO. 2	LIN CCD	MOS	3.00	4	20,000	243,400	0	1000	JAPAN	M
NEC	YAMAGATA	YAMAGATA LTD	TSURUOKA N	LOG LIN	BIP	2.00	5	40,000	760,800	0	N/A	JAPAN	M
NEC	KANAGAWA	SAGAMIHARA	BLDG. B FLOOR 1	ARRAYS CBIC	MOS	2.00	5	28,000	532,560	5,400	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
NEC	YAMAGUCHI	YAMAGUCHI LTD	PHASE 2	1Mb DRAM 4Mb DRAM 1Mb SRAM	CMOS BICMOS	0.80	6	20,000	547,600	2,300	10	JAPAN	M
NEC	YAMAGATA	YAMAGATA LTD	TSURUOKA N	LOG LIN DIS	BIP	3.00	4	20,000	243,400	0	N/A	JAPAN	M
NEC	SHIGA	KANSAI LTD	NO. 1	PWR TRAN DIS CCD	BIP	4.00	4	15,000	182,550	0	1000	JAPAN	M
NEC	KANAGAWA	SAGAMIHARA	BLDG. B FLOOR 2	ARRAYS CBIC SRAM EPROM	CMOS	1.25	5	12,000	228,240	5,400	N/A	JAPAN	M
NEC	SHIGA	KANSAI LTD	NO. 4	ARRAYS MCU SRAM 4Mb DRAM	CMOS	0.80	6	20,000	547,600	0	100	JAPAN	M
NEC	HIROSHIMA	CHUGOKU	PHASE 1	4Mb DRAM SRAM MPU 4Mb ROM	CMOS	0.80	6	27,000	739,260	3,600	N/A	JAPAN	M
NEC	KANAGAWA	YAMAGAWA WORKS	N/A	ASIC EPROM MCU MPU	CMOS MOS	1.40	5	20,000	380,400	0	N/A	JAPAN	M
NEC	YAMAGATA	YAMAGATA LTD	TSURUOKA W	64K SRAM	MOS	2.00	4	20,000	243,400	0	N/A	JAPAN	M
NEC	KAGOSHIMA	KAGOSHIMA	N/A	LIN TELECOM LASER	BIP GaAs SI	0.78	4	4,200	51,114	0	N/A	JAPAN	M
NEC	SHIGA	KANSAI LTD.	N/A	N/A	GaAs	0.00	3	0	0	0	N/A	JAPAN	M
NEC	KANAGAWA	SAGAMIHARA	BLDG. C FLR 3	4Mb DRAM ASIC MPU 4Mb ROM	CMOS BICMOS	0.80	6	10,000	273,800	4,300	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
NEC	KANAGAWA	SAGAMIHARA	G-2	16Mb DRAM	CMOS	0.55	6	500	13,690	3,500	1	JAPAN	M
NEW JAPAN RADIO	SAITAMA	KAWAGOE WORKS	N/A	LED FET DIODE	GaAs GaAlAs	1.50	3	2,800	19,796	0	N/A	JAPAN	M
NEW JAPAN RADIO	SAITAMA	KAWAGOE WORKS	N/A	OP AMP	BIP	0.00	3	25,000	176,750	0	N/A	JAPAN	M
NEW JAPAN RADIO	SAITAMA	KAWAGOE WORKS	N/A	OP AMP	BIP	0.00	3	25,000	176,750	0	N/A	JAPAN	M
NEW JAPAN RADIO	SAITAMA	KAWAGOE WORKS	N/A	CUSTOM LOG A/D D/A OPTO	CMOS	1.20	5	20,000	380,400	0	10	JAPAN	M
NEW JAPAN RADIO	SAITAMA	KAWAGOE WORKS	N/A	OP AMP A/D D/A REG	BIP	0.00	4	17,000	206,890	0	1000	JAPAN	M
NIHON S/C	IBARAGI	N/A	PHASE 1	ARRAYS CBIC MPU 64K SRAM	CMOS	1.50	6	20,000	547,600	0	1	JAPAN	M
NIPPON DENSO	AICHI	HQ	N/A	DIODE LOG CUSTOM MCU	BIP MOS	3.00	4	20,000	243,400	0	N/A	JAPAN	C
NIPPON DENSO	AICHI	HQ	N/A	CUSTOM	BIP	5.00	3	5,000	35,350	0	N/A	JAPAN	C
NIPPON DENSO	AICHI	KODA WORKS	BLDG. 1	LOG CUSTOM MCU OPTO	MOS	1.50	5	2,000	39,040	0	N/A	JAPAN	C

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
NIPPON DENSO	AICHI	KODA WORKS	BLDG. 2	MCU CUSTOM	MOS	0.00	6	10,000	273,800	0	N/A	JAPAN	C
NIPPON PRECISION CIRC.	TOCHIGI	N/A	N/A	LOG LIN A/D D/A MODEM	CMOS	2.00	5	13,000	247,260	3,000	1000	JAPAN	C
NIPPON PRECISION CIRC.	TOCHIGI	SHIOBARA	N/A	A/D D/A DSP LOG ASSP	CMOS	0.80	6	20,000	547,600	2,000	1	JAPAN	C
NIPPON STEEL	KANAGAWA	ELECT. LAB	N/A	ASIC	N/A	0.80	6	15,000	410,700	0	N/A	JAPAN	M
NISSAN	KANAGAWA	CENTRAL RSCH.	N/A	MCU CUSTOM	CMOS	2.00	5	500	9,510	1,500	10	JAPAN	C
NKK	KANAGAWA	N/A	EDRL	1Mb SRAM 4Mb SRAM MASK ROM RISC MPU ASIC	N/A	0.80	8	5,000	243,350	0	1	JAPAN	M
NMB S/C	CHIBA	N/A	M3	4Mb DRAM SAMPLE 16Mb	CMOS	0.80	6	20,000	547,600	0	1	JAPAN	M
NMB S/C	CHIBA	N/A	M1	256K DRAM 64K SRAM ASIC	CMOS	1.20	5	20,000	380,400	3,994	1	JAPAN	M
NMB S/C	CHIBA	N/A	M2	1Mb DRAM	CMOS M1	0.80	6	20,000	547,600	3,994	1	JAPAN	M
OKI	MIYAZAKI	MIYAZAKI OKI	M3	4Mb DRAM 90K ARRAYS	CMOS	0.50	6	30,000	821,400	9,000	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
OKI	MIYAGI	MIYAGI OKI	N/A	4Mb DRAM VRAM 1Mb SRAM	CMOS	0.80	6	20,000	547,600	0	N/A	JAPAN	M
OKI	MIYAZAKI	MIYAZAKI OKI	M1	256K DRAM SRAM ARRAYS MPU	CMOS	1.50	5	50,000	951,000	0	100	JAPAN	M
OKI	MIYAGI	MIYAGI OKI	N/A	ARRAYS 1Mb DRAM VRAM LOG	CMOS	0.80	6	20,000	547,600	0	10	JAPAN	M
OKI	MIYAZAKI	MIYAZAKI OKI	M2	256K DRAM 1Mb DRAM EEPROM	CMOS	1.30	5	30,000	570,600	2,800	10	JAPAN	M
OKI	TOKYO	HACHIOJI	V-4	16Mb DRAM 64Mb DRAM	CMOS BICMOS	0.30	8	500	24,335	2,600	N/A	JAPAN	M
OLYMPUS	NAGANO	TATSUNO WORKS	N/A	SIT IMAGE SENSOR	CMOS	3.00	5	5,000	95,100	0	N/A	JAPAN	C
OMRON TATEISHI	SHIGA	MINAKUCHI	N/A	OPTO IMAGE SENSOR	BIP GaP	0.00	4	20,000	243,400	4,620	N/A	JAPAN	M
OMRON TATEISHI	SHIGA	MINAKUCHI	N/A	OPTO IMAGE SENSOR	BIP GaP	3.00	4	1,000	12,170	1,320	N/A	JAPAN	M
ORIGIN ELECT.	TOCHIGI	N/A	N/A	TRAN DIODE DIS	BIP	0.00	4	17,000	206,890	0	N/A	JAPAN	M
PIONEER VIDEO CORP.	YAMANASHI	N/A	N/A	ARRAYS LOG SAW CCD	CMOS	3.00	5	8,000	152,160	0	N/A	JAPAN	C
RICOH	OSAKA	N/A	N/A	ARRAYS	CMOS	1.00	6	10,000	273,800	0	N/A	JAPAN	C

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
RICOH	OSAKA	N/A	N/A	ARRAYS ROM PLD LOG	BICMOS CMOS	2.00	4	15,000	182,550	1,420	100	JAPAN	C
RICOH	OSAKA	N/A	N/A	256K ROM ARRAYS CBIC	CMOS MOS	1.30	6	7,000	191,660	0	100	JAPAN	C
ROHM	KYOTO-FU	LSI RSCH.	N/A	256K SRAM ASIC MCU EEPROM	CMOS BICMOS	1.20	6	15,000	410,700	2,100	10	JAPAN	M
ROHM	OKAYAMA	SHINDO ELECTRIC	N/A	TRAN DIODE	BIP	0.00	3	23,000	162,610	0	1000	JAPAN	M
ROHM	FUKUOKA	N/A	N/A	PWR ICs MPU MODEM	BIP	3.00	4	20,000	243,400	0	N/A	JAPAN	M
ROHM	FUKUOKA	N/A	N/A	TRAN DIS	BIP	0.00	4	20,000	243,400	0	N/A	JAPAN	M
ROHM	KYOTO-FU	MAIN OFFICE	N/A	MPU LASER MODEM TRAN LED	BIP GaAs	0.00	4	25,000	304,250	0	N/A	JAPAN	M
SANKEN	SAITAMA	HQ	N/A	PWR TRAN DIODE LED	N/A	0.00	3	15,000	106,050	0	1000	JAPAN	
SANKEN	YAMAGATA	YAMAGATA SANKEN	N/A	PWR TRAN DIODE LED	N/A	0.00	5	10,000	190,200	0	1000	JAPAN	
SANKEN	SAITAMA	S/C TECH. CTR.	N/A	PWR TRAN DIODE LED	N/A	0.00	5	6,000	114,120	0	N/A	JAPAN	

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
SANSHA	OKAYAMA	OKAYAMA	N/A	PWR TRAN PWR DIODE	BIP	0.00	5	15,000	285,300	0	N/A	JAPAN	
SANYO	NIIGATA	NIIGATA SANYO	BLDG. 2 CMOS	ASIC PLD 1Mb DRAM 4Mb DRAM	BICMOS CMOS	1.00	6	16,000	438,080	0	N/A	JAPAN	M
SANYO	GUNMA	S/C DIV.	N/A	N/A	BIP	2.00	4	30,000	365,100	4,645	10	JAPAN	M
SANYO	GUNMA	S/C DIV.	N/A	SRAM	MOS	1.20	4	25,000	304,250	0	N/A	JAPAN	M
SANYO	NIIGATA	NIIGATA SANYO	BLDG. 3 #4	16-BIT MCU DSP	CMOS	1.00	6	20,000	547,600	0	N/A	JAPAN	M
SANYO	GIFU	VLSI DIV.	N/A	256K SRAM 4Mb ROM 8Mb ROM	N/A	0.80	6	17,000	465,460	0	N/A	JAPAN	M
SANYO	TOTTORI	TOTTORI SANYO	N/A	LASER LED	GaAs GaP	5.00	3	20,000	141,400	3,000	1000	JAPAN	M
SANYO	GUNMA	S/C DIV.	N/A	TRAN DIODE	N/A	4.00	4	40,000	486,800	4,180	1000	JAPAN	M
SANYO	GIFU	VLSI DIV.	BLDG. G	CCD ARRAY CBIC	CMOS	1.50	5	15,000	285,300	0	10	JAPAN	M
SANYO	NIIGATA	NIIGATA SANYO	BLDG. 1	64K 256K DRAM 8-bit MPU	CMOS	1.20	5	30,000	570,600	0	10	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
SANYO	NIIGATA	NIIGATA SANYO	BLDG. 2 BIP	LIN	BIP	2.00	5	25,000	475,500	3,500	1000	JAPAN	M
SANYO	GIFU	VLSI DIV.	BLDG. F	CCD SRAM ARRAYS CBIC ROM	CMOS	2.00	4	25,000	304,250	0	100	JAPAN	M
SANYO		N/A	N/A	16Mb DRAM 64Mb DRAM		0.00	8	0	0	0		JAPAN	M
SEIKO INSTRUMENT	CHIBA	TAKATSUKA	BLDG. B	TELECOM	CMOS	2.00	5	10,000	190,200	0	N/A	JAPAN	C
SEIKO INSTRUMENT	CHIBA	TAKATSUKA	N/A	SRAM ARRAYS CBIC EEPROM	CMOS	1.25	6	3,000	82,140	0	10	JAPAN	C
SEIKO-EPSON	NAGANO	FUJIMI	BLDG. D	1Mb SRAM ASIC	CMOS BICMOS	0.80	6	25,000	684,500	0	N/A	JAPAN	M
SEIKO-EPSON	NAGANO	FUJIMI	BLDG. A	ARRAYS 256K SRAM EPROM	CMOS	1.50	5	30,000	570,600	0	100	JAPAN	M
SEIKO-EPSON	NAGANO	FUJIMI	BLDG. B	ARRAYS CBIC SRAM EEPROM	CMOS MOS	2.00	4	40,000	486,800	0	100	JAPAN	M
SEIKO-EPSON	YAMAGATA	TOHOKU EPSON	N/A	256K ARRAYS CBIC 1Mb SRAM	CMOS BICMOS	0.80	6	20,000	547,600	0	10	JAPAN	M
SHARP	HIROSHIMA	FUKUYAMA	BLDG. 2 #2	4Mb DRAM 16Mb ROM ASIC	CMOS	0.80	6	24,000	657,120	0	N/A	JAPAN	M
SHARP	NARA	NARA	N/A	LASER LED OPTO	GaAs	0.00	3	22,000	155,540	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
SHARP	NARA	TENRI	NO. 2	OPTO	CMOS MOS	2.00	4	20,000	243,400	0	N/A	JAPAN	M
SHARP	HIROSHIMA	FUKUYAMA	BLDG. 1	1Mb DRAM SRAM ARRAYS ROM	MOS	1.00	5	35,000	665,700	3,500	10	JAPAN	M
SHARP	NARA	TENRI	NO. 4	N/A	MOS	1.50	5	10,000	190,200	0	N/A	JAPAN	M
SHARP	NARA	SHINJO	N/A	DIODE TRAN COUPLERS	N/A	0.00	4	25,000	304,250	0	N/A	JAPAN	M
SHARP	NARA	TENRI	NO. 3	ARRAYS CBIC	CMOS MOS BIP	1.20	5	20,000	380,400	0	N/A	JAPAN	M
SHARP	HIROSHIMA	FUKUYAMA	BLDG. 2 #1	1Mb DRAM SRAM ROM ASIC	CMOS	0.80	6	24,000	657,120	0	1	JAPAN	M
SHARP	NARA	TENRI	NO. 1	LOG LIN	BIP	3.00	4	20,000	243,400	0	N/A	JAPAN	M
SHARP	NARA	IC TECH. CTR.	TRIAL LINE	ARRAYS	CMOS	0.80	6	1,650	45,177	0	10	JAPAN	M
SHINDENGEN	SAITAMA	N/A	N/A	PWR MOSFET LIN LOG	MOS BIP	2.00	5	22,000	418,440	1,860	100	JAPAN	C
SHINDENGEN	AKITA	AKITA DIV.	BLDG. 2	DIODE VARISTER THYRISTOR	BIP	0.00	5	30,000	570,600	1,800	N/A	JAPAN	C

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
SHINDENGEN	YAMAGATA	HIGASHINE DIV.	BLDG. 1	TRAN DIODE	N/A	0.00	4	15,000	182,550	0	1000	JAPAN	C
SHINDENGEN	YAMAGATA	HIGASHINE DIV.	BLDG. 2 DIS.	TRAN DIODE LIN	BIP	0.00	5	30,000	570,600	2,537	N/A	JAPAN	C
SHINDENGEN	YAMAGATA	HIGASHINE DIV.	BLDG. 2 MOS	CUSTOM	CMOS MOS	2.00	5	25,000	475,500	2,537	N/A	JAPAN	C
SHINDENGEN	YAMAGATA	HIGASHINE DIV.	BLDG. 3	CUSTOM	CMOS MOS	0.00	5	10,000	190,200	0	N/A	JAPAN	C
SHINDENGEN	AKITA	AKITA DIV.	BLDG. 1	DIODE THYRISTOR VARISTER	BIP	0.00	4	20,000	243,400	0	N/A	JAPAN	C
SHINDENGEN	SAITAMA	N/A	N/A	DIS LIN	BIP	0.00	4	10,000	121,700	0	1000	JAPAN	C
SHOWA DENKO	TOKYO	N/A	N/A	N/A	GaAs	0.00	0	0	0	0	N/A	JAPAN	M
SONY	NAGASAKI	SONY NAGASAKI	1G	256K SRAM CCD	CMOS	1.00	6	20,000	547,600	2,322	10	JAPAN	M
SONY	KANAGAWA	ATSUGI	N/A	ROM 2.4Mb VRAM 4Mb SRAM	CMOS	0.80	6	12,000	328,560	0	100	JAPAN	M
SONY	KAGOSHIMA	SONY KOKUBU	#3	LIN A/D D/A	BIP	2.00	4	25,000	304,250	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
SONY	KAGOSHIMA	SONY KOKUBU	CCD	CCD	MOS	1.50	4	20,000	243,400	0	N/A	JAPAN	M
SONY	KAGOSHIMA	SONY KOKUBU	#2	DIS	N/A	3.00	4	15,000	182,550	0	N/A	JAPAN	M
SONY	KAGOSHIMA	SONY KOKUBU	#1	DIS	N/A	4.00	4	15,000	182,550	0	N/A	JAPAN	M
SONY	KANAGAWA	ATSUGI	N/A	LIN	BIP	2.00	4	24,000	292,080	0	N/A	JAPAN	M
SONY	NAGASAKI	SONY NAGASAKI	3G	1Mb SRAM 4Mb VRAM CDD	CMOS	0.80	6	40,000	1,095,200	0	N/A	JAPAN	M
SONY	NAGASAKI	SONY NAGASAKI	2G	CCD 256K SRAM SAMPLE 1Mb	CMOS	0.80	6	20,000	547,600	0	N/A	JAPAN	M
SONY	KAGOSHIMA	SONY KOKUBU	#4	SRAM MPU CCD	BICMOS CMOS	1.30	5	30,000	570,600	0	10	JAPAN	M
SONY	KANAGAWA	ATSUGI	N/A	MEM LIN OPTO DIS HEMT	GaAs CMOS	0.00	0	0	0	0	N/A	JAPAN	M
SONY	KANAGAWA	ATSUGI	N/A	FET LASER CCD HEMT	GaAs	0.00	3	0	0	0	N/A	JAPAN	C
STANLEY	YAMAGATA	TSURUOKA WORKS	N/A	LED	N/A	0.00	3	12,000	84,840	0	N/A	JAPAN	C
STANLEY	KANAGAWA	STANLEY ELECT.	N/A	LASER LED	N/A	0.00	4	10,000	121,700	0	N/A	JAPAN	C

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
SUMITOMO METAL MINING	OSAKA	OSAKA WORKS	N/A	LED DIODE	GaAs	0.00	3	1,000	7,070	0	N/A	JAPAN	M
SUMITOMO METAL MINING	OITA	N/A	N/A	N/A	N/A	0.00	5	3,000	57,060	464	N/A	JAPAN	M
SUMITOMO METAL MINING	HYOGO	FUTURE TECH LAB	N/A	4Mb DRAM	N/A	0.80	0	0	0	0	N/A	JAPAN	M
TATEISHI ELECTRIC	N/A	MINAKUCHI	N/A	OPTO CUSTOM	BIP	0.00	6	10,000	273,800	1,306	10	JAPAN	C
TDK/SILICON SYSTEMS	IBARAGI	N/A	N/A	ASIC MPR LOG A/D D/A	CMOS BIP	0.00	0	0	0	0	N/A	JAPAN	M
TI	IBARAGI	MIHO	MIHO 5	ASSP ASIC MCU DSP CBIC	MOS	1.00	5	25,466	494,363	2,322	1	U.S.	M
TI	OITA	HIJI	HIJI 1	LOG LIN ARRAYS	BIP	1.20	5	10,976	208,764	0	100	U.S.	M
TI	SAITAMA	HATOGAYA	N/A	MCU DSP CBIC ARRAYS	CMOS MOS	2.00	3	15,000	285,300	0	100	U.S.	M
TI	IBARAGI	MIHO	MIHO 6	1Mb DRAM 4Mb DRAM ASSP RISC	CMOS BICMOS	0.75	6	21,221	581,031	2,787	1	U.S.	M
TI	OITA	HIJI	MOS 8	SRAM 16Mb DRAM	CMOS BICMOS	0.50	8	2,706	131,701	2,500	1	U.S.	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
TOHOKU S/C	MIYAGI	SENDAI	PHASE 2	4Mb DRAM SRAM MPU ARRAYS	CMOS	0.70	6	20,000	547,600	0	100	JAPAN/U.S.	M
TOHOKU S/C	MIYAGI	SENDAI	PHASE 1	1Mb DRAM 256K SRAM MPU	CMOS	1.00	6	25,000	684,500	0	100	JAPAN	M
TOKIN	MIYAGI	SENDAI WORKS	N/A	POWER SIT	SIP	0.00	3	10,000	70,700	0	N/A	JAPAN	C
TOKO	SAITAMA	SAITAMA	N/A	N/A	MOS	3.00	5	15,000	285,300	0	N/A	JAPAN	M
TOKO	SAITAMA	SAITAMA	N/A	A/D D/A TELECOM DIODE	BIP	3.50	5	20,000	380,400	0	N/A	JAPAN	M
TOREX SEMICONDUCTOR	OKAYAMA	N/A	N/A	N/A		0.00	0	0	0	0		JAPAN	M
TOSHIBA	IWATE	IWATE TOSHIBA	BLDG. 2	4Mb ROM 4Mb EEPROM	CMOS	1.00	6	15,000	410,700	0	100	JAPAN	M
TOSHIBA	FUKUOKA	KITAKYUSHU	N/A	LIN	BIP	3.00	5	30,000	570,600	4,000	N/A	JAPAN	M
TOSHIBA	FUKUOKA	KITAKYUSHU	KUBIC 1	LASER LED	GaAs	2.00	3	25,000	176,750	1,600	N/A	JAPAN	M
TOSHIBA	CHIBA	KIMITSU	PHASE 2	DIODE RECTIFIER THYRISTOR	BIP	0.00	5	18,000	342,360	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
TOSHI.A	HYOGO	HIMEJI	N/A	TRAN DIODE	BIP	3.00	4	30,000	365,100	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA BLDG #2	C-1	256K DRAM 1Mb DRAM	CMOS MOS	1.00	5	30,000	570,600	0	100	JAPAN	M
TOSHIBA	OITA	OITA BLDG #1	LSI 2	MPU LOG ROM EPROM	CMOS MOS	1.50	5	45,000	855,900	0	N/A	JAPAN	M
TOSHIBA	IWATE	IWATE TOSHIBA	BLDG. 3	4Mb EPROM ROM 172K ARRAYS	BICMOS CMOS	0.80	5	24,000	456,480	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA BLDG #3	C-3 #1	1Mb DRAM	CMOS	1.00	6	14,000	383,320	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA BLDG #3	C-3 #2	1Mb DRAM	CMOS	1.00	6	15,000	410,700	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA BLDG #3	C-4 #2	4Mb DRAM	CMOS	0.80	6	15,000	410,700	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA BLDG #1	LSI 1	MPU LOG 64K DRAM	MOS	2.00	4	20,000	243,400	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA BLDG #2	C-2	1Mb DRAM	CMOS	1.00	5	30,000	570,600	0	N/A	JAPAN	M
TOSHIBA	KANAGAWA	TAMAGAWA	N/A	LOG LIN	BIP	2.00	5	15,000	285,300	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA BLDG #4	#1	1Mb DRAM 4Mb DRAM ARRAYS CBIC	CMOS	0.80	6	30,000	821,400	3,716	10	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
TOSHIBA	OITA	OITA BLDG #4	#2	4Mb DRAM SAMPLE 16Mb	BICMOS CMOS	0.60	6	20,000	547,600	3,716	N/A	JAPAN	M
TOSHIBA	CHIBA	KIMITSU	PHASE 1	DIODE RECTIFIER THYRISTOR	BIP	0.00	4	20,000	243,400	0	N/A	JAPAN	M
TOSHIBA	FUKUOKA	NIPPO INDUST.	NAKAMA P	LED P_DIODE IMAGE SENSOR	N/A	0.00	4	30,000	365,100	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA BLDG #3	C-4 #1	4Mb DRAM 256K SRAM ASIC	CMOS	0.80	6	15,000	410,700	0	N/A	JAPAN	M
TOSHIBA	HYOGO	HIMEJI	N/A	PWR FET GTO TRAN DIODE	CMOS BIP	1.00	5	45,000	855,900	0	N/A	JAPAN	M
TOSHIBA	IWATE	IWATE TOSHIBA	BLDG. 1	ARRAYS CBIC MPU CUSTOM	CMOS	1.50	5	20,000	380,400	0	100	JAPAN	M
TOSHIBA	IWATE	IWATE TOSHIBA	BLDG. 2	ARRAYS CCD	CMOS	1.50	5	20,000	380,400	0	N/A	JAPAN	M
TOSHIBA	FUKUOKA	KITAKYUSHU	KUBIC 2	ASIC OPTO LOG	BICMOS BIP	2.00	5	30,000	570,600	2,000	100	JAPAN	M
TOSHIBA	KANAGAWA	TAMAGAWA	N/A	1Mb DRAM SAMPLE 4Mb DRAM 16Mb DRAM	CMOS	0.80	6	10,000	273,800	0	N/A	JAPAN	M
TOSHIBA	OITA	OITA TECH. CTR.	N/A	4Mb DRAM 16Mb DRAM VRAM	N/A	0.50	0	0	0	0	N/A	JAPAN	M

(Continued)

Table 1 (Continued)
Japanese Existing Pilot and Production Fab Lines
(Including Fabs Going Into Production During 1991)

Company	Prefect.	Plant Name	Fab Name	Products Produced	Process Technology	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (square meters)	Clean Room Class	Origin of Owner	Merchant or Captive
TOSHIBA		N/A	N/A	4Mb DRAM 16Mb DRAM	CMOS	0.00	8	500	24,335	0		JAPAN	
TOSHIBA	IWATE	IWATE TOSHIBA	BLDG. 3	ARRAYS CBIC	CMOS BICMOS	0.70	6	10,000	273,600	0	N/A	JAPAN	M
TOYO	KANAGAWA	TECHNICAL LAB	N/A	STATIC INDUCT. THYRISTOR	N/A	0.00	5	5,000	95,100	0	10	JAPAN	C
TOYOTA	AICHI	CENTRAL LAB	N/A	MCU PWR ICs CUSTOM	CMOS BIP	2.00	5	500	9,510	0	100	JAPAN	C
UNIZON	HYOGO	ITAMI	N/A	ZENER DIODE RBB ARRAYS	BIP	0.00	5	15,000	285,300	0	N/A	JAPAN	M
YAMAHA	KAGOSHIMA	KAGOSHIMA	N/A	LIN ROM CBIC ASSP MPR	CMOS MOS	1.20	5	20,000	380,400	0	N/A	JAPAN	M
YAMAHA	KAGOSHIMA	KAGOSHIMA	N/A	ROM CBIC ASSP	CMOS	0.80	6	14,000	383,320	0	N/A	JAPAN	M
YAMAHA	SHIZUOKA	TOYOOKA WORKS	EE DEV CTR	CBIC LOG	CMOS	1.00	6	6,000	164,280	0	10	JAPAN	M
YAMAHA	SHIZUOKA	TOYOOKA WORKS	N/A	CBIC LOG	CMOS	1.50	4	10,000	121,700	0	N/A	JAPAN	M
YOKOGAWA HOKUSHIN	TOKYO	N/A	N/A	CUSTOM	BIP	0.00	4	17,000	206,890	3,000	N/A	JAPAN	M
YOKOGAWA IMT	NAGANO	N/A	N/A	TRAN DIODE OPTO	N/A	0.00	4	2,800	34,076	0	N/A	JAPAN	M

NA = Not available

Source: Dataquest (October 1991)

Table 2
Japanese Future Pilot and Production Fab Lines
Planned Facilities Going Into Production By Year

Company	Prefect.	Plant Name	Fab Name	Products	Process Technology	Fab Type	Target Date Prod. Begins	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (Square Meters)
Production Begins: 1991												
KAWASAKI STEEL	TOCHIGI	PHASE 1	N/A	256K SRAM CBIC ARRAYS	CMOS NTT	NP	09/01/91	0.80	6	10,000	273,800	0
MATSUSHITA	OSAKA	S/C RSCH. CTR.	PROTOTYPE	16Mb DRAM 64-bit MPU	CMOS	P	02/01/91	0.60	6	8,000	219,040	0
NIPPON STEEL	KANAGAWA	ELECT. LAB	N/A	ASIC	N/A	DP	09/01/91	0.80	6	15,000	410,700	0
OKI	TOKYO	HACHIOJI	V-4	16Mb DRAM 64Mb DRAM	CMOS BICMOS	PR	11/01/91	0.30	8	500	24,335	2,600
SONY	KANAGAWA	ATSUGI	N/A	MEM LIN OPTO DIS HEMT	GaAs CMOS	P		0.00	0	0	0	0
SUMITOMO METAL MINING	HYOGO	FUTURE TECH LAB	N/A	4Mb DRAM	N/A	F	03/01/91	0.80	0	0		0
TOSHIBA	IWATE	IWATE TOSHIBA	BLDG. 3	ARRAYS CBIC	CMOS BICMOS	PAT	04/01/91	0.70	6	10,000	273,800	0
Production Begins: 1992												
FUJITSU	IWATE	IWATE	NO. 5	16Mb DRAM	CMOS	F		0.60	6	13,000	355,940	0
FUJITSU	MIE	N/A	N/A	16Mb DRAM		F	09/01/92	0.00	8	14,000	681,380	0
HITACHI	YAMANASHI	N/A	N/A	4Mb DRAM	CMOS	F	01/01/92	0.00	8	10,000	486,700	0

(Continued)

Table 2 (Continued)
Japanese Future Pilot and Production Fab Lines
Planned Facilities Going Into Production By Year

Company	Prefect.	Plant Name	Fab Name	Products	Process Technology	Fab Type	Target Date Prod. Begins	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (Square Meters)
				16Mb DRAM								
KTI SEMICONDUCTOR	HYOGO	N/A	N/A	LOG ASIC	CMOS	F	08/01/92	0.80	8	9,000	438,030	0
LSI LOGIC	IBARGI	N/A	FAB II	ASIC		F		0.00	6	12,500	342,250	0
MATSUSHITA	TOYAMA	N/A	NO 2.	16Mb DRAM 64Mb DRAM CCD MCU	CMOS	F	05/01/92	0.00	8	8,000	389,360	0
MITSUBISHI	KUMAMOTO	KUMAMOTO WORKS	D	ARRAYS CBIC ASSP MCU	N/A	F		0.00	0	0	0	0
MITSUBISHI	EHIME	SAIJO A	A-1F	16Mb DRAM	CMOS M2	F	01/01/92	0.50	8	20,000	973,400	0
MITSUBISHI	OSAKA	ULSI	N/A	64Mb DRAM 256Mb DRAM	CMOS	RP	12/31/92	0.35	8	0	0	0
NEC	KUMAMOTO	KYUSHU	FAB 8	4Mb SRAM RISC MPU 16Mb DRAM	CMOS BICMOS	F	07/01/92	0.50	8	20,000	973,400	3,716
NEW JAPAN RADIO	KUMAMOTO	KYUSHU	N/A	CUSTOM CONSUMER LOG	CMOS	F		1.00	6	20,000	547,600	0
NIHON S/C	IBARAGI	N/A	PHASE 2	ARRAYS CBIC MPU 1Mb SRAM	N/A	F	05/01/92	0.80	6	25,000	684,500	0

(Continued)

Table 2 (Continued)
Japanese Future Pilot and Production Fab Lines
Planned Facilities Going Into Production By Year

Company	Prefect.	Plant Name	Fab Name	Products	Process Technology	Fab Type	Target Date Prod. Begins	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (Square Meters)
NIPPON DENSO	AICHI	KODA WORKS	BLDG. 2	MCU CUSTOM	MOS	P		0.00	6	10,000	273,800	0
NKK	KANAGAWA	N/A	EDRL	1Mb SRAM 4Mb SRAM MASK ROM RISC MPU ASIC	N/A	P	10/01/92	0.80	8	5,000	243,350	0
NMB S/C	CHIBA	N/A	M4	4Mb DRAM 16Mb DRAM	BICMOS CMOS	OF		0.60	8	20,000	0	0
SANYO	NIIGATA	NIIGATA SANYO	BLDG. 3 #5	4Mb DRAM	CMOS	P	06/01/92	0.80	6	20,000	547,600	0
SHARP	HIROSHIMA	FUKUYAMA	BLDG. 3	4Mb DRAM 16Mb DRAM 4Mb SRAM 32 Mb ROM	CMOS	F		0.00	8	24,000	1,168,080	0
SONY	KAGOSHIMA	SONY KOKUBU	#5	LOG MEM MPU LIN DIS OPTO	BIP CMOS MOS	FAT		0.80	6	0	0	0
SONY	MIYAGI	N/A	N/A			FA		0.00	0	0	0	0
TDK/SILICON SYSTEMS	IBARAGI	N/A	N/A	ASIC MPR LOG A/D D/A	CMOS BIP	P		0.00	0	0	0	0
TI	OITA	HIJI	BLDG. 3	4Mb SRAM 16Mb DRAM	CMOS BICMOS	P		0.60	8	20,000	973,400	0

(Continued)

Table 2 (Continued)
Japanese Future Pilot and Production Fab Lines
Planned Facilities Going Into Production By Year

Company	Prefect.	Plant Name	Fab Name	Products	Process Technology	Fab Type	Target Date Prod. Begins	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (Square Meters)
TOSHIBA	MIE	N/A	PHASE 1	4Mb DRAM SAMPLE 16Mb DRAM	CMOS	F	04/01/92	0.60	8	20,000	973,400	3,716
TOSHIBA	OITA	OITA BLDG #4	#3	4Mb DRAM 16Mb DRAM	CMOS	F		0.80	6	20,000	547,600	3,716
TOSHIBA	ISHIKAWA	KAGA	N/A	DIS	N/A	FAT		0.00	5	80,000	1,521,600	15,000
TOSHIBA	OITA	OITA TECH. CTR.	N/A	4Mb DRAM 16Mb DRAM VRAM	N/A	P		0.50	0	0	0	0
Production Begins: 1993												
ASAHI KASEI (CHEMICAL)	MIYAZAKI	N/A	N/A	ASIC SRAM	CMOS HITACHI	F	12/31/93	0.80	6	16,500	451,770	4,500
FUJITSU	FUKUSHIMA	WAKAMATSU	BLDG. 2 #2	ARRAYS CBIC 32-bit MCUs	CMOS	F		0.70	6	15,000	410,700	5,250
NEC	HIROSHIMA	CHUGOKU	PHASE 2	EPROM 4Mb DRAM SAMPLE 16Mb DRAM	CMOS	F	12/31/93	0.60	8	30,000	1,460,100	0
NEC	YAMAGATA	TSURUOKA	N/A	ASIC MCU	CMOS	F	04/01/93	0.80	6	20,000	547,600	21,000
NEC	YAMAGUCHI	YAMAGUCHI LTD.	N/A	16Mb DRAM	CMOS	F		0.50	8	0	0	0
OKI	MIYAZAKI	MIYAZAKI OKI	M4	16Mb DRAM	CMOS	F	03/31/93	0.50	8	20,000	973,400	8,400

(Continued)

Table 2 (Continued)
Japanese Future Pilot and Production Fab Lines
Planned Facilities Going Into Production By Year

Company	Prefect.	Plant Name	Fab Name	Products	Process Technology	Fab Type	Target Date Prod. Begins	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (Square Meters)
SEIKO-EPSON	NAGANO	FUJIMI	BLDG. E	SRAM ARRAYS	CMOS BICMOS	NFAT		0.00	0	0		0
SGS THOMPSON	N/A	N/A	N/A	CONSUMER LOG DRAM	N/A	F		0.00	0	0		0
TOHOKU S/C	MIYAGI	SENDAI	PHASE 3	16Mb DRAM	CMOS TOSHIBA	F		0.60	8	20,000	973,400	0
TOSHIBA	MIE	N/A	PHASE 2	16Mb DRAM 4 Mb DRAM	CMOS	F		0.50	8	20,000		3,716
TOSHIBA	OITA	OITA BLDG #4	#4	16Mb DRAM	BICMOS CMOS	F		0.60	6	20,000	547,600	3,716
Production Begins: 1994												
MOTOROLA	MIYAGI	SENDAI	MOS-10	4Mb DRAM MPU CUSTOM	CMOS	F	04/01/94	0.80	6	25,000	684,500	2,322
NEC	HIROSHIMA	CHUGOKU	PHASE 3	16Mb DRAM MPU EPROM	CMOS	F		0.60	8	22,000	1,070,740	0
NIHON S/C	IBARAKI	N/A	PHASE 3	ASIC CBIC MPU SRAM MPR	CMOS BICMOS	F		0.50	8	20,000	973,400	0
Production Begins: 1995												
KAWASAKI STEEL	TOCHIGI	PHASE 2	N/A	SRAM DRAM ARRAYS	CMOS NTT	F		0.00	6	15,000	410,700	0

(Continued)

Table 2 (Continued)
Japanese Future Pilot and Production Fab Lines
Planned Facilities Going Into Production By Year

Company	Prefect.	Plant Name	Fab Name	Products	Process Technology	Fab Type	Target Date Prod. Begins	Est. Min. Line-width	Waf. Size	Wafer Start Capacity (4 wks.)	Sq. In. Start Capacity (4 wks.)	Clean Room (Square Meters)
NEC	HIROSHIMA	CHUGOKU	PHASE 4	16Mb DRAM MPU EPROM	CMOS	F		0.60	8	22,000	1,070,740	0
NISSAN	N/A	N/A	N/A	CUSTOM	N/A	FAT		0.00	0	0	0	0
Production Begins: 1996												
TOSHIBA	MIE	N/A	PHASE 3	16Mb DRAM	CMOS	F		0.50	8	25,000	1,216,750	3,716
Production Begins: 1999												
KAWASAKI STEEL	TOCHIGI	PHASE 3	N/A	16Mb DRAM SRAM ARRAYS	CMOS NTT	F		0.00	6	15,000	410,700	0

NA = Not available

Source: Dataquest (October 1991)

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Dataquest Perspective Index

Semiconductors *Japan*

SCJA-SVC-IX-9201 April 30, 1992

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This is a cumulative index of key industry terms, companies, and products for the first quarter 1992 issues of *Dataquest Perspective.* Entries are followed by the date of publication and the page number(s). Product names are listed under the company that manufactures/publishes the product. General information about a company itself is found under the full company name. Each citation indicates only the beginning page of a discussion of a topic (the range of page numbers is not cited). A Table of Contents for the first quarter 1992 issues of *Dataquest Perspective*—listing each issue number, date, and article title—is included at the end of the index.

Note: The *DQ Monday Report* Volume Mean Pricing table, which appears on page 2 of Semiconductors Japan *Dataquest Perspective,* is not indexed.

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Index

October-December 1991 January 31, 1992

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Dataquest Perspective

Semiconductors
Japan

Vol. 1, No. 4 December 30, 1991

0012481

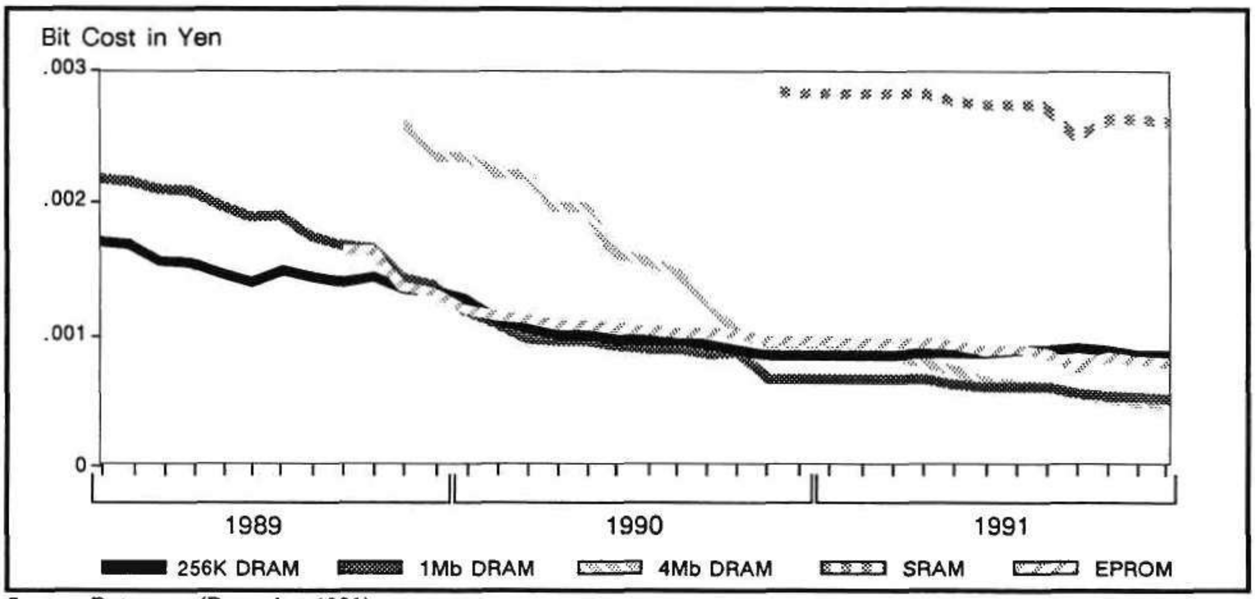
Regional Pricing Update

DQ Monday Report: Volume Mean Pricing

Family	United States	Japan	Europe	Taiwan	Hong Kong	Korea
DRAM 1Mbx1-8	3.75	4.14	3.80	4.40	4.10	3.80
DRAM 256Kx1-8	1.75	1.69	1.70	1.43	1.45	1.10
DRAM 4Mbx1-8	14.20	15.33	16.10	17.78	17.30	14.00
EPROM 1Mb, 170ns	3.85	4.64	3.55	4.75	3.90	3.80
EPROM 2Mb, 170ns	7.68	10.16	7.00	8.65	7.90	7.00
SRAM 1Mb, 128Kx8	14.23	15.14	13.30	17.10	17.80	NA
SRAM 256K, 32Kx8	4.03	4.18	3.60	4.25	4.10	3.30
SRAM 64K, 8Kx8	2.13	1.58	1.90	1.60	1.40	1.20
68020-16	31.00	49.63	29.00	47.25	44.50	NA
80286-16	11.75	13.80	12.00	11.50	12.80	12.70
80386DX-25	147.50	172.48	160.00	184.00	186.00	NA
80386SX-16	48.50	65.16	55.00	58.50	60.40	55.00
R3000-25	125.00	147.57	132.00	NA	NA	NA

Note: These figures correspond with the *DQ Monday Report* dated December 2, 1991, and reflect prices in U.S. dollars.
NA = Not available
Source: Dataquest (December 1991)

Memory Bit Price in Japan



Source: Dataquest (December 1991)

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Market Analysis

Japanese Semiconductor Alliances in 1991

Dataquest has been tracking alliances in the Japanese semiconductor sector since 1980. During this period, the strategic alliance has grown from a relatively obscure business practice to its current status as an essential ingredient to survival for all participants in an industry where next-generation capital investment requirements now exceed the corporate growth rates of even the most successful companies.

Alliance Pace Levels

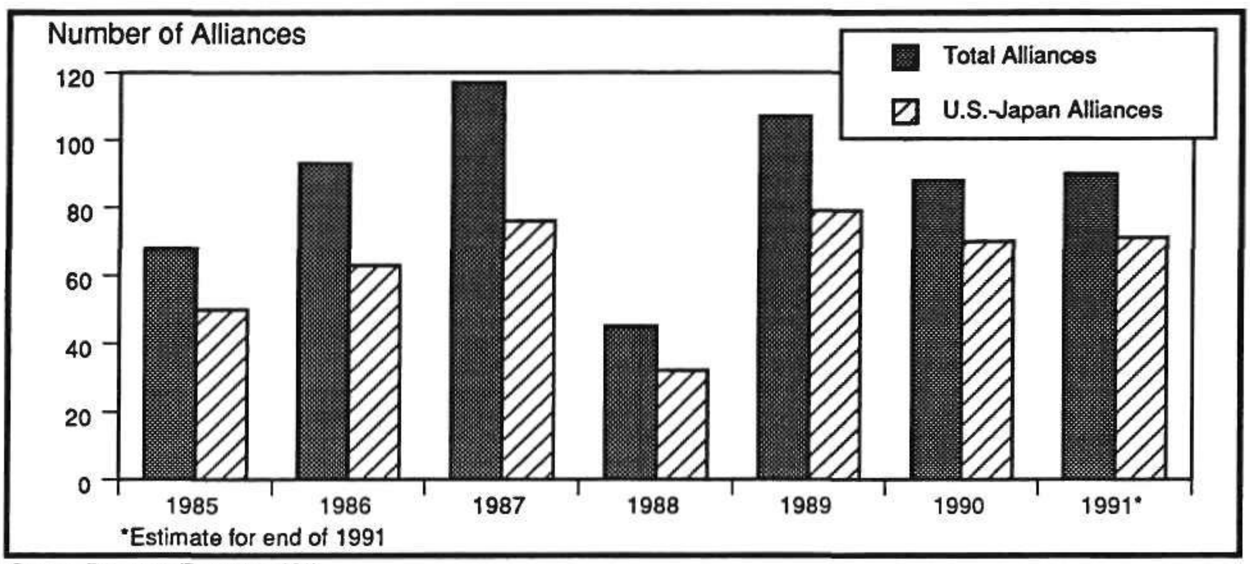
As of September 1991, marking the end of the third quarter of the year, Dataquest recorded 74 new alliance agreements for 1991. This translates to a formation frequency of 8.2 new alliances per month and exceeds last year's average pace of 7.3 per month. At the current rate of new alliance formation, 1991 should conclude with about 90 new alliances signed by Japanese companies.

Figure 1 shows the number of Japanese semiconductor alliances that Dataquest recorded from 1985 through 1990 and includes the extrapolated estimate of the 1991 year-end total. The peak number of alliances occurred in 1987 when 117 new alliances were finalized. Although the annual alliance formation rate has declined since 1987, during the past two years the alliance formation trend involving Japanese companies has essentially settled to a level of roughly 90 per year.

Another trend observed during the period from 1988 through the first three quarters of 1991 is that roughly 75 percent of the new alliances linked a Japanese company with an American company as business partners. This statistic represents a significant increase over the percentage of Japanese-U.S. corporate alliances observed during the period from 1985 through 1987, when only 68 percent of new Japanese alliances in the semiconductor industry involved an American company. A second shadow bar in Figure 1 depicts the number of Japanese alliances involving American companies for each year since 1985.

There are many possible political and economic factors that have had an impact on the Japanese-involved alliance trends during the past several years. In particular, the 1986 U.S.-Japan Semiconductor Trade Arrangement probably has contributed significantly to creating the current environment in which agreements between U.S. and Japanese companies are both economically advantageous and, should they succeed in reducing the electronics trade deficit, politically correct. The trade agreement may already have affected the percentage of U.S.-Japanese alliances relative to the total number of annual alliances as described in the previous paragraph. Dataquest has noted previously that the finite number of possible participants in alliance agreements could conceivably result

Figure 1
Japanese Semiconductor Strategic Alliances



Source: Dataquest (December1991)

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in a saturation, a slow decline, or even an oscillation—with a period equal to the average alliance contract duration—in the formation rate for new alliances.

The recession that has hit the U.S. economy, with the accompanying slowdown of the Japanese economy, evidently has neither dampened nor stimulated alliance activity in the Japanese electronics sector. Because alliances are generally perceived as long-term strategies, economic conditions may have little impact on this type of business activity.

Semiconductor Alliances by Product Type

Table 1 categorizes the Japanese semiconductor alliances since 1985 according to product types. From this table, the most obvious change in the 1991 data from the previous year's results was in the trend of multiproduct alliances, where the partnerships cover more than one product or technology. It would appear that companies have been much more focused in the specifications of their alliance agreements in 1991.

It is now common for individual companies to have several concurrent agreements in progress with different partners; therefore, we can only infer that the potential gains of maintaining a diverse set of partnerships outweigh the potential conflicts that might be expected from these types of parallel arrangements. From a purely quantitative perspective, more alliance agreements could imply a gain of mileage from a company's intellectual property assets, via such mechanisms as patent portfolio licensing exchanges, as well as a maximization of capital or research and development investment risk diversification. Alternatively, a dip in multiproduct alliances could be partially due to depletion of the number of companies large enough to support these broader agreements.

RISC Business

In the microprocessor arena, much attention has been focused on the growing market competition between complex-instruction-set computing (CISC) and reduced-instruction-set computing (RISC) designs. Although it is generally accepted that RISC architectures possess a fundamental advantage in yielding a greater microprocessor performance-to-cost ratio, RISC-based systems have yet to penetrate the large-volume nontechnical PC markets established by CISC architectures. Nevertheless, of the 8.5 million 32-bit microprocessor units sold worldwide in 1990, 15.8 percent were based on a RISC design. Furthermore, Dataquest projects that the RISC chip share will exceed one-half of the worldwide 32-bit microprocessor market by 1995. This anticipated market share growth is stimulating a surge in RISC design licensing and technology-exchange agreements.

Besides the traditional motives for entering into alliance agreements, microprocessor designers perceive alliances and open licensing as useful vehicles for establishing a dominant or major hardware standard; the reward is that such standards are known to drive software development, which in turn would further proliferate the hardware standard. Several RISC chip designs from various U.S. vendors are in contention to establish their architecture as a workstation standard. The current workstation market leader—Sun Microsystems—established the SPARC International group early on to promote its own SPARC MPU design as the first virtually open RISC standard. The Advanced Computing Environment (ACE) group, lead by such traditional PC vendors as Compaq Computer Corporation and Microsoft Corporation, followed Sun's example by endorsing MIPS Computer's RISC design as perhaps the next most open platform, which allowed wide accessibility to both chip

Table 1
Japanese Semiconductor Alliances by Product Type

	1985	1986	1987	1988	1989	1990	1991*
Multiproducts	4	14	3	2	9	11	3
Memory	10	11	22	9	24	16	14
Microcomponents	17	11	15	7	13	10	10
ASICs	8	17	16	7	10	8	9
Other Devices	11	15	23	9	14	23	20
CAD Tools	1	3	8	2	14	7	3
Equipment	11	12	22	3	17	10	9
Materials	6	10	8	4	1	3	3
Others	0	0	0	2	5	0	3
Total	68	93	117	45	107	88	74

*As of September 30, 1991
Source: Dataquest (December 1991)

foundries and system builders alike to implement the MIPS design in their own applications.

In response to the momentum gained by the SPARC and MIPS camps, several RISC platforms made strides toward less proprietary schemes through licensing and/or joint venture agreements. Apple Computer Inc., IBM Corporation, and Motorola Incorporated have allied themselves in an effort to further the cause of IBM's internal RISC architecture, which, rumor has it, possibly will be available for licensing from IBM or for purchase as a commodity chip from Motorola. Finally, both Digital Equipment Corporation and Hewlett-Packard Company (HP) are attempting to promote their own RISC architectures by licensing their designs.

Table 2 summarizes RISC-related Japanese semiconductor alliances that were established during the past four years since 1987. Dataquest classifies strategic alliances into the following major categories used in Tables 2 and 3:

- LA—Licensing agreement
- SS—Second-source agreement
- SA—Sales agency agreement
- FA—Fab agreement
- AT—Assembly and testing agreement
- TE—Technology exchange
- JV—Joint venture
- JD—Joint development
- IV—Investment
- CO—Coordination of standard
- PC—Procurement agreement
- OT—Other

Table 2
RISC-Related Japanese Semiconductor Alliances

Agmt. Date	Company 1	Company 2	Agmt. Type	Comment
7/87	Fujitsu	Sun Microsystems	LA, FA, JD	SPARC RISC
10/87	Kubota	MIPS Computer	LA, FA, IV	MIPS RISC MPUs
2/88	Sanyo	VLSI Technology	LA, SA, FA	ACORN RISC chip and peripheral chip set
6/88	Fujitsu	Mizer/Wind River Systems	JD	Peripheral chip set for SPARC RISC
9/88	Matsushita	Sun Microsystems	LA	SPARC RISC for Solbourne workstation
10/88	Seiko Instruments	Sun Microsystems	LA	SPARC chip for own workstation
2/89	NEC	MIPS Computer	LA, PA	MIPS RISC MPUs
2/89	Dia Semicon	Integrated Device Technology	SA	IDT RISC MPUs
2/89	Fuji Xerox	Sun Microsystems	JV	CAD workstation software based on UNIX
3/89	Fujitsu	VIA Technology	IV	Peripheral ICs for SPARC CPU
3/89	Sony	MIPS Computer	LA, FA	MIPS RISC for NEWS workstation
4/89	Fujitsu	Sun Microsystems	LA, FA	Produce and supply SPARC RISC chips
7/89	Hitachi	Hewlett-Packard	LA, FA	PA RISC chips for workstation
7/89	Toshiba	Sun Microsystems	LA, FA	SPARC RISC chips
11/89	NEC	Four companies	CO	Standardize specifications for MIPS MPUs
12/89	ASCII/Signetics	Tera Microsystems	IV	RISC ICs for workstation
2/90	Toshiba	MIPS Computer	LA	MIPS R4000 RISC
4/90	Kobe Steel	Megatest	SA	Testers for RISC MPUs
6/90	Hitachi	Hewlett-Packard	LA, FA	Expansion of 1989 agreement
9/90	Oki/Others	Intel	LA, CO	Alliance for Intel 860i RISC MPU
9/90	Mitsubishi Corp.	VIA Technology	IV	RISC MPU peripheral chip set
1/91	Toshiba	MIPS Computer	LA, FA	Merchant MIPS RISC market
7/91	Fujitsu	Tera Microsystems	FA	Peripheral chip set for SPARC RISC
8/91	Fujitsu (FMI)	Sun Microsystems	LA	SPARC RISC and "GX" graphics chips
8/91	Mitsubishi Corp.	Tera Microsystems	SA, IV	Peripheral chip set for SPARC RISC
8/91	Fujitsu	HaL Computer	IV	Proprietary version of SPARC
9/91	NKK	Integrated Device Technology	FA, JD	MIPS R3051 controller
9/91	Oki	Hewlett-Packard	LA, FA	HP "PA-RISC" chip
10/91	Toshiba/Siemens	Integrated Device Technology	SA, JD	IDT RISC MPUs
11/91	Toshiba	Siemens	FA, JD	MIPS RISC MPUs and peripheral chips

Source: Dataquest (December 1991)

Table 3
HDTV-Related Semiconductor Alliances

Agmt. Date	Japanese Company	Foreign Partner	Agmt. Type	Comment
8/89	NHK	Texas Instruments	LA	The first U.S. company received MUSE technology
2/90	NHK	Samsung/Goldstar	LA	Companies plan to compete with Japanese manufacturers
5/90	NHK	LSI Logic	JD	With Japanese appliance companies
12/90	Toshiba	Motorola	JD	Codevelop MUSE decoder
7/91	Sanyo	LSI Logic	JD	Codesign high-powered HDTV chip set
8/91	Fujitsu/Hitachi/Sony	Texas Instruments	JD	Develop MUSE decoder by spring 1992
10/91	NHK/Oki/Matsushita El./ Dainippon Printing		JD	Plasma display for HDTV
11/91	Matsushita/NEC/Sharp/ Mitsubishi/Pioneer/JVC/ Matsushita El./NEC HE	LSI Logic/VLSI Technology	JD	Jointly develop MUSE decoder Allocate development cost and risk

Source: Dataquest (December 1991)

Sun Microsystems has found allies in Fujitsu Ltd., Matsushita Electric Industrial Company Ltd., and Seiko Instruments, while the MIPS architecture is now supported by both NEC Corporation and Sony Corporation. As an indication of how truly open or nonexclusive the SPARC and MIPS architectures appear to be, we note that Toshiba Corporation has successfully licensed both the SPARC and MIPS designs. Meanwhile, HP has enlisted Hitachi Ltd. and Oki Electric Industries Company Ltd., which itself has a license agreement with Intel Corporation concerning Intel's 860 RISC chip.

As a systems supplier in the fast-growing workstation and PC markets, Hitachi has yet to make an impact in world markets commensurate with its size and potential. Furthermore, from its corporate semiconductor revenue growth rates (see the Dataquest Perspective Vol.1, No.1 article entitled "Hitachi: Diversifying a Sleeping Giant"), Hitachi appears to have failed to capitalize on the worldwide growth in the MOS microprocessor segment of the commodity chip business; the company may have been excluded from this business partly because of the current dominance of proprietary CISC-based microprocessors. Another possible explanation is that Hitachi would, as a vertically integrated player, prefer to manufacture microprocessors primarily for internal use in systems manufacturing. Although open RISC architectures, such as the SPARC and MIPS designs, appear to offer the most accessible platforms for foundries and second-source manufacturers to gain commodity microprocessor market share, Hitachi appears to have chosen a more exclusive platform by aligning itself with the Hewlett-Packard Precision Architecture (PA) RISC design. Hitachi's strategy of designing systems around the HP PA RISC would be consistent with the role of a sophisticated supplier of high-end systems and may signify Hitachi's intention to avoid merely participating in the commodity RISC market. By combining its expertise in semiconductor manufacturing of MOS logic, memories, and microprocessors with its established systems-manufacturing capabilities, the workstation and PC products Hitachi develops should prove to be competitive if not ground breaking for a Japanese supplier.

Massively parallel supercomputer architectures currently are gaining acceptance within the supercomputer community. Moreover, RISC chips are quickly becoming the preferred building block used to construct these types of supercomputers. Thinking Machines' use of the SPARC chip in its latest machine, the CM-5, and Intel's use of its own i860/XP RISC chip to build and market its own line of supercomputers are perhaps precursors of a generation of RISC-based supercomputers that could serve as a real catalyst to growth in the RISC chip market. Because many of these RISC-based supercomputers use a version of UNIX and have scalable architectures, the success of these machines could have spill-over benefits to a broad spectrum of machines, ranging from the desktop PC to the supercomputer. Hence, should RISC-based supercomputers become a breakthrough commercial success, Dataquest would anticipate a steep increase in the number of Japanese companies seeking alliance agreements covering both hardware and software with U.S.-based RISC specialists.

HDTV Alliance Progress

High-definition TV (HDTV) is expected to become a $2.5 billion market by the year 2000.

Although only three new alliances specifically pertaining to HDTV development were signed this year, the number and size of the Japanese companies participating in these alliance agreements are significant. As shown in Table 3, most of the projects address the development of decoders under an alliance of Japanese companies with the U.S. companies LSI Logic Corporation, Motorola Incorporated, Texas Instruments, and VLSI Technology Inc.

Dataquest Perspective

The initiation of alliances by Japanese corporations continues to expand and evolve into a sophisticated business methodology. Areas that are likely to see more alliance activity by Japanese companies will be in RISC-associated chip development and technologies related to high-definition displays. Both of these broad categories might include related ASIC development and, in the case of high-definition displays, joint efforts to develop technologies connected to the fabrication processes of flat panel displays.

Dataquest remains convinced that Japanese semiconductor companies have not had any fundamental changes in their attitudes regarding strategic alliances. We expect these companies to continue to use strategic alliances as a means of diversification and expansion. ■

By Junko Matsubara

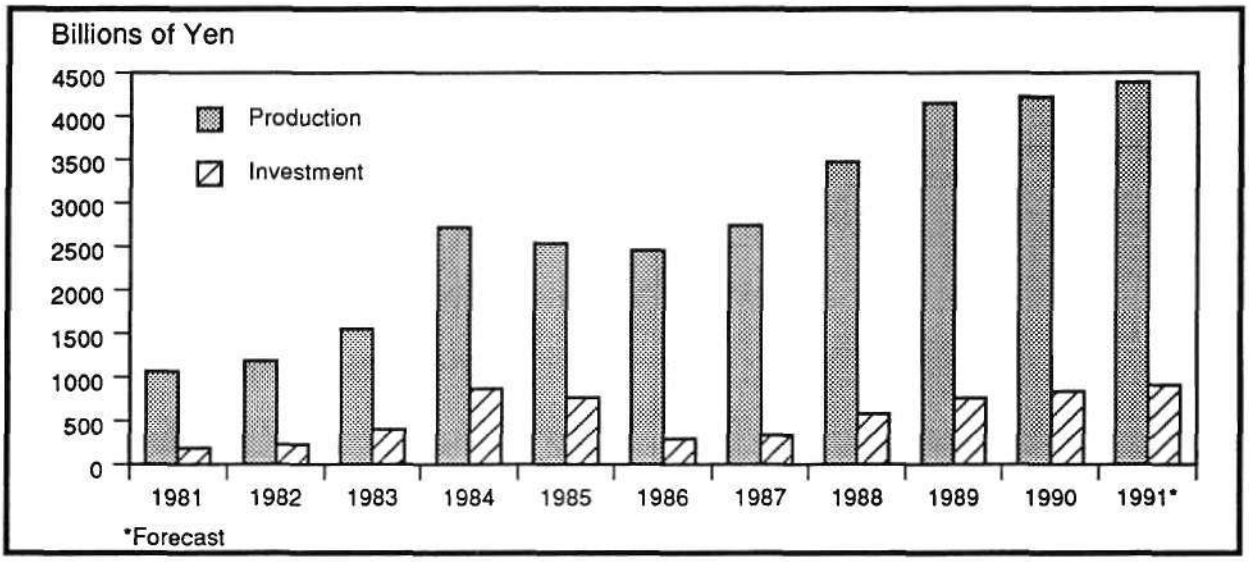
Will Semiconductor Investment Continue to Be Productive in the 1990s?

Productivity of capital investment in the Japanese semiconductor market was favorably high in the early 1980s despite negative impacts of the silicon cycle; then it deteriorated in the latter half. Today, it seems to remain stable within the rapidly growing semiconductor industry. Yet semiconductor investment entails uncertainties that come from the necessity to pursue technological innovation while giving consideration to profitability—an intrinsic nature of this capital-intensive industry.

Trends in Japanese Semiconductor Investment and Its Productivity

From 1981 through 1991, capital investment related to semiconductors and semiconductor production grew at compound annual growth rates (CAGRs) of 17 percent and 15 percent, respectively (see Figure 1). In this period, capital investment grew by 4.9 times and production by 4.1 times, indicating that growth of production does not match that of investment. Total amount of investment in Japan in 1981 almost equals the investment amount of only two companies in 1991. This fact indicates the

Figure 1
Semiconductor Production and Capital Investment in Japan



Source: Dataquest (December 1991)

large investment required to establish volume production capacities of the next-generation devices. Today's semiconductor industry, especially DRAMs, has grown to be truly capital intensive.

Productivity of capital investment can be measured in terms of investment/output ratio and elasticity of investment. The investment/output ratio in the semiconductor industry is expressed by capital investment and semiconductor production on a value basis, which represents the degree of resource input to the semiconductor business. The average investment/output ratio between 1981 and 1990 was 20.2 percent (see Figure 2). This average was exceeded three times: in 1983 when volume production of 64Kb DRAMs was started, in 1984 when 256Kb DRAMs were first mass produced, and in 1985. The ratio reached its bottom at a 12 percent level in 1986 and 1987 when the semiconductor industry was in a depression, indicating a significant decline in semiconductor investment. Between 1986 and 1990, after 1Mb DRAMs went into volume production, the ratio averaged 16.5 percent, reflecting a constant increase. Although the ratio in 1990 was below the five-year average, it represents a significant increase in semiconductor investment in relative terms, according to increasing integration of devices. After 1986, manufacturers invested to establish and then strengthen 1Mb production lines and to develop the next-generation device—the 4Mb DRAM.

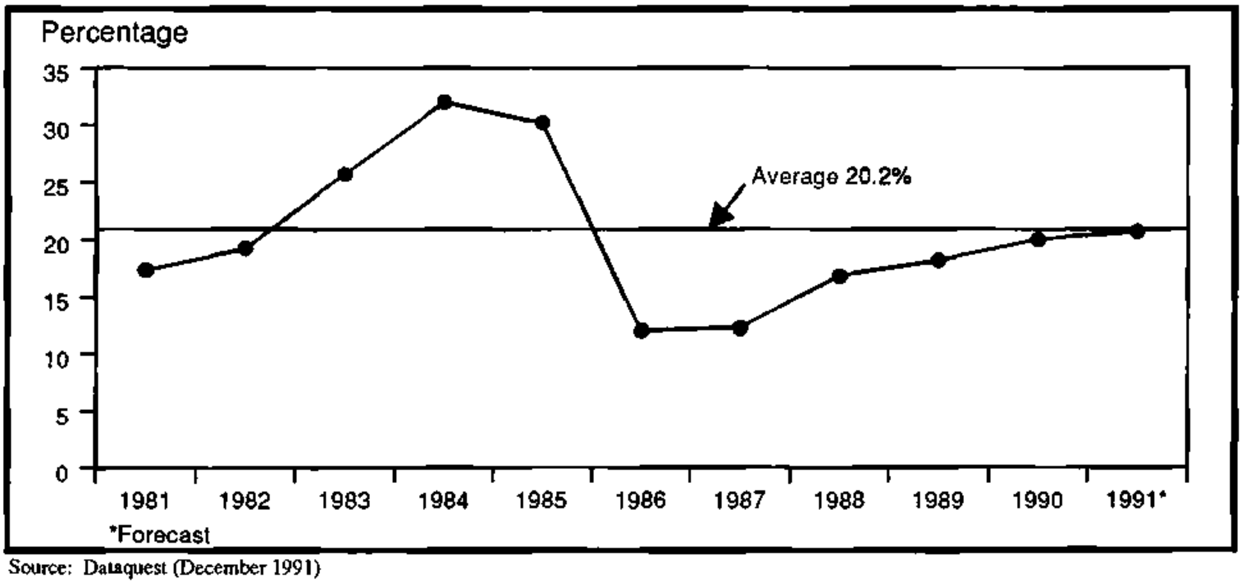
Secondly, elasticity of investment is calculated by dividing an incremental portion of production in each year by the amount of capital investment in the preceding year, serving as one surrogate for return on investment. This measurement reached peak levels in 1984 and 1988—the peak years of silicon cycles (see Figure 3). The highest level was 2.9 in 1984, but the figure rose for three consecutive years, starting in 1982 and 1983. Thus the semiconductor recession that started in the latter part of 1984 was difficult to predict. After 1986, the elasticity peaked at 2.2 in 1988 and declined thereafter. In 1990 and 1991, it showed slight growth of 0.1 to 0.2 points.

Changes in Productivity of Investment by Region

The investment/output ratio for semiconductor makers in major regions was analyzed on the basis of world investment and production data. Note that these figures are based on ownership; that is, overseas production and investment by Japanese makers are added to Japanese data.

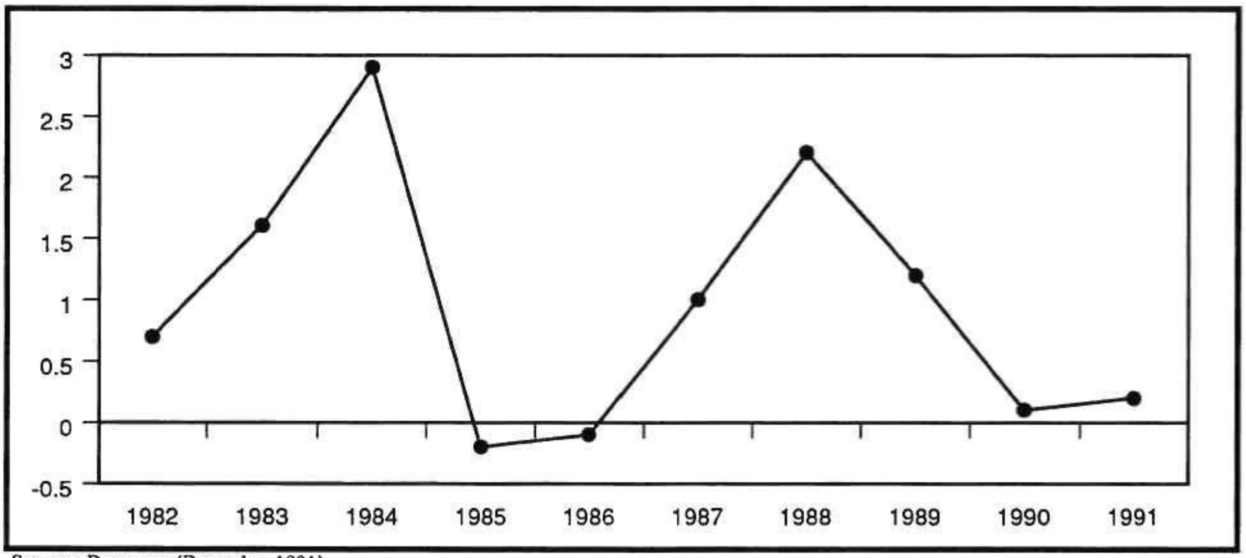
The average worldwide ratio between 1985 and 1990 was 18.5 percent. Japanese manufacturers were closest to the average (18.3 percent), while those in Asia and the rest of world (ROW) region showed the highest figure of 78.4 percent to reflect entry of Korean and Taiwanese makers to the DRAM market. At the

Figure 2
Productivity of Investment in Japan



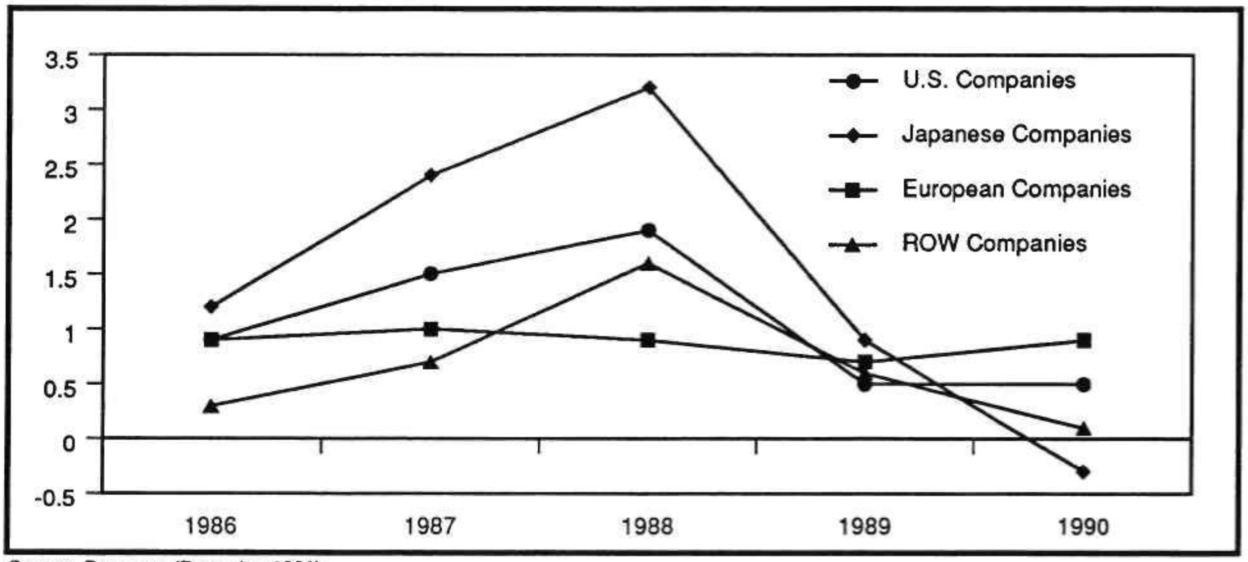
Source: Dataquest (December 1991)

Figure 3
Elasticity of Investment in Japan



Source: Dataquest (December 1991)

Figure 4
Elasticity of Investment (Ownership Base)



Source: Dataquest (December 1991)

same time, output did grow as much as the significant increase in capital investment (including fab construction), resulting in relative low productivity of investment. Japanese companies recorded a higher investment/output ratio than the U.S. and European companies, partly because of relatively large production of memories—DRAMs in particular—to accompany larger investment and partly because of active investment in semiconductor production.

As semiconductor manufacturers are moving toward local production, elasticity of investment in the world markets becomes relevant. Japanese makers have been maintaining their elasticity level higher than the world average (see Figure 4). In 1990, however, it dropped to negative 0.3—below the worldwide average and at the lowest level of the past five years—because of the decrease in production on a value basis in consequence of the 1990 DRAM recession and expansion of overseas production bases. Furthermore, Japanese makers invested heavily in volume production capacities for the next-generation 16Mb DRAMs in response to the sluggish 4Mb DRAM demand. Whatever the causes, Dataquest believes that the negative elasticity figure will affect investment strategies of Japanese semiconductor manufacturers.

Dataquest Perspective

It is clear that productivity of investment in the Japanese semiconductor market reached its peak in 1984 and 1988, coinciding with both silicon cycles. However, productivity deteriorated steadily after 1986 when volume production of 1Mb DRAMs was started, marking a sharp contrast to the trend observed up to 1984. Dataquest expects the investment/output ratio to be 20.7 percent and the elasticity of investment to be 0.2 in 1991. We expect semiconductor production in Japan to grow at an annual 4 percent and investment to increase by 8 percent, leading to an expanded semiconductor market and lower profitability.

At the same time, productivity of investment on an ownership basis suggests that it inevitably will deteriorate if Japanese makers continue their DRAM-oriented production, as evidenced by the negative figure in 1990. In particular, Dataquest believes that it would not be wise for Japanese semiconductor manufacturers, prompted by the slow growth of the 4Mb DRAM market, to rush into the development races for 16Mb DRAMs and 64Mb DRAMs. ■

By Kazunori Hayashi

Product Analysis

The Future of the SRAM Market

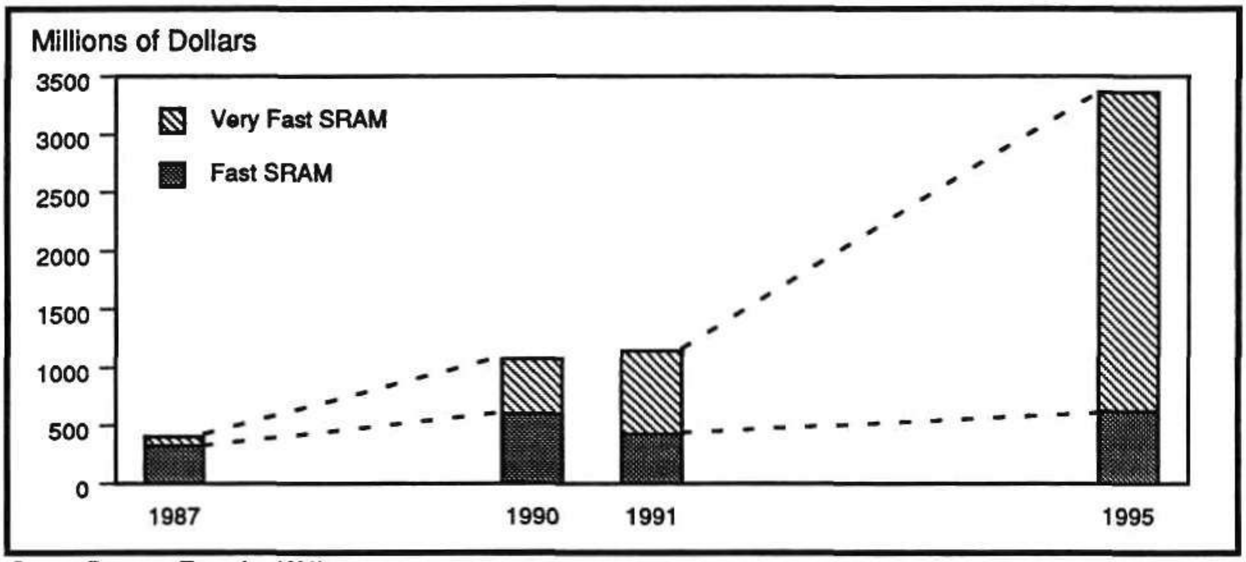
The static RAM (SRAM) market has grown to its current size because of high-speed access and low power consumption, which more than compensated for relatively low density. However, emergence of high-speed DRAMs and flash memories is eroding the traditional competitive edge for slower SRAMs. It is a little easier to enter the SRAM market than the DRAM market because of facility capacity. DRAM requires very advanced technology, and the DRAM business is very risky. The number of SRAM suppliers is larger than that of DRAM suppliers. Therefore, in order to survive in the SRAM market, SRAM suppliers compete with one another through competitive prices. Price erosion is the result.

High-Speed SRAM Market in 1990

Dataquest estimates that the worldwide high-speed SRAM market increased at a compound annual growth rate (CAGR) of 6.4 percent in 1990 to reach approximately $1,076.7 million (see Figure 1). This is healthy and strong growth compared with the negative growth of the MOS memory market, which was down 19.7 percent from the previous year to $12.6 billion. In fact, only high-speed SRAMs (access time of 70ns and faster) and flash memories recorded growth among MOS memory products in 1990 (see Table 1).

High-speed SRAMs are used mainly for cache and main memories of computers. In particular, cache memories use very fast 64Kb to 256Kb SRAMs with access times of 5 to 35ns, and they are becoming increasingly important to govern the entire system performance. The 5ns bipolar SRAMs are generally used in supercomputers and mainframes, while 10 to 35ns versions are used in minicomputers and workstations. Recently, workstations have required 10ns or faster SRAMs because of the increasing use of reduced-instruction-set computing (RISC) CPUs. Similarly, more and more PCs use cache memories to consume 25 to 35ns 64Kb and 256Kb SRAMs. Applications are further extended to caches for external storage (on disk), which requires low power consumption because of battery backup in addition to fast access time. Cache memories for workstations and PCs often use multibit SRAMs to minimize the address space, whereas main memories of

Figure 1
Worldwide Fast SRAM Forecast



Source: Dataquest (December 1991)

Table 1
Worldwide MOS Memory Market (Millions of Dollars)

Device	1989	1990	Growth Rate (%) 1989-1990
DRAM	8,968	6,830	-23.8
SRAM (>70ns)	2,364	1,745	-26.2
SRAM (≤70ns)	1,008	1,076	6.7
EPROM	1,808	1,446	-20.0
ROM	1,221	1,157	-5.2
EEPROM	318	314	-1.3
Flash	11	35	218.2
Total	15,698	12,603	-19.7

Source: Dataquest (December 1991)

supercomputers consume a large amount of ×1 or ×4 versions with large capacities.

High-Speed SRAM Market Trends

Recently, high-speed SRAM demand has been growing rapidly for use as cache memories for 33-MHz or faster complex-instruction-set computing (CISC) and RISC MPUs. On the other hand, profitability has deteriorated recently because of competitive pricing by a large number of vendors. The 33-MHz 386, 486, and RISC MPUs are designed to use the cache system, and 256Kb SRAMs used for 33-MHz SPARC and R3000 require access times of 30ns or faster. In particular, R3000 demands SRAMs with access times of twice the frequency—15ns or faster. Demand for high-speed SRAMs also comes from emerging microprocessor units (MPUs) with clock frequency of 50 MHz or higher. These facts point to rapid expansion of demand for SRAMs with very high speeds. In fact, these SRAMs have boosted their share of the high-speed SRAM market from 20 percent in 1987 to 44 percent in 1990; their share is expected to grow to 62 percent in 1991 and then over 80 percent in 1995. Nevertheless, there are some hurdles to be cleared before these goals are attained. First, delay due to external standard logic ICs would affect system performance significantly in the high-speed operating environment at the 50-MHz level. One solution to improve performance is to integrate logic circuits into SRAMs to reduce delay by 2ns to 3ns, which is then allocated to memories. In practice, some SRAM systems incorporate the address latch circuit between MPU and memories. This solution is designed to implement application-specific memories optimized for different types of microprocessors. For instance, Motorola Incorporated and NEC Corporation are marketing cache memories dedicated to R3000, SPARC, or i386. Customized SRAMs offer large bit width, integrating the address latch circuit and other functions to reduce chip count for cache system compared with general-purpose high-speed SRAMs. Availability is a major problem, however, necessitating the securing of second sources.

Another problem is that the price remains at a relatively high level because of the small number of suppliers. To secure a stable supply, some U.S. MPU manufacturers are looking for Japanese SRAM makers—a seemingly mutually beneficial deal.

Although an attempt is being made to incorporate cache into MPUs, it is not technologically feasible in the short run to integrate the second cache into a single chip, partly because of chip size. Instead, the multichip module is receiving increasing attention as a solution to avoid delay due to external memory and data input/output; by mounting the MPU, cache memories, and other devices on a single module, wiring impedance can be minimized and operating frequency in the module can be increased. On the other hand, even the SRAM with transistor-transistor logic (TTL)-level interface requires 10ns access time or less. To achieve such high speed, while dealing with an accompanying noise problem, the upgrading from TTL-level to emitter-coupled logic (ECL)-level interface is required. For this purpose, the BiCMOS process must be suitable for both TTL and ECL levels and there must be commercialization of the 3.3V system, which allows speed to increase while maintaining compatibility with TTL. The ECL process is also a potential solution for implementation of high-speed versions, but high cost and power consumption are likely to limit its application to some very high speed products. Finally, improvement is expected in packaging; compared with the conventional package in which the power source and GND pins are arranged at the corners, very high speed SRAMs will have them at the center of the package in order to minimize impedance in lead frame.

Dataquest Perspective

As the increase in processing speed of MPUs leads to the increase in operating speed of workstations and PCs, Dataquest expects cache memories to play an increasingly important role. While the high-speed SRAM market is encroached upon by high-speed DRAMs and the slow SRAM market faces a threat from flash memories, we expect very high speed SRAMs to become a growth center in the SRAM market. Clearly, high speed as well as low power consumption are keys to the future prosperity of the SRAM market. At the same time, Dataquest sees that SRAM manufacturers must survive through development of cache memories optimized for different MPUs—jointly with capable microprocessor makers—to build up a reliable supply capability. In this sense, the SRAM market is about to enter an industry-wide restructuring period characterized by strategic alliances. ■

By Akira Minamikawa

In Future Issues

The following topics will be addressed in future issues of Semiconductors Japan *Dataquest Perspective:*

- Preliminary 1991 Japanese semiconductor market shares
- DRAM demand trends

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Dataquest Perspective

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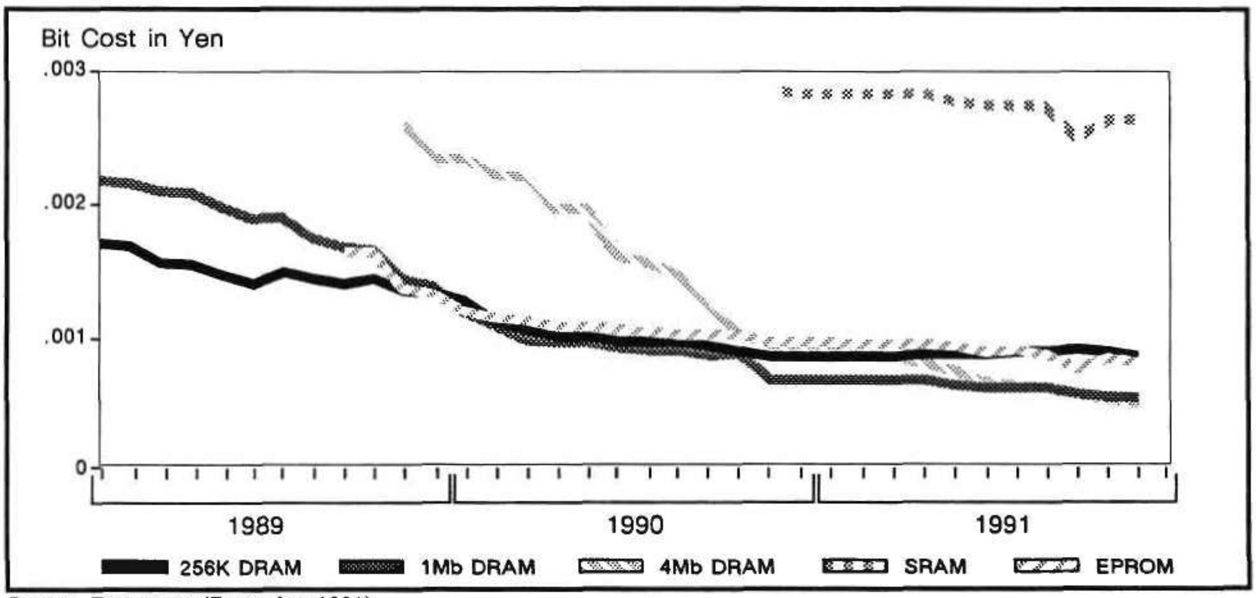
Regional Pricing Update

DQ Monday Report: Volume Mean Pricing

Family	United States	Japan	Europe	Taiwan	Hong Kong	Korea
DRAM 1Mbx1-8	3.93	4.14	3.90	4.40	4.30	3.80
DRAM 256Kx1-8	1.73	1.69	1.70	1.43	1.45	1.10
DRAM 4Mbx1-8	14.38	15.33	16.10	17.78	17.70	14.00
EPROM 1Mb, 170ns	3.90	4.64	3.60	4.75	3.90	3.80
EPROM 2Mb, 170ns	7.78	10.16	7.10	8.65	7.90	7.00
SRAM 1Mb, 128K×8	14.38	15.14	13.40	17.10	17.80	NA
SRAM 256K, 32K×8	4.08	4.18	3.70	4.25	4.10	3.30
SRAM 64K, 8K×8	2.13	1.58	1.90	1.60	1.40	1.20
68020-16	32.00	49.63	29.00	47.25	46.50	NA
80286-16	12.18	13.80	12.00	11.50	12.65	12.70
80386DX-25	147.50	172.48	160.00	189.00	185.00	NA
80386SX-16	50.00	65.16	55.00	58.50	60.50	55.00
R3000-25	127.00	147.57	132.00	NA	NA	NA

Note: These figures correspond with the *DQ Monday Report* dated November 18, 1991, and reflect prices in U.S. dollars.
NA = Not available
Source: Dataquest (December 1991)

Memory Bit Price in Japan



Source: Dataquest (December 1991)

Market Analysis

Japanese Semiconductor Market Forecast: 1992—Another Peak in the Silicon Cycle?

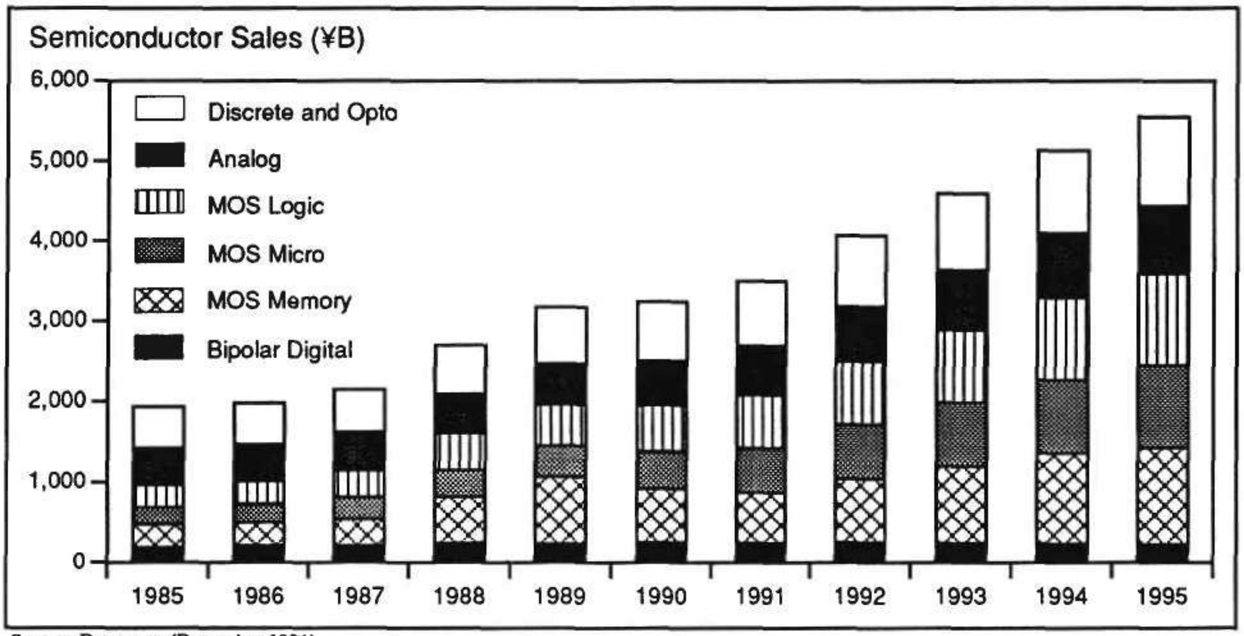
Today, the Japanese semiconductor market is slow because of sluggishness in 4Mb DRAM demand, which would otherwise have driven strong growth. Dataquest predicts that MOS memories in the Japanese market will record negative growth of 5.7 percent in 1991 compared with 1990. Clearly, sluggishness of the MOS memory market is not temporal; rather it appears to be a sign of structural changes in the entire semiconductor market. Against the background of such industry-wide changes, the following sections analyze the future outlook for 4Mb DRAM demand and the silicon cycle, which is expected to reach its peak in 1992 (see Figure 1).

4Mb DRAMs: How Leading Makers Are Responding

At present, 4Mb DRAMs are the focus of attention in the semiconductor industry. Prices of 4Mb DRAMs plummeted from a level of ¥4,000 at the beginning of this year to ¥2,200 by the end of September, less than four times that of 1Mb DRAMs, to create price competitiveness on a per-bit basis. According to the conventional wisdom, we were supposed to see the full blossoming of 4Mb DRAM demand. However, sluggishness in the U.S. PC industry has put off such expectations (see Figure 2), forcing Japanese DRAM makers to adjust their original production plans downward toward the year end. This adjustment is reflected in the outlook for performance of major semiconductor/computer manufacturers in the fiscal year ending in March 1992. Hitachi and Toshiba announced about a 20 percent drop in earnings, and Fujitsu and Mitsubishi Electric revealed double-digit decline. And erosion of 4Mb prices, resulting in deterioration of profitability in the semiconductor business, is said to be blamed.

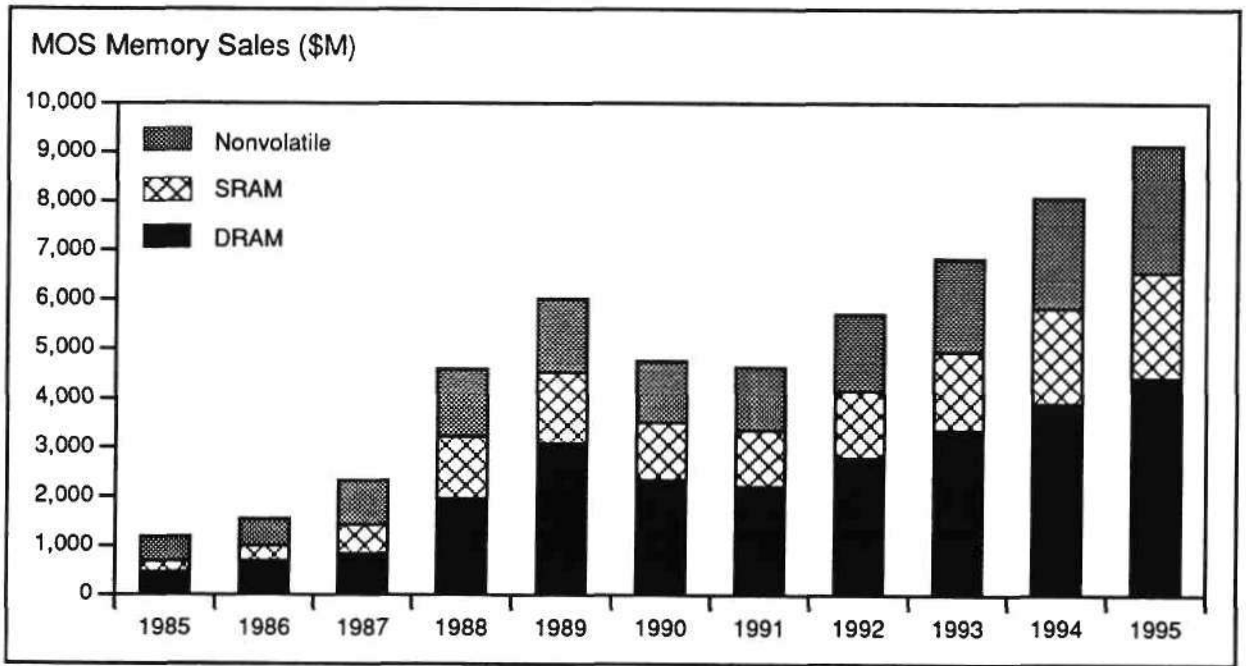
Is 4Mb DRAM demand really sluggish? Comparing 4Mb production trends over the past two and a half years since the start of volume production with trends of its predecessors—1Mb and 256Kb—over the same duration showed a similar growth rate up to the eighth quarter (Q8), indicating that the 4Mb does not break from tradition (see Figure 3). However, including forecasts up to Q9 and Q10 (late 1991), the 4Mb does not show as much momentum as 1Mb or 256Kb DRAMs.

Figure 1
Japanese Semiconductor Forecast



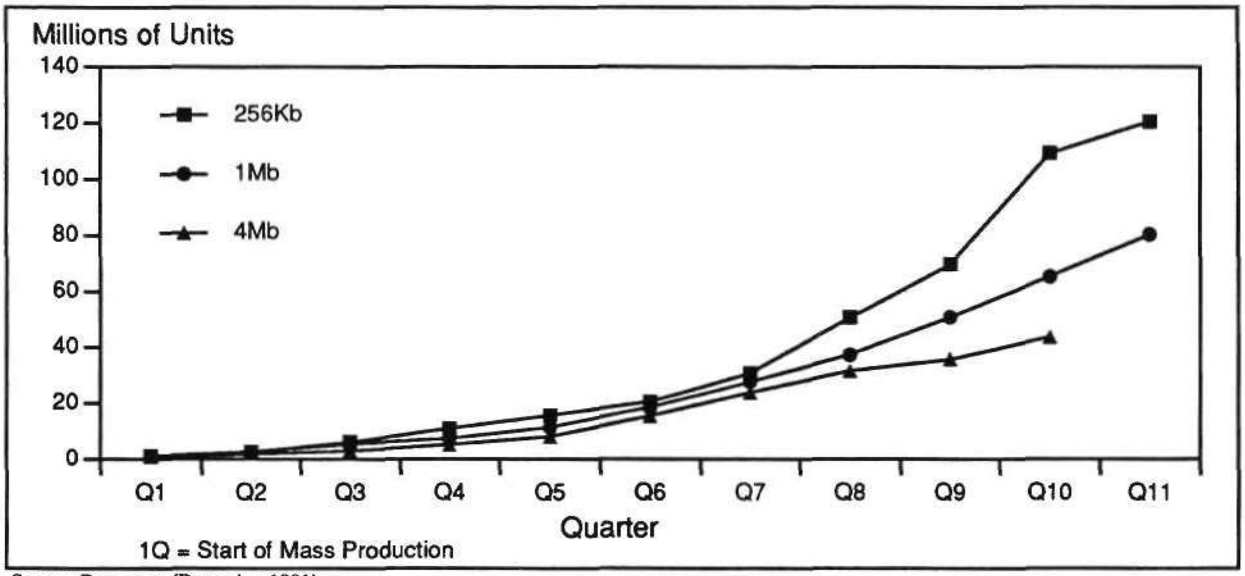
Source: Dataquest (December 1991)

Figure 2
Japanese MOS Memory Forecast



Source: Dataquest (December 1991)

Figure 3
Japanese DRAM Vendor Production Trend



Source: Dataquest (December 1991)

As of September 1991, 4Mb DRAM production by leading Japanese makers totaled 14 million units per month; Hitachi produced 3.5 million; Toshiba, 3 million; NEC, 2.5 million; and Fujitsu, 2.3 million. On the other hand, in mid-1988 when 1Mb DRAM production reached the same level, Toshiba produced 4.8 million units; NEC, 2 million; Fujitsu, 1.4 million; and Hitachi, 1.3 million. In the 1Mb DRAM market, Toshiba took a lead to leave other makers far behind, resulting in serious shortage. In reaction to past experience, all manufacturers were quick to boost 4Mb production, leading to oversupply. This effect is seen clearly in the bit price crossover between generations; it took three years and eight months for per-bit 1Mb prices to fall below 256Kb prices, but only two years for 4Mb to do so.

In the DRAM marketplace, a new generation appears every three years. If a new generation of DRAMs is to grow at the same pace as the previous generation, it requires annual 58.7 percent growth in terms of bit growth—measurement of the absolute growth of DRAM demand. Worldwide shipments of 4Mb DRAMs will total approximately 160 million units in 1991, according to Dataquest's forecast. The 1Mb reached the same level in early 1988, and the 256Kb reached it in 1984. In terms of bit growth, annual DRAM shipments surged 88 percent in 1988 and 134 percent in 1984. These years were peak years in the silicon cycles. On the other hand, recent bit growth has been below 58.7 percent, although showing upward trends; it increased by 47 percent in 1989, 49 percent in 1990, and an estimated 52 percent in 1991. This bit growth resulted in slower growth of DRAM demand to delay the peak of volume shipments to every four years, while a new generation still comes out every three years.

However, major DRAM makers have invested more than ¥50 billion in 4Mb production, and they deserve to expect returns. Nevertheless, Dataquest's forecast shows that unit growth of 4Mb DRAMs from late 1991 to 1992 will be below that of 1Mb and 256Kb DRAMs during similar periods, and the price situation will be not as favorable as 1Mb. Dataquest expects the Japanese MOS memory market to record a 5.7 percent decrease from the previous year, largely because of price erosion caused by the increase in production capacity over demand growth. With regard to product, 1Mb DRAMs appear to drag the 1991 growth on a value basis, as a result of unit volumes exceeding 4Mb.

1991 Forecasting

Between January and June 1991, total semiconductor shipments to the Japanese market on a value basis grew 4.9 percent from the same period in 1990. Strong growth was seen in microcontrollers and MOS logic, increasing 21.5 percent and 10.5 percent, respectively, followed by analog (9.4 percent) and optoelectronics (13.5 percent). In contrast, MOS memories recorded negative growth of 11.1 percent. Production of electronic equipment during the same period grew 5.2 percent. Consumer electronics and communications equipment showed strong growth, posting 9.4 percent and 7.2 percent, respectively. On the other hand, computers and peripherals slowed down to a 5.2 percent increase. In particular, PCs—a major memory use—showed a meager 4 percent growth. Notable trends in electronic equipment are the high growth of products that successfully use highly integrated semiconductors for enhanced features appealing to consumers, as seen in video cameras (37.3 percent), large-screen TVs capable of receiving broadcasting-via-satellite programs (10.5 percent), and mobile cellular phones (119.5 percent). Contrary to a general impression from the sluggish MOS memory market, the Japanese semiconductor and electronic equipment markets are continuing to have stable growth fueled by microcontrollers, MOS logic, and analog devices, which are less susceptible to price fluctuation. Although there are ominous clouds over the future of the Japanese economy, as seen in spending cutbacks by industries and consumers, We expect the Japanese semiconductor market to record annual 8 percent growth for 1991, despite a slowdown in the second quarter.

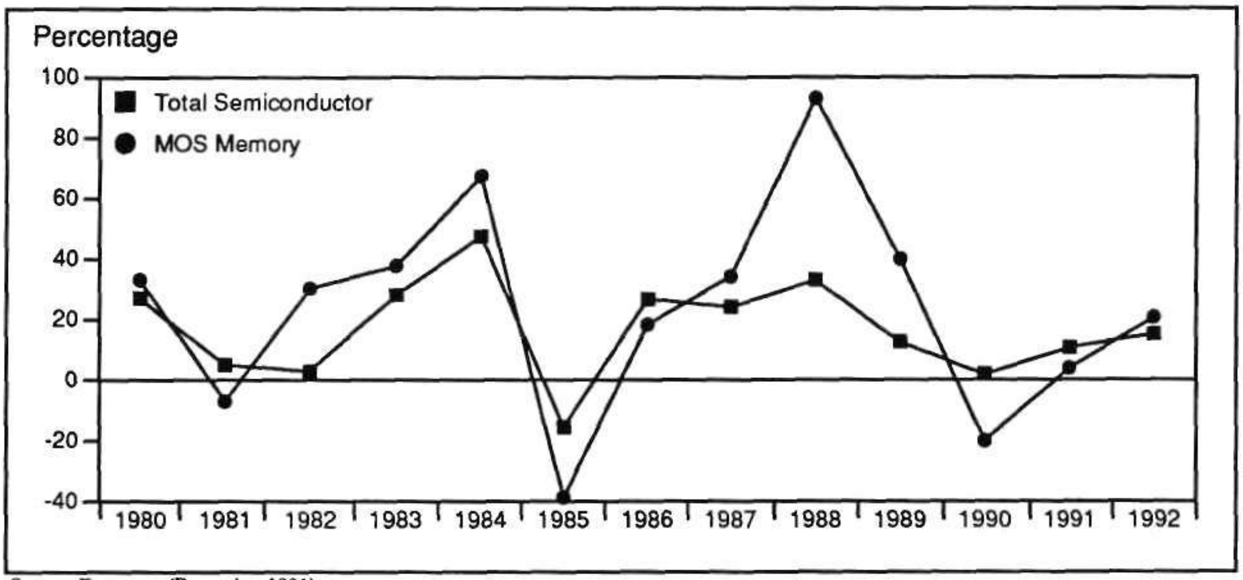
Peak Year in the Silicon Cycle

The silicon cycle is said to occur in response to a shift in generations of semiconductor devices that takes place every three to four years as a result of cyclical electronic equipment demand and advancement in semiconductor technology, changes in semiconductor supply and demand balance, and the resulting price changes. In the previous silicon cycle, the total semiconductor demand grew 12.5 percent in the peak year of 1988, while MOS memories jumped approximately 39.9 percent. Semiconductor sales bottomed out in 1990, when the total sales managed to grow 1.8 percent and MOS memories recorded negative growth of 20 percent (see Figure 4). The magnitude of a silicon cycle is governed by changes in growth of the total semiconductor market, with its amplitude being accelerated by fluctuation in the MOS memory market. Thus, if MOS memories are excluded, the silicon cycle shows gentle growth patterns.

Dataquest classifies semiconductor applications into six categories. Among these categories, the largest user is data processing systems, accounting for 48.7 percent of all semiconductor demand. EDP market represented 74.7 percent of total MOS memory consumption in this segment.

In 1990, worldwide shipments of personal computers reached 23.99 million units, amounting to

Figure 4
Worldwide Semiconductor Market Annual Growth



Source: Dataquest (December 1991)

$49,864 million. This accounted for 47.0 percent of total computer shipments on a value basis and 94.4 percent on a unit basis. This made PCs the largest user of MOS memories, 70 percent of the total consumed in the computer segment. Thus, the silicon cycle is governed by the MOS memory market, which is in turn governed by the PC market. As shown in Figures 5 and 6, yearly changes in unit shipments of PCs since 1983 and annual growth rates—particularly the growth rate curve—form patterns similar to the silicon cycle.

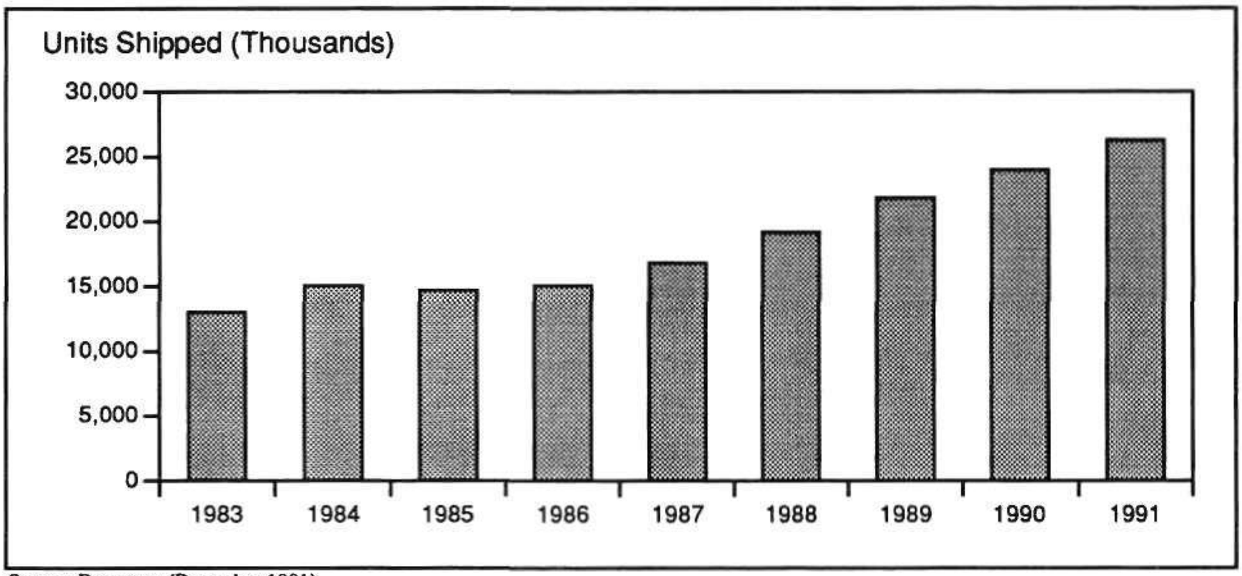
Maturing PC Market

Just as the MOS memory market is affected by the PC market, so can the future silicon cycle be projected from the future outlook for the PC market. In essence, Dataquest believes that the PC market—a major driver for the semiconductor market—will lose its previous momentum because of limitations in market saturation, technological advancement, and software.

PCs made their debut in the late 1970s and have been adopted quickly by business and individuals. In the 1990s, however, the seemingly nonstop growing PC market appears to face saturation. Up to 1991, 83,460,000 units of PCs had been shipped to the U.S. market and 14,530,000 units to the Japanese market. The United States has a population of about 248.2 million people, with a working population of approximately 118.5 million. Japan's population totaled 123.6 million, of which 63.3 million were working. Combining these figures, the percentage of the population owning PCs was 34 percent in the United States and 12 percent in Japan; for the working populations, it was 70 percent and 23 percent, respectively. Although these figures need to be adjusted downward because the total shipments include PCs that are out of service, they clearly show that the PC market—which seemed to offer endless growth potential—has faced the inevitable issue of market saturation, as experienced by automobiles and household appliances, and now has to depend more on renewal demand than on new purchasers.

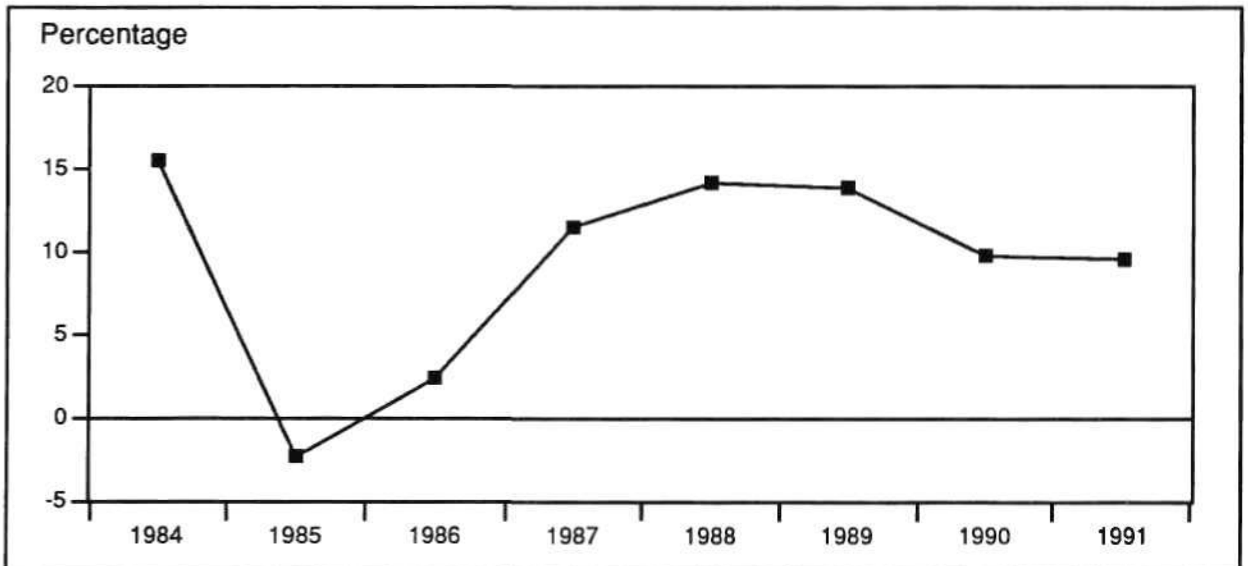
The PC and MOS memory demands culminated twice in 1983/1984 and in 1987/1989. In the former, shipments of 8086 and 68000 microprocessors started to accelerate a shift from 8-bit to 16-bit PCs. In the latter boom, 80286, 80386, 68020, and 68030 microprocessors were increasingly used on PCs to promote the upgrading from 16-bit to 32-bit machines. If the future PC market has to rely on such upgrading, the question is whether significant technological advancement will occur to offer PCs attractive enough for users to discard old ones. The answer is negative. The general-application programs, other than processing of

Figure 5
Worldwide PC Shipments



Source: Dataquest (December 1991)

Figure 6
Worldwide PC Shipment Growth



Source: Dataquest (December 1991)

image and voice data, will not require the 64-bit word instruction in the years to come; thus, it is not likely that 64-bit PCs will be widely used.

Note that, although the 2GB memory area became usable in 1985 when 80386 shipments started, its actual use had to wait until 1990 when MS Windows was commercially available. Likewise, 16-bit PCs are principally used for word processing, tabulation, and databases since the early 1980s; these roles remain unchanged in 32-bit PCs, which are increasingly used in the 1990s. The reality is that software does not make such rapid advancement as hardware, and, without evolution of software, existing PC users are not attracted to new models. Therefore, the memory demand does not grow much. So the question is: Will a market that consumes memories in large quantities—emulating or exceeding PCs—emerge by 1995? Unfortunately, even such a fast-growing market as workstations, expected to reach 2.2 million units by 1995, will account for only 5.4 percent of the PC market. And considering larger chip counts, workstations will consume only 27 percent of memories used by PCs. Thus, Dataquest sees no prospect for a major memory demand alternative to PCs.

Dataquest Perspective

Dataquest forecasts that the semiconductor market will enter the next peak in 1992 and 1993, fueled by growth of the world economy. However, MOS memories will not be able to enjoy past booms, with bit growth remaining at around 60 percent, to form a mild peak for the entire industry compared with previous silicon cycles.

In 1990, the worldwide electronic equipment market reached $613,315 million and the semiconductor market reached $58,225 million. The two markets have been growing at an unprecedented pace by continuously producing new products driven by technological advancement and creating new markets. Now, grown to considerable size and with their products used everywhere, they have lost momentum for rapid growth. As a result, their growth patterns will come close to those of corporate and individual income.

At the same time, the semiconductor industry will face increasing financial burdens from R&D and capital expenditure. According to Dataquest's forecast, the worldwide semiconductor market will grow at a compound annual growth rate (CAGR) of 12.6 percent between 1990 and 1995. During the same period, capital spending by the industry is expected to grow at a 13.7 percent CAGR, exceeding the pace of market growth. By 1995, the worldwide semiconductor market will go through a wave of global-scale alliances, mergers, acquisitions, and restructuring, as seen in alliances between SEMATECH and JESSI today. This wave will hit MOS memory makers particularly hard in the form of major structural changes. ■

By Susumu Kurama

Product Analysis

Japanese Facsimile Market Outlook: Both Waves of Digital and Personal

Facsimile equipment with transmission and receiving technology was developed originally by a U.S. manufacturer. At that time, however, telex was widely used in the United States, and little interest was created in facsimile. Japan, in contrast, was quick to adopt this new machine. As Japanese makers devoted resources to development of new technologies, they soon came up with products that were better than the U.S. and European manufacturers' in performance, quality, and price. Later, the speeding up of transmission time by facsimiles to emulate telex machines enabled Japanese makers to establish a dominant position in the world market by supplying foreign makers on an OEM basis. Finally, adoption of Japanese facsimiles as worldwide standards under recommendation of the International Telephone and Telegraph Consultative Committee (CCITT) has worked as a major impetus for further growth of exports.

Japanese Facsimile Production in 1990

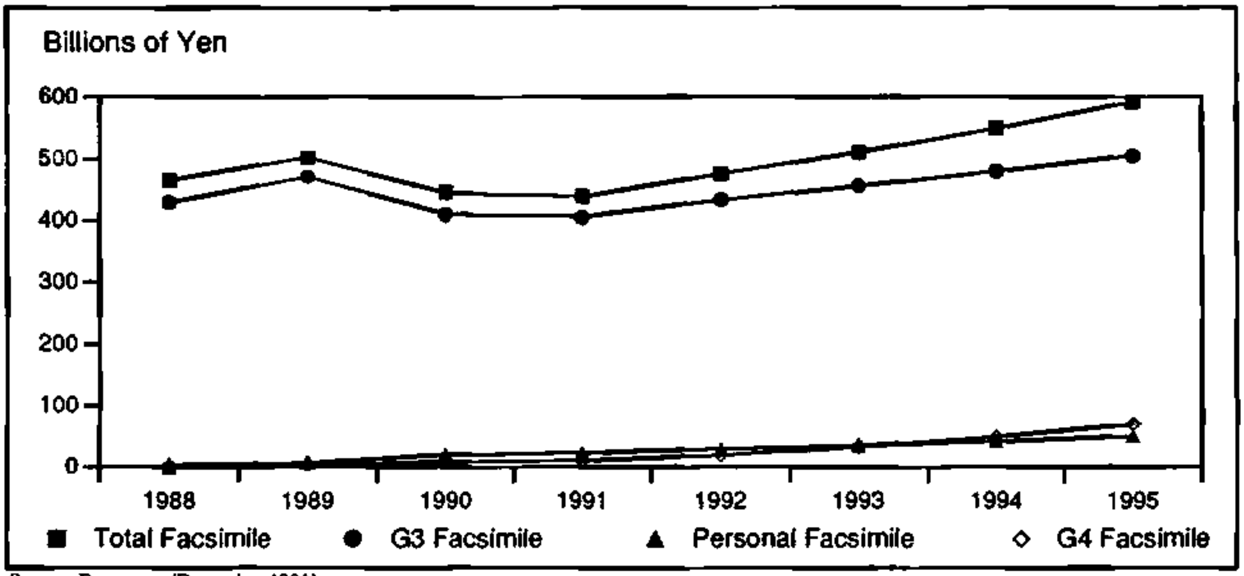
In 1990, 4,350,000 facsimile units were produced in Japan, amounting to ¥445 billion that accounted for 15 percent of the total value of communications equipment production in Japan (see Table 1 and Figure 1). Compared with the previous year, however, production declined by 10.4 percent on a unit basis and 11.3 percent on a value basis. Dataquest believes that this decline is due to the high degree of dependency by Japanese facsimile manufacturers on overseas markets, principally on the U.S. and European markets. In 1990, 81.4 percent of facsimiles produced in Japan were exported. The sluggish U.S. and European demand that occurred in the same year caused rapid inventory increases in these markets, leading to a slowdown in production. In terms of product category, G3 facsimiles represented a major portion of 1990 production while G4 machines hold less than a 2 percent share, or ¥8.2 billion. Production of home facsimile machines amounted to ¥20 billion, a 4.5 percent share, and makers are focusing on them as a promising market segment.

Table 1
Japanese Facsimile Production Forecast—1988-1995
(Thousands of Units)

	1988	1989	1990	1991	1992	1993	1994	1995
Total Facsimile	4,328	4,857	4,350	4,544	4,966	5,336	5,751	6,202
G3 Facsimile	4,166	4,723	4,188	4,356	4,748	5,080	5,431	5,784
Personal Facsimile	NA	146	435	718	1,120	1,568	2,132	2,835
G4 Facsimile	6	4	7	10	24	56	112	202

NA = Not available
Source: Dataquest (December 1991)

Figure 1
Japanese Facsimile Production Forecast—1988-1995



Source: Dataquest (December 1991)

Japanese Facsimile Production Share by Manufacturer

The largest facsimile production maker in 1990 was Matsushita Communication Industry, which accounted for 22.1 percent of the total. It was followed by Ricoh, which started overseas production in 1990; Canon; NEC; and Toshiba (see Figure 2). Manufacturers in the Others category with a combined share of 22.7 percent included Sharp, which boosted its share by personal facsimiles; Hitachi; Mitsubishi Electric; Fuji Xerox; and Oki. Notably, each maker offers a varied product mix. While Ricoh is positioning facsimiles as part of total office equipment strategy, such as integration with copiers, Sharp announced personal-use models equipped with cassette tape memory. Toshiba uses liquid crystal displays (LCDs) to show transmitted messages. All in all, they attempt to establish their market position by offering very original products.

Japanese Facsimile Production Forecast Outlook

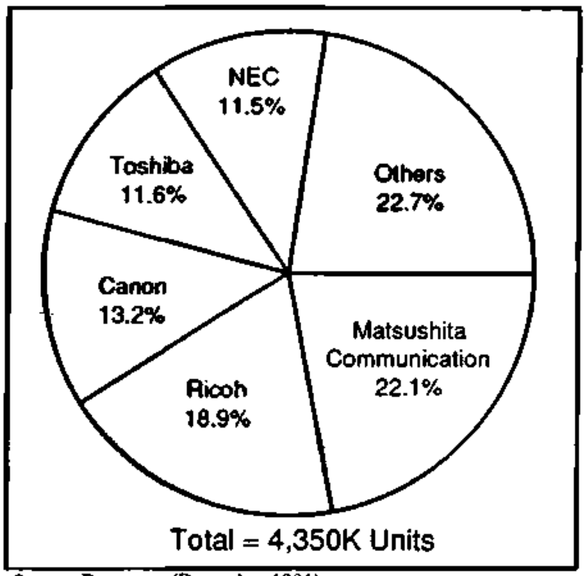
We expect facsimile production in Japan to grow at a compound annual growth rate (CAGR) of 5.8 percent between 1990 and 1995 to the ¥600 billion level. Principal sources of growth are personal facsimiles and quick acceptance of digital communication lines including Integrated Services Digital Network (ISDN).

Personal Facsimile

Personal facsimile is expected to achieve significant production growth in the next five years and to establish its position as the critical personal data processing equipment closely related to daily life. We expect production of home facsimiles to grow to 2,835,000 units in 1995, accounting for 45 percent of total, and to ¥51 billion, holding an 8.6 percent share.

Prerequisites to full spread of personal facsimiles are a price decline and an increase in

Figure 2
Japanese Facsimile Production Share—1990



Source: Dataquest (December 1991)

applications. Two models are already priced below ¥100,000, and increasing competition is likely to drive prices down further. At the same time, communication using facsimiles has improved in recent years; for example, some makers offer various services such as F-Net. At present, services available for G3 facsimiles include printing service for PCs, facsimile broadcasting, facsimile mail, and SIS terminals.

Many of these can be used by individuals, providing opportunities for use as a new individual communications terminal. For PC printers alone, a sizable potential market exists; 500,000 people are estimated to use PC-based communication in 1991. In particular, using facsimile as the SIS terminal offers an advantage in allowing low-cost system configuration compared with use of PCs, requiring high initial costs (both hardware and software) for companies and retail stores—many of which already use facsimile machines. Also, this application is expanding to automatic money transfer and ordering systems as part of point-of-sale terminals and two-way network systems.

G4 Facsimile

The G4 facsimile market, expected to start full-scale acceptance earlier than this, has been slow because of an unfavorable environment (including delay in installation of ISDN lines) that discouraged businesses to purchase the new machine. Thus, Dataquest believes that accelerated installation of public digital lines holds the key to market expansion; once it starts, production of G4 facsimiles will grow steadily. An important factor is the multiplier effect on teleconference systems, digital multifunctional telephones, and digital PBX (developed as major applications of ISDN) and G4 facsimiles (adopted before them). Manufacturers are already promoting G4 machines by incorporating G4 features in G3 machines or by marketing low-cost models.

We expect volume production of G4 facsimiles to start in 1992. G4 facsimile machines will account for 11.8 percent of the 1995 total to reach ¥69.9 billion, surpassing ¥51 billion of personal facsimiles (not on a unit basis), thus growing to a market with good profitability. This is due to availability of applications that can only be implemented by these advantages offered by G4 facsimile machines:

- Super high-speed transmission (three seconds to send A4-size paper) to reduce the cost to one-sixth of that for G3 machines
- Multiple accessibility implemented by combining G3 and G4 features
- Improving delayed autodialing and temporary storage features by using large memories
- Laser beam printing on ordinary paper
- Super-fine mode to achieve resolution eight times that of G3 machines

Other innovative applications are being developed, including facsimile mail service using advanced memory functions and LAN-based use in combination with facsimile servers.

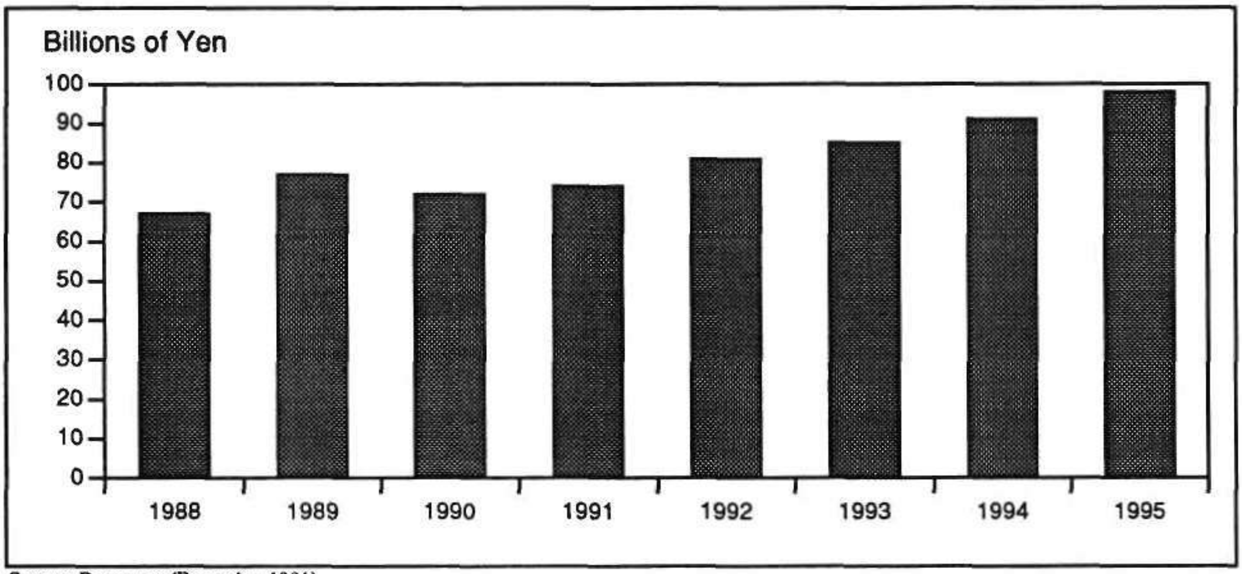
Semiconductor Consumption Trends for Facsimile in Japan

As discussed, we expect the facsimile market to grow on the basis of G4 and personal-use machines and become a major market for semiconductor devices.

Consumption by Type

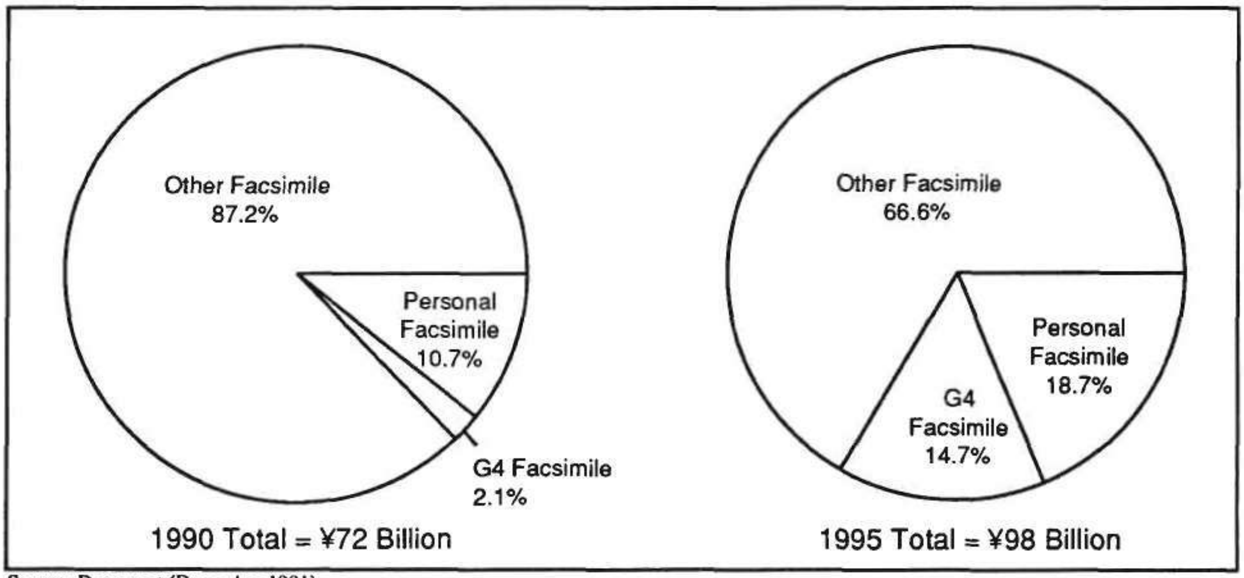
In 1990, semiconductor consumption for facsimiles amounted to ¥72 billion (see Figure 3). Devices for G4 and personal-use facsimiles still accounted for small portions of the total (see Figure 4). Nevertheless, production of personal facsimile machines is expected to grow rapidly between 1992 and 1994; then both personal-use and G4 machines will consume an increasing amount of semiconductor devices in 1995 to become a significant market. While cost reduction of personal facsimiles due to intensive competition is anticipated between 1994 and 1995 to create pressure on device prices, sales

Figure 3
Japanese Semiconductor Consumption Forecast for Facsimile—1988-1995



Source: Dataquest (December 1991)

Figure 4
Japanese Semiconductor Consumption for Facsimile by Type



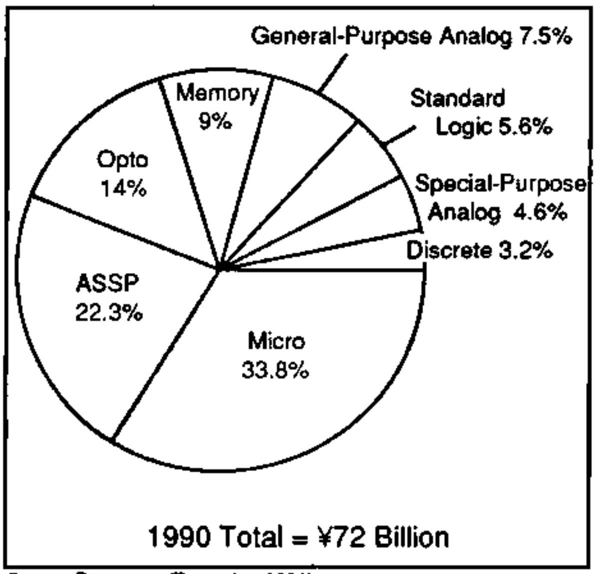
Source: Dataquest (December 1991)

of G4 machines will grow rapidly in the same period, thereby supporting sustainable growth of the device market. We expect the market to represent 33.4 percent of the semiconductor market for facsimiles on a value basis in 1995 by serving the two growing segments.

Consumption by Device

Among semiconductor devices consumed for facsimile machines, microdevices held the largest share at 33.8 percent, followed by application-specific standard products (ASSPs) with 22.3 percent; the top two products dominated the market (see Figure 5). This situation reflects manufacturers' major efforts on signal processing and modem functions, which are a core of facsimile operation. In particular, ASSPs will be used increasingly for personal facsimiles, and Dataquest expects market spread to accelerate price decline and integration of devices.

Figure 5
Japanese Semiconductor Consumption for Facsimile by Device



Source: Dataquest (December 1991)

Also, opto devices, ranked third by a 14.0 percent share, are used in a core of facsimile machines; manufacturers are rushing to develop charge-coupled device (CCD) and contact-type image sensors. Currently, CCDs account for most image sensors available, but contact-type image sensors are expected to increase as demand grows for smaller machines, including personal-use models. Contact-type image sensors are twice as expensive as CCDs now, but cost reduction is likely to speed up if they are adapted to small models in quantities to boost volume production. If this occurs, Dataquest believes that the contact-type image sensors will divide the market with CCDs in 1993. However, we expect memory consumption to grow as many G4 facsimile makers use semiconductor memories for data processing. This growth will intensify if G4 machines are used in LAN environments or to send high-quality or color image data.

Dataquest Perspective

The Japanese facsimile industry, serving most of the world market, maintains peculiar relationships with users—it is heavily dependent on exports and public investment in digital networks. Facsimile production in Japan declined 11.3 percent on a value basis between 1989 and 1990 and is expected to register negative growth in 1991. At the same time, the facsimile market is entering a turning point in its growth as a result of high percentage of ownership, so that facsimile makers will be forced to redirect their strategies including product mix. Dataquest expects future growth to shift from the present office-oriented market to the personal market based on small and low-cost machines as well as the G4-based advanced office market. In terms of semiconductor device consumption, ASSPs will be increasingly used with downsizing of G3 machines, while consumption of microdevices and memories (in addition to ASSPs) in G4 machines will grow significantly for enhanced features. We believe that facsimile makers having an edge in business machines are likely to design and manufacture semiconductor devices on their own to satisfy increasingly advanced features and that manufacturers focusing on small machines will establish strategies relying on procurement of low-cost devices to secure price competitiveness in the future. ■

By Kun Soo Lee

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Dataquest Perspective

Semiconductors
Japan

Vol. 1, No. 2 November 11, 1991

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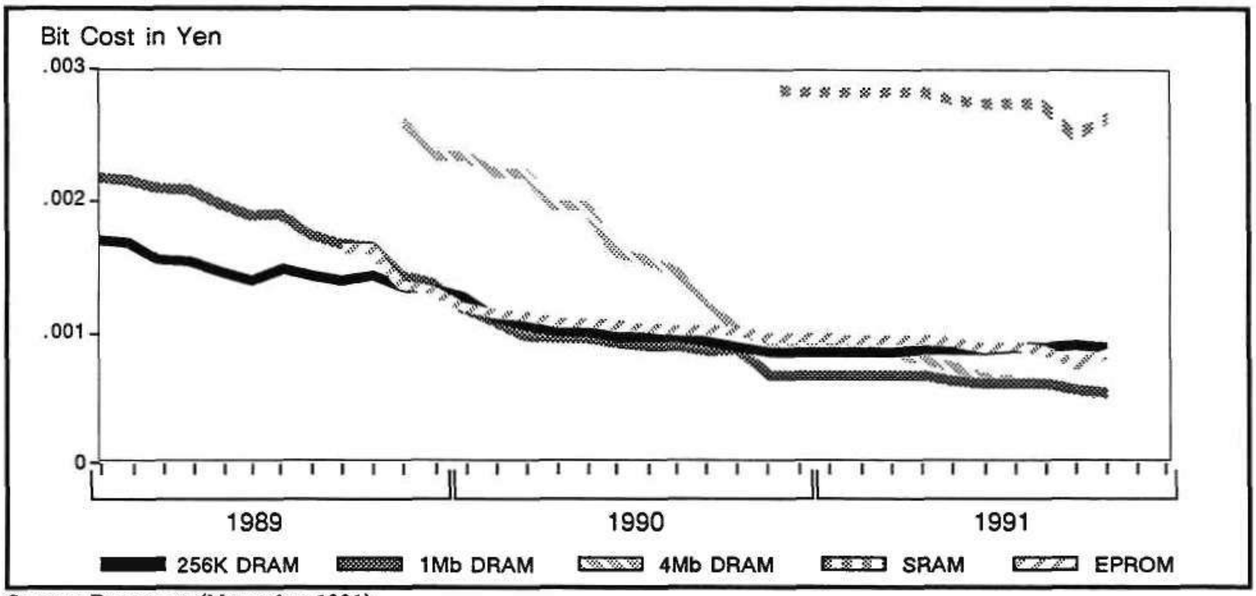
Regional Pricing Update

DQ Monday Report: Volume Mean Pricing

Family	United States	Japan	Europe	Taiwan	Hong Kong	Korea
DRAM 1Mb×1-8	3.93	4.23	3.92	4.40	4.40	3.80
DRAM 256K×1-8	1.70	1.77	1.65	1.43	1.50	1.10
DRAM 4Mb×1-8	15.00	16.44	16.20	17.95	18.40	14.50
EPROM 1Mb, 170ns	3.95	5.00	3.65	4.75	4.00	3.80
EPROM 2Mb, 170ns	7.85	11.73	7.10	8.65	8.00	7.00
SRAM 1Mb, 128K×8	14.88	16.48	13.40	17.10	18.70	NA
SRAM 256K, 32K×8	4.08	4.19	3.45	4.25	4.80	3.30
SRAM 64K, 8K×8	1.90	1.58	1.65	1.60	1.50	1.20
68020-16	34.75	50.20	29.00	47.25	47.50	NA
80286-16	12.50	13.84	12.00	11.50	12.80	13.00
80386DX-25	152.50	172.94	160.00	189.00	193.00	NA
80386SX-16	50.00	66.87	55.00	58.50	63.20	55.00
R3000-25	127.00	161.82	132.00	NA	NA	NA

Note: These figures correspond with the *DQ Monday Report* dated October 21, 1991, and reflect prices in U.S. dollars.
NA = Not available
Source: Dataquest (November 1991)

Memory Bit Price in Japan



Source: Dataquest (November 1991)

Market Analysis

Japanese Research and Development

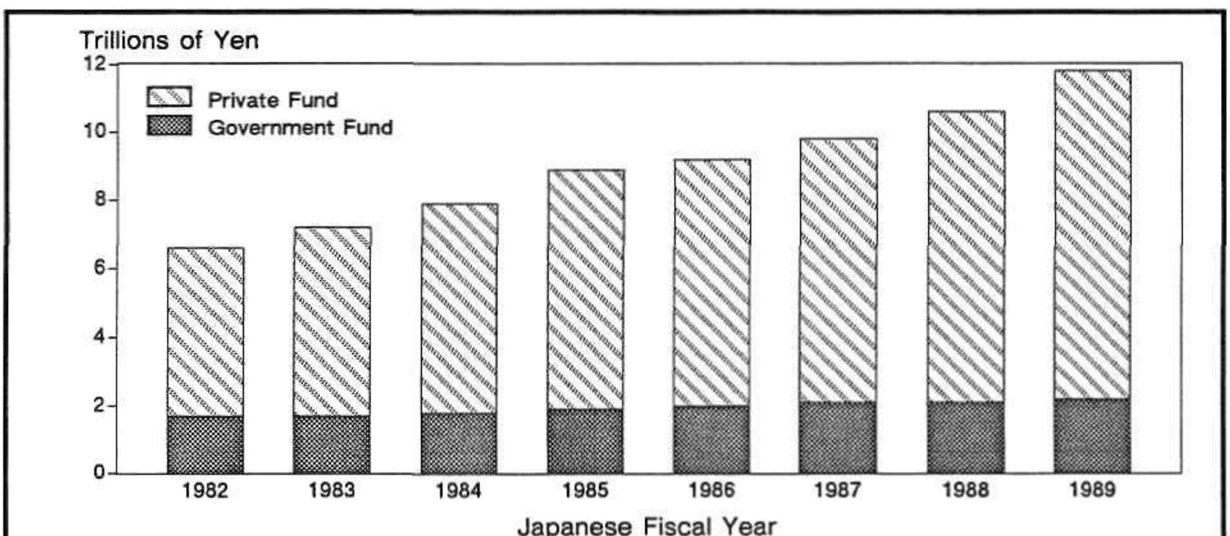
In an effort to raise Japan's industrial base to a parity with the West during the 1950s and 1960s, the Japanese government devised industrial policies that revolved around improvements to manufacturing capabilities. Although many in the West continue to believe that the Japanese tend to overemphasize product development at the expense of more inventive pursuits, this is possibly the result of the Japanese companies' manufacturing successes simply eclipsing their research and development efforts, as opposed to any fundamental lack of motivation for doing research. One need only examine the growing number of patents granted both in the United States and in Japan to Japanese companies to realize the amount of research effort being conducted in Japan. This fact is particularly true in the realm of semiconductor chip manufacturing, where manufacturing and research are often indistinguishable.

Total R&D Expenses

Japan's research and development (R&D) spending rose to ¥11.8 trillion in fiscal year 1989, which placed Japan behind only the United States in total R&D spending for a single country during the fiscal period. Japan spent 2.9 percent of the nation's gross national product (GNP) to conduct research and development activities; this ratio is the highest of all G-7 nations.

Figure 1 provides a categorization of Japanese R&D expenses broken down by source of funding. The compound annual growth rate (CAGR) of R&D spending for the past five years was 7.4 percent, and the main source of funds is clearly the private sector. During fiscal year (FY) 1989, total R&D spending grew by 11.2 percent over the previous year's spending; however, government-sponsored research did not keep pace, growing by only 4.0 percent. Japan's government-sponsored research fell to 18.6 percent of the country's total R&D spending figure, implying that privately funded R&D accounted for more than 80 percent of the country's R&D efforts. Thus, the Japanese government funded a smaller percentage of its country's research activities than did the governments of the United States, France, or Germany during the same period. Moreover, the Japanese government's share of R&D spending has been steadily declining during the past several years. It is difficult to reconcile the paradox of the Japanese government's strong influence over private R&D activities and consortia with its ever-diminishing contributions to those same projects.

Figure 1
Total Japanese R&D Expenditure by Source of Funds



Source: Japan Statistics Bureau, Dataquest (November 1991)

Basic Research

Japan has been criticized by its neighbors for overemphasizing applications and not contributing sufficiently to fundamental advances through basic research. Figure 2 illustrates Japanese R&D expenditure by purpose or function. Although the Japanese government and industries concede the importance of basic research for future prosperity, their investments in basic research are modest. Japanese corporations do not typically budget for pure research; traditionally, they rely on the academic and national laboratory communities to do basic research. The recent labor shortage, which has even had an impact on the supply of research personnel, will likely not improve the short-term basic research outlook in Japan. However, in an effort to further its commitment to raising the level of domestic research, Japan is currently recruiting technical personnel—particularly software engineers—from abroad.

Technology Calls for International Cooperation

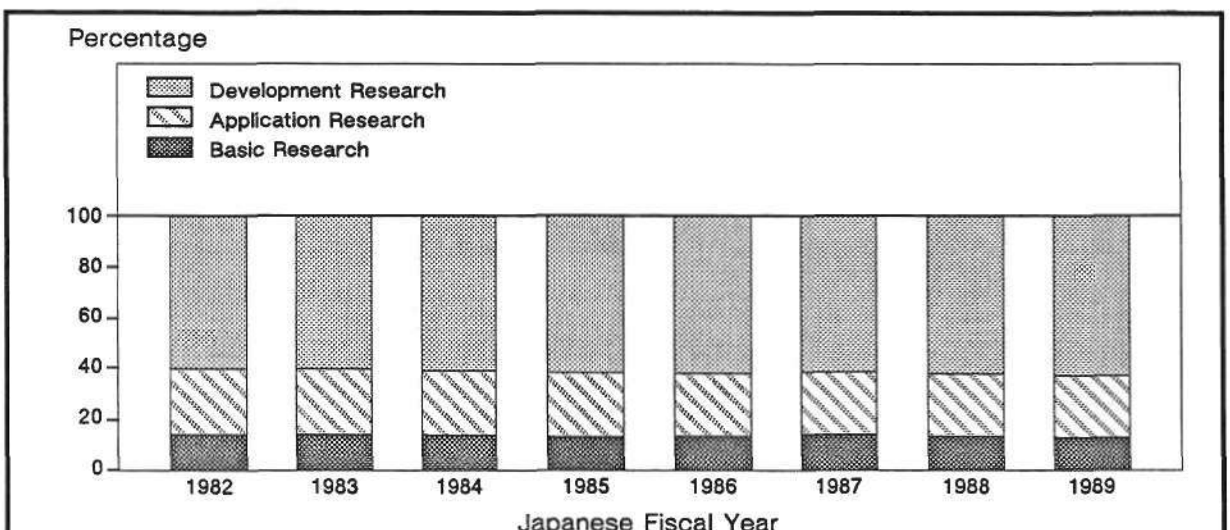
In FY 1989, Japan's total trade balance of technology (which is a measure of technology transactions with other countries in areas such as patents and other intellectual property items) was a surplus for the first time ever; that is, exports exceeded imports. Nevertheless, in the electronics and telecommunications segments of the U.S.-Japan technology trade balance, Japan still registered an export-to-import ratio deficit of 0.17, indicating that Japan remains dependent on the United States to supply key technologies.

Japan has drawn increasing criticism for its lack of participation in and funding of international research projects such as the U.S. government's Superconducting Super Collider (SSC) project. It now seems clear that the various groups making decisions concerning such funding are undecided about the SSC project and the $2 billion required of the Japanese to gain "membership." In contrast, the new "6th Generation Computer Project," a consortia sponsored by the Japanese Ministry of International Trade and Industry (MITI) to investigate a massively parallel computer architecture, has attracted much interest from both the private and public sectors, including such diverse institutions as AT&T, IBM, Stanford University, and the University of Colorado. In addition, Korea, Singapore, and some European countries have all expressed interest in participating in the MITI project.

Semiconductor R&D

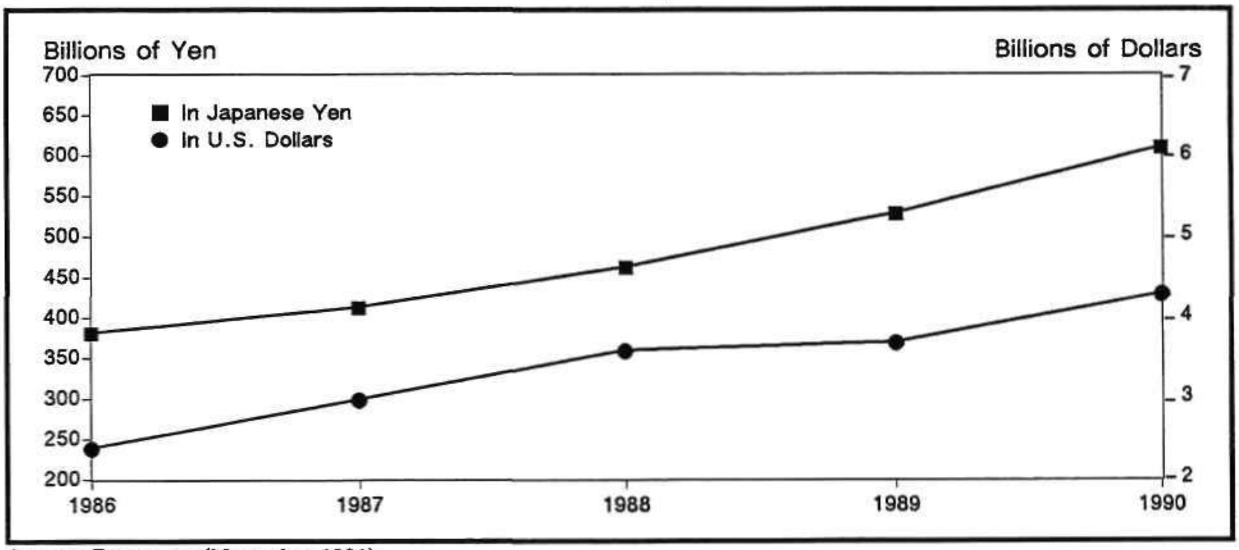
Figure 3 contains estimates of total Japanese semiconductor R&D expenses in units of both Japanese yen and U.S. dollars. The total semiconductor R&D expenditure in FY 1990 was estimated to be ¥611 billion ($4.3 billion), and this expenditure's CAGR for the past five years was 12.4 percent. This figure exceeded the

Figure 2
Total Japanese R&D Expenditure by Purpose



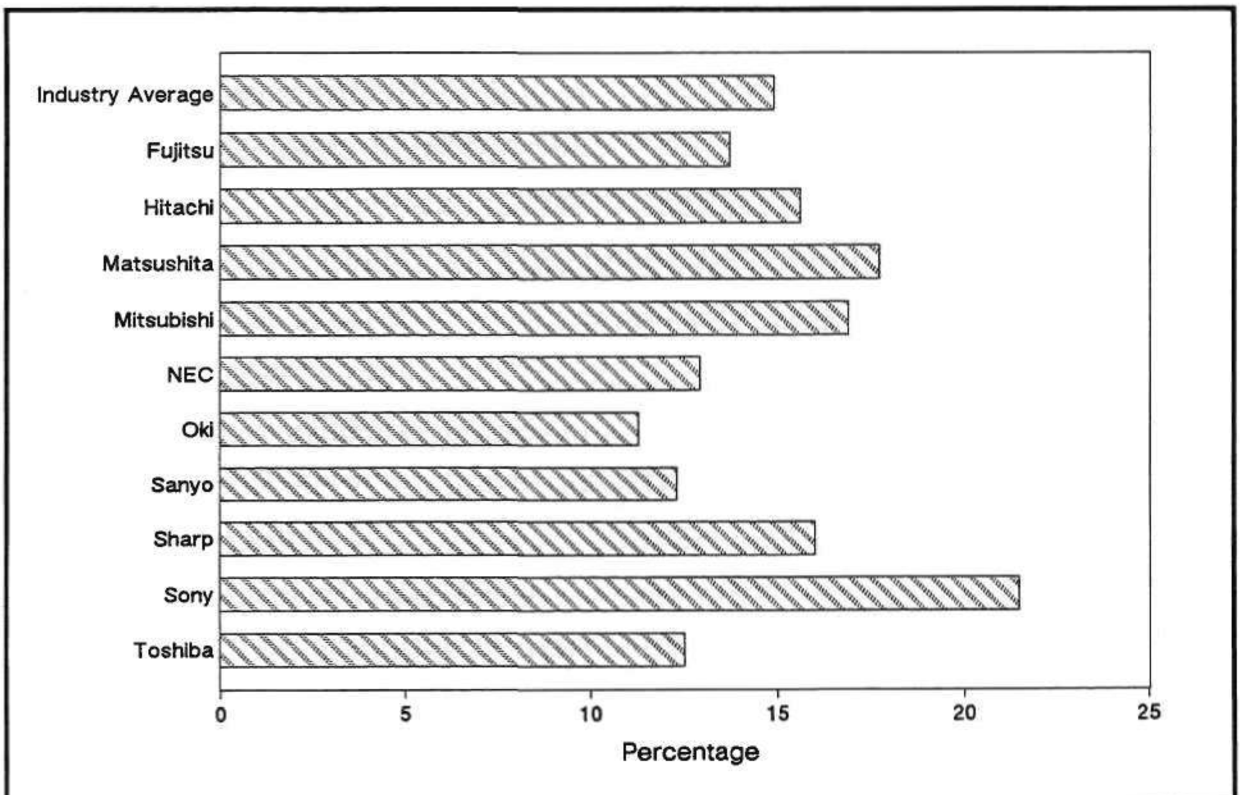
Source: STA, Dataquest (November 1991)

Figure 3
Estimated Total Japanese Semiconductor R&D Expenditure



Source: Dataquest (November 1991)

Figure 4
Japanese Semiconductor R&D-to-Sales Ratios



Source: Dataquest (November 1991)

CAGR of Japan's total R&D spending of 7.4 percent. Although the dollar figure appears flat between 1988 and 1989, this is primarily due to the large yen depreciation ($/¥128-¥142) during the same period; the yen basis figure shows steady growth of R&D spending for the past five years. Japanese electronics companies have begun moving many R&D facilities offshore as the difficulties involved in long distance technology transfers are beginning to demonstrate that localized R&D is usually more effective. Nevertheless, for most Japanese companies, the main R&D activities are conducted in domestic facilities.

Figure 4 shows semiconductor ratios of R&D expenses to semiconductor sales for the top 10 performers. For FY 1990, the average R&D expense-to-sales ratio was 14.9 percent. Compared with the previous year's 12.9 percent, the industry as a whole suffered a heavier R&D burden during FY 1990. This was more the result of lower sales during FY 1990 than a large jump in R&D expenditure relative to the previous year's investments. R&D spending-to-sales ratios exhibited this same phenomenon during the semiconductor industry recessions in 1985 to 1987, when the top 10 Japanese companies' semiconductor R&D-to-sales ratio soared to more than 17.0 percent. These figures reflect the notion held by most far-sighted companies that continued R&D expenditure, even during a business slump, represents necessary investments for future prosperity. Some companies have much higher ratios, which means that semiconductor R&D consumes a disproportionate amount of total R&D funding.

Dataquest Perspective

Discontent is growing among some Japanese company officials who believe that the merchant semiconductor business is rapidly becoming an unprofitable one. It now entails excessive capital spending and R&D investments, with the accompanying risk rising faster than the potential gains. One important factor of the semiconductor business that frequently necessitates continued investments in semiconductor manufacturing capacity involves the information systems vendor roles of most large Japanese electronics companies. These companies are, as IBM is, required to manufacture semiconductors to remain competitive in their system products. Still, even IBM is applying the practice of allying itself with strategic business partners to help avoid the expense and risk of doing all chip manufacturing internally. Dataquest believes that it is important to realize the ease with which even the largest global players run the risk of spreading themselves too thin over their chosen markets and possibly losing in all of them for lack of an adequate business strategy.

By Junko Matsubara

Company Analysis

Japanese Semiconductor Alliance Update: The Third Quarter of 1991

During the third quarter of 1991, which ended on September 30, Dataquest recorded 28 new alliance agreements involving Japanese semiconductor companies (see Table 1).

Dataquest classifies strategic alliances into the following major categories:

- LA—Licensing agreement
- SS—Second-source agreement
- SA—Sales agency agreement
- FA—Fab agreement
- AT—Assembly and testing agreement
- TE—Technology exchange
- JV—Joint venture
- JD—Joint development
- IV—Investment
- CO—Coordination of standard
- PC—Procurement agreement
- OT—Other

RISC Camps Drawn

Four of the 28 third-quarter alliances were related to the exchange of RISC microprocessor technology. Oki has become the second Japanese semiconductor manufacturer, behind Hitachi, to adopt Hewlett-Packard's (HP's) Precision Architecture (PA) RISC design. Several RISC chip designs from various U.S. vendors are now competing to gain dominance in the growing workstation segment of the computer market.

Table 1
Japanese Semiconductor Alliance (Third Quarter of 1991)

Company 1	Company 2	Product	Agreement Type	Date
Sanyo	Micron Technology	16-bit-wide 1Mb DRAM	LA	7/91
Asahi Kasei Microsystems	DSP Group	Digital signal processing chips	LA, SA, JD	7/91
Mitech	Xilinx	Programming serial ROMs	SA, FA	7/91
Sanyo	LSI Logic	MUSE decoder	JD	7/91
Fujitsu	Tera Microsystems	SPARC RISC chip set	FA	7/91
NEC	Omron	Fuzzy logic microcontroller	JD	7/91
Hitachi	Bull	IC card	LA	8/91
Fujitsu	Sun Microsystems	SPARC RISC chip	LA	8/91
Toshiba	Kubota	Image processing ICs	SA	8/91
Fujitsu, Hitachi, Sony	TI	MUSE decoder	JD	8/91
Hoya	AT&T	Semiconductor photo mask	SA, TE, JD	8/91
Mitsubishi Corp.	Tera Microsystems	Peripheral chip set for RISC	IV	8/91
Olympus Optics	LSI Technology	Gate array	FA	8/91
SMK	Windbond	64, 256K SRAMs	SA	8/91
Nippon Denso	AT&T	IC card	JD	8/91
Fujitsu	HaL Computer Systems	CMOS RISC microprocessor	JD, IV	8/91
Sumitomo Chemical	Oriental Chemical	Semiconductor cleaning material	JV	9/91
Kanematsu	Technique	Semiconductor plating equipment	SA	9/91
Mitsubishi	AT&T	8-bit microcontroller	FA	9/91
New Japan Radio	Raytheon	High-frequency semiconductors	JD	9/91
NKK	Macronics International	1, 2, 4Mb flash memory	JD	9/91
Hoya	Munich Laser Systems	Laser manufacturing equipment	IV	9/91
Mitsubishi Corp.	Cymer Laser	Ultraviolet excimer laser	IV	9/91
Toyota Motor	6 companies	Automotive ICs	JD	9/91
Mitsubishi	AT&T	GaAs semiconductors	FA	9/91
Toshiba	Motorola	Semiconductors	SA	9/91
NKK	IDT	32-bit MIPS RISC architecture	JD	9/91
Oki	Hewlett-Packard	HP RISC architecture	LA	9/91

Source: Dataquest (November 1991)

Adopting an open, or at least less proprietary, RISC architecture such as the SPARC standard currently appears to be a popular strategy among RISC players to gain sufficient market presence in order to stimulate independent software development. This trend toward open hardware systems has resulted in a surge of licensing and technology exchange agreements. Fujitsu/Sun, Hitachi/HP, NEC/MIPS, Sony/MIPS, Toshiba/Sun, and Toshiba/MIPS have all entered into cooperative ventures. Although Oki already has endorsed an Intel RISC design for the past year, the company has demonstrated a commitment toward adding the HP PA-RISC design to its portfolio. The addition of Oki to the HP RISC team, which was recently organized into a consortium, will likely boost the prospects of the HP RISC design becoming a major force in the workstation market.

Collectively, Japanese automotive manufacturers were quite active in soliciting alliances during the third quarter.

Also during the third quarter, NKK teamed with Integrated Device Technology (IDT) to manufacture IDT's version of MIPS' RISC design.

Active Automakers

Collectively, Japanese automotive manufacturers were quite active in soliciting alliances during the third quarter. Toyota Motor agreed to jointly develop application-specific chips with six U.S. suppliers to be used in future Toyota vehicles. And Nippon Denso, Japan's largest auto parts company, has entered the IC memory card business with AT&T as its partner. Japanese automotive companies have been resorting to design-in type alliances with semiconductor manufacturers and design houses at a growing pace.

Dataquest expects the total number of alliances in 1991 to exceed last year's total of 88 new agreements.

The new U.S.-Japan Semiconductor Trade Arrangement, which became effective in August 1991, may be responsible for some of these renewed efforts by Japanese companies to both purchase chips from as well as communicate their needs to U.S. chip suppliers. To this end, the Japanese government, in concert with industry organizations such as the Electronics Industry Association of Japan (EIAJ) and the Japan Auto Parts Industries Association (JAPIA), has been actively promoting the joint ventures between Japanese automobile makers and U.S. chip supplying partners. It is clear that Toyota and other automakers are beginning to respond to these lobbying efforts.

Strategic Alliances

The following paragraphs briefly summarize some strategic alliances recorded by Dataquest during the third quarter.

Hoya/AT&T

AT&T Microelectronics, Hoya Micro Mask Inc., and Hoya Corporation have agreed to exchange mask-making technology and to market AT&T's captive mask-making capacity to U.S. chip vendors. Under the three-pronged agreement, Hoya will market AT&T's mask capacity in the United States and will purchase some computer-integrated manufacturing software and an automated mask production line from AT&T.

Nippon Denso/AT&T

Nippon Denso reached a cooperative agreement to take AT&T's smart card systems to Japan. Under the agreement, AT&T and Nippon Denso will jointly develop applications for use with AT&T's smart card. Nippon Denso will have exclusive rights to manufacture AT&T's reader/writer and to market the jointly developed applications in Japan. AT&T will supply smart cards for applications and provide technical services and training.

Oki/HP

Oki has signed a RISC license agreement with HP. The second Japanese company after Hitachi to license the PA-RISC from HP, Oki will commercialize a RISC chip in fiscal 1993 and incorporate the chip into its products, including communications systems, automotive electronics equipment, and printers.

Sanyo/LSI Logic

Sanyo and the Japanese subsidiary of LSI Logic will codevelop a single-chip decoder for the MUSE HDTV system. The decoder, which will replace about 40 devices used in the current generation part, will be used in HDTV systems that also can display normal NTSC television.

Dataquest Perspective

As of the end of September, we observed 79 alliances or 8.8 alliances per month during the first three quarters of 1991. This alliance formation rate represents a clear escalation over last year's rate of 7.2 alliances per month and even exceeded the 8.3 alliances per month rate recorded in 1989, when the yearly total reached 107.

Dataquest expects the total number of alliances in 1991 to exceed last year's total of 88 new agreements. This trend demonstrates a willingness of Japanese companies to use alliance relationships as a means of diversifying and maintaining competitiveness. In addition, the large number of alliances involving U.S. companies should hopefully stimulate both the U.S. chip and systems industries.

By Junko Matsubara

Technology Analysis

DSP Market: Assessing Potential

Digital signal processing technology—an emerging medium to digitally process analog signals in voice, image, and telecommunication—has been driven by advancement of signal-processing theory as well as algorithms built on the basis of such theory. Increasing density of semiconductors has recently given birth to a digital signal processor (DSP) that implements an advanced signal-processing algorithm on a single chip. This allowed the development of low-cost and compact electronic systems in a wide range of applications including audio/image processing, communication, and control. This article reviews the current situation and the outlook for the DSP market.

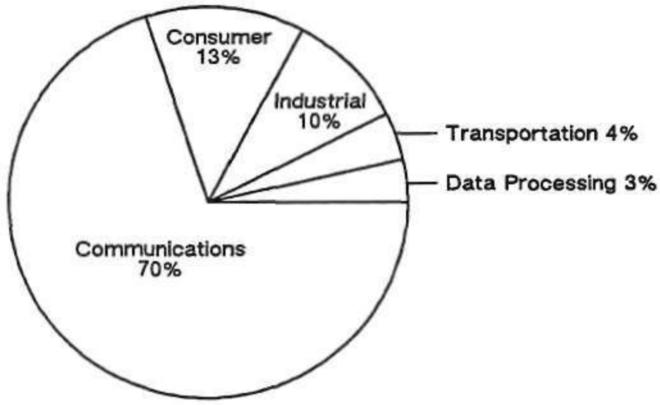
DSP Technology

Digital signal processing is performed in the form of repeated arithmetic operations—multiplication and addition—such as digital filter and high-speed Fourier transformation. DSP is a processor dedicated to high-speed operation, containing arithmetic circuits to execute signal processing on a real-time basis. In particular, DSP features: a high-speed multiplier capable of running each multiplication and instruction in one machine cycle; ROMs and RAMs to store program and data, with internal buses to allow parallel processing such as pipeline control and multiplex operation; expanded bit width for the accumulator and ALU to implement highly accurate calculation; and I/O interface for the external analog signals.

DSP Market and Major Applications

In 1990, the worldwide DSP market amounted to $263 million, of which the Japanese market accounted for 27.8 percent, or $73 million. In the Japanese DSP market, communications equipment including modems, facsimiles, and voice codec are the largest users, accounting for 70 percent of the total (see Figure 1), followed by consumer electronic equipment such as audio equipment and musical instruments (13 percent) and industrial applications for control of NC machine tools, industrial robots, and AC motors. Some workstations also use DSPs in voice codec and image-processing circuits. DSPs are used in car stereos and are being considered for use in control of engines and ABS systems.

Figure 1
DSP Applications in Japan



Source: Dataquest (November 1991)

Based on 1990 sales, Texas Instruments Inc. (TI) ranked first in the world DSP market, representing 41.8 percent of the total, followed by NEC Corporation (11.8 percent), Fujitsu Ltd., and Motorola Incorporated (see Figure 2).

Standard DSP and Custom DSP

DSPs are classified according to their architecture into general-purpose DSPs and specialty DSPs, which are optimized to specific applications. More precisely, general-purpose DSPs are based on an architecture designed with flexibility adapted to a variety of applications, while custom DSPs are optimized to data and algorithms required for each application.

Today, DSPs are used in consumer electronics, telecommunication, and industrial applications and contribute to improvement of performance and cost reduction for a variety of electronic systems.

The general-purpose DSP market totaled 10.06 million units in 1990. Shipments of TI's TMS320C10 amounted to 3.5 million units, boasting the largest share, followed by the TMS320C25 (2.62 million units), and NEC's µPD77C20 (1.13 million units). TI alone dominated the market with a 61.8 percent share (see Figure 3). In terms of bits, 16-bit DSPs accounted for 91.3 percent of the total units; 24-bit versions, 5.9 percent; and leading-edge 32-bit versions, a meager 2.7 percent.

Promising Applications

New applications for DSPs with high growth potential are discussed in the following paragraphs.

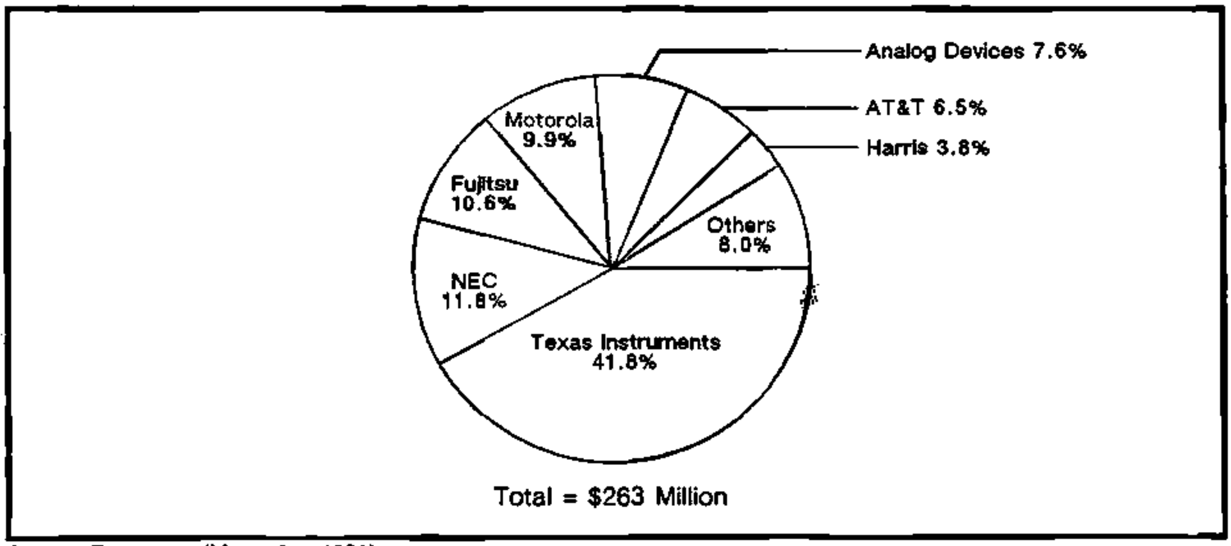
Digital Mobile and Cellular Phones

Technical standards for digital mobile and cellular phones were adopted by the Consultative Committee on International Radio (CCIR) in 1990. Japan will start service based on these standards in 1992. For digital voice codec to be used in the new mobile and cellular phones, various chipmakers are supplying large-scale integration devices (LSIs) that use 16-bit fixed-point DSPs as the core unit and contain AD/DA converters. Now, LSIs equipped with frame processing and digital modulation/demodulation features are being developed. This market has high growth potential and could greatly benefit custom DSPs.

Acoustic Field Control for Home Audio and Car Stereo Systems

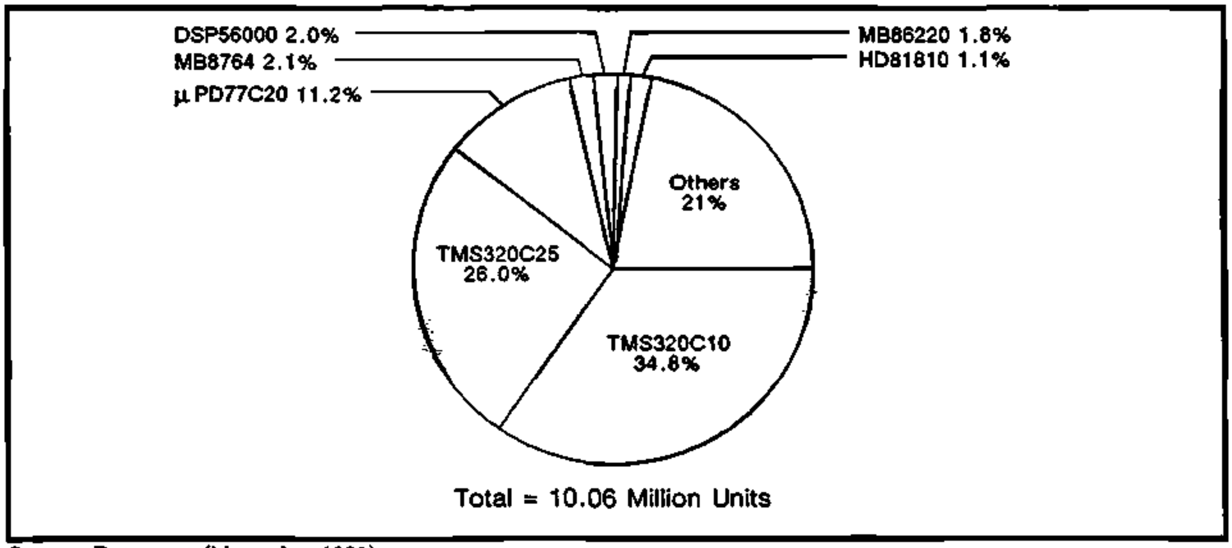
Audio systems with acoustic field control features have become available recently to give concert-hall presence at home or in the car. Again, 24-bit floating-point DSPs are used for

Figure 2
1990 DSP Revenue by Vendor



Source: Dataquest (November 1991)

Figure 3
1990 Worldwide Standard DSP Shipments



Source: Dataquest (November 1991)

advance signal processing, including sound delay and frequency control, sound volume control, and binaural crosstalk canceling. In the near future, multichannel reproduction—recommended for HDTV—and digital field control will also be commercialized.

High-Efficiency Image Coding

The International Telegraph and Telephone Consultative Committee (CCITT) and the International Organization for Standards (ISO) have announced three international standards for the high-efficiency image coding to compress image data. They include the still-picture coding method adopted for TV phone/teleconferencing named H.261 and the coding method adopted for color still pictures by the Joint Photographic Experts Group (JPEG). Then, in September 1990, the moving picture coding system was adopted by the Moving Picture Experts Group (MPEG). These standards are based on high-efficiency coding by means of discrete cosign transformation (DCT), and various makers have announced LSIs capable of DCT/reverse-DCT processing. High-efficiency image coding will find a number of applications including telecommunication, computers, and audio/visual equipment, creating sizable semiconductor demand.

Dataquest Perspective

Today, DSPs are used in consumer electronics, telecommunication, and industrial applications and contribute to improvement of performance and cost reduction for a variety of electronic systems. In particular, DSPs are expected to serve as a key device in multimedia systems integrating computers, audio and video systems, and communications equipment.

Adoption of international standards for voice and image coding will accelerate the shift to multimedia systems. Furthermore, the use of DSPs with CPUs in PCs will create powerful tools to handle voice, image, and communication, although commercialization is still a long way off. However, it will not be long before we see IC cards that can be inserted into notebook PCs and work as a facsimile, a modem, or a portable phone.

As information processing and signal processing integrate more and more with advancing semiconductor technology and DSP, and as market penetration of multimedia systems increases as anticipated, Dataquest believes that DSPs will become a critical product for chipmakers as well as for MPUs.

By Susumu Kurama

In Future Issues

The following topics will be featured in future issues of Semiconductors Japan *Dataquest Perspective:*

- Quarterly Japanese semiconductor industry forecast update
- Facsimile market in Japan
- Company analysis: NEC Corporation

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Dataquest Perspective

Semiconductors
Japan

Vol. 1, No. 1 — October 28, 1991

Regional Pricing Update

Market Analysis

Product Analysis

Company Analysis

0011507

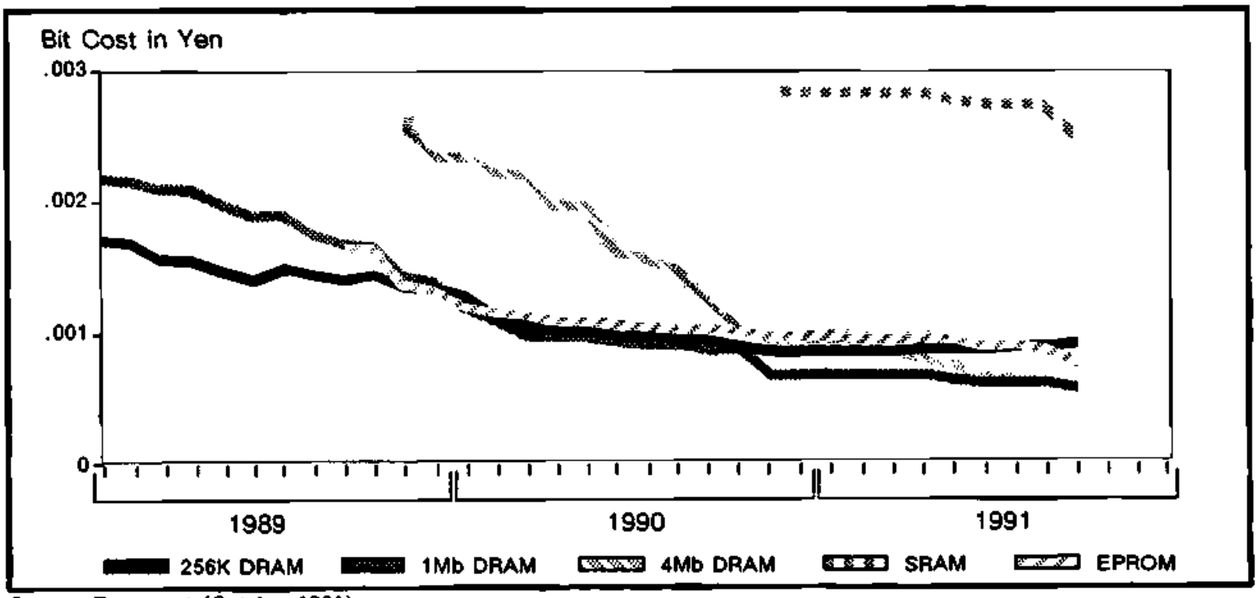
Pricing Update

DQ Monday Report: Volume Mean Pricing

Family	United States	Japan	Europe	Taiwan	Hong Kong	Korea
DRAM 1Mbx1-8	3.93	4.11	3.92	4.40	4.40	3.80
DRAM 256Kx1-8	1.70	1.72	1.65	1.43	1.50	1.10
DRAM 4Mbx1-8	15.13	15.87	16.20	18.25	18.40	15.00
EPROM 1Mb, 170ns	3.95	4.86	3.65	4.75	4.00	3.80
EPROM 2Mb, 170ns	7.85	11.38	7.10	8.75	8.00	7.30
SRAM 1Mb, 128Kx8	14.88	16.05	13.40	17.10	18.70	NA
SRAM 256K, 32Kx8	4.08	4.07	3.45	4.25	4.20	3.30
SRAM 64K, 8Kx8	1.90	1.53	1.65	1.60	1.50	1.20
68020-16	34.75	47.78	29.00	47.25	47.50	NA
80286-16	12.50	13.44	13.00	11.50	12.80	13.50
80386DX-25	152.50	167.97	160.00	189.00	193.00	NA
80386SX-16	50.00	64.95	55.00	58.50	63.20	55.00
R3000-25	127.00	147.45	132.00	NA	NA	NA

Note: These figures correspond with the *DQ Monday Report* dated October 7, 1991, and reflect prices in U.S. dollars.
NA = Not available
Source: Dataquest (October 1991)

Memory Bit Price in Japan



Source: Dataquest (October 1991)

Market Analysis

Semiconductor Equipment Market: Fear of New Trade Friction?

The U.S.-Japan Semiconductor Trade Arrangement has just been settled; however, another episode of trade friction is about to occur. This time, the target is upstream—semiconductor manufacturing equipment. Historically, the semiconductor equipment market has been dominated by the U.S. companies, but now significant portions of major wafer process equipment are Japanese made. Today the semiconductor market cannot do without advanced semiconductor equipment, particularly development of leading-edge devices. Thus, whether or not a chipmaker has the latest equipment can determine its success in the market.

The semiconductor equipment industry is highly competitive, and nearly 300 manufacturers—greatly varied in size—are flocking to serve the world market. This situation is in sharp contrast to the semiconductor market, which is dominated by electronics giants such as NEC Corporation and Toshiba Corporation. Also, the semiconductor equipment industry is characterized by a highly customized production process and full-time maintenance base. This article reviews recent changes in the semiconductor equipment market and the challenges facing the major Japanese manufacturers.

The Semiconductor Equipment Industry

Background

In Japan, approximately 550 companies are engaged in the semiconductor production business, including equipment and materials as well as distribution. Within this highly varied structure, the semiconductor equipment market has the following characteristics. First of all, complexity of semiconductor manufacturing process has led to segmentation and specialization of equipment makers according to major processes. Interestingly, these market segments vary greatly in terms of size of players. For instance, the stepper market is dominated by large companies—including Canon, Hitachi Ltd., and Nikon Corporation—whereas smaller companies are playing large roles in other segments. In terms of production, the wafer fab equipment market is highly customized to meet diverse needs of users; thus, small-lot production is the norm of the industry. Furthermore, customers are demanding. Sizable R&D and capital expenditure are required to catch up with production technology, which continues to advance; and the full-time maintenance base is required from the initial installation.

In 1990, the worldwide semiconductor equipment market amounted to approximately $5,027 million (see Figure 1). In the worldwide semiconductor device market, Japanese chipmakers moved ahead of their U.S. counterparts in share in 1986 and held a 50 percent share in 1990. The same trend was observed in the semiconductor equipment market with some time lag. In 1988, Japanese manufacturers achieved a 44.8 percent share to surpass the U.S. manufacturers; in 1990, they had a majority of the market. The U.S.-Japan trade friction regarding semiconductor devices surfaced in 1985 and developed into a major political issue between the two countries. The semiconductor equipment industry, which has been following in the footsteps of the semiconductor device industry, cannot watch this friction from a distance. This situation calls for more detailed analysis of semiconductor equipment industries in the two countries, particularly their major characteristics and differences.

Japanese Semiconductor Equipment Market

The Japanese semiconductor equipment market, which bottomed out in 1986, has been expanding steadily and recorded an annual 6 percent growth in 1990 when the semiconductor device market stagnated. During this period, U.S. manufacturers grew in share but below the market growth rate. Nevertheless, joint ventures by U.S. and Japanese companies boosted their share, and the combined share of U.S. equipment makers and joint ventures remained at a 20 percent level (see Figure 2).

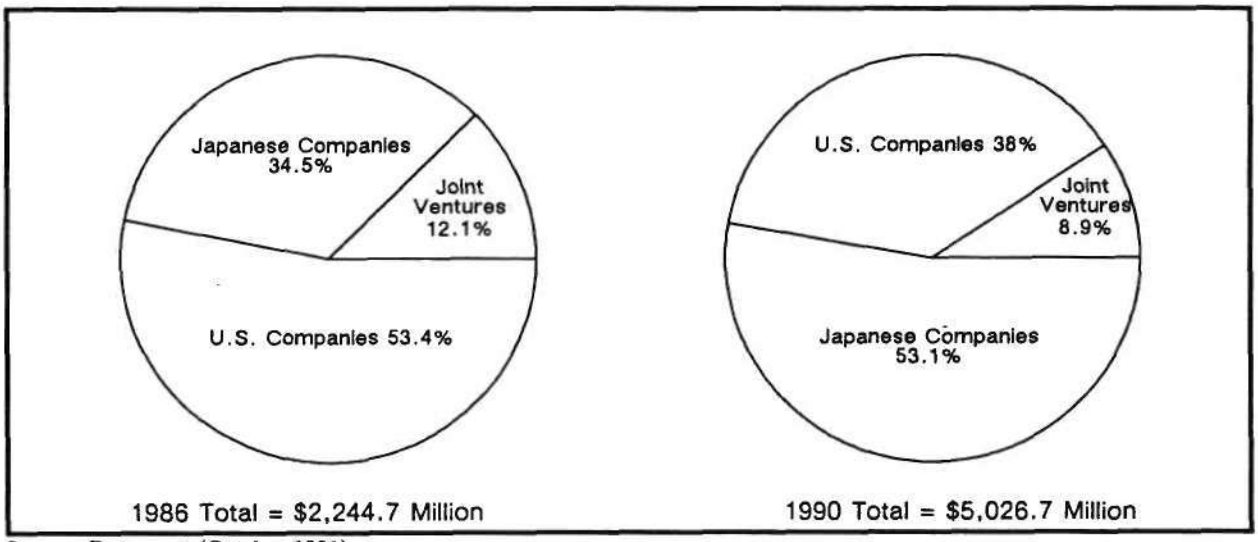
Originally, the U.S. equipment makers sold their products in Japan through sales representatives, but they faced difficulties in equipment modification to meet the needs of users, a long period required from installation to acceptance, and maintenance requirements. Meanwhile, Japanese equipment makers grew rapidly to threaten the U.S. companies' dominance—culminating in the 1985 and 1986 semiconductor recession, through which Japanese equipment manufacturers managed to survive and serve customers.

In contrast, leading U.S. manufacturers resorted to reduction in scale, mergers, and acquisitions, losing the confidence of Japanese device makers. It is easy to lose confidence in the equipment industry because a semiconductor maker can suffer a considerable loss if equipment breakdown stops a fab line for a full day. In this sense, the semiconductor industry is "equipment intensive," and relationships with equipment makers must be built upon reliability.

U.S. Semiconductor Equipment Market

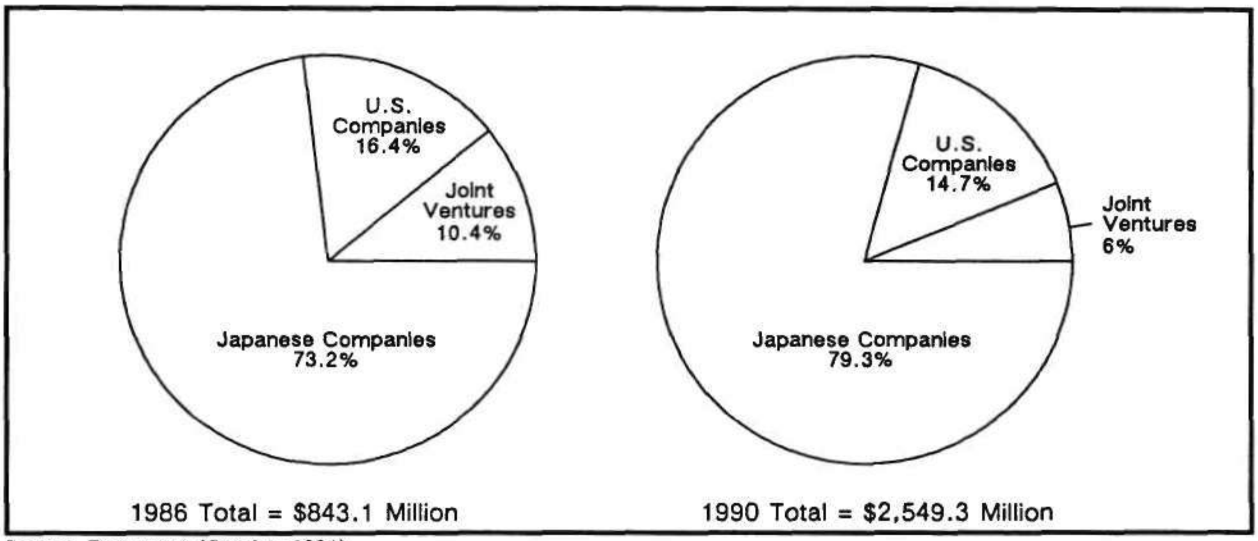
The U.S. semiconductor equipment market is dominated by domestic manufacturers, which hold a nearly 80 percent share, and Japanese manufacturers have the rest (see Figure 3). There are several reasons for this low penetration of the U.S. market by Japanese companies. The first factor is the difference in products.

Figure 1
Semiconductor Equipment Market Share—Worldwide (Ownership)



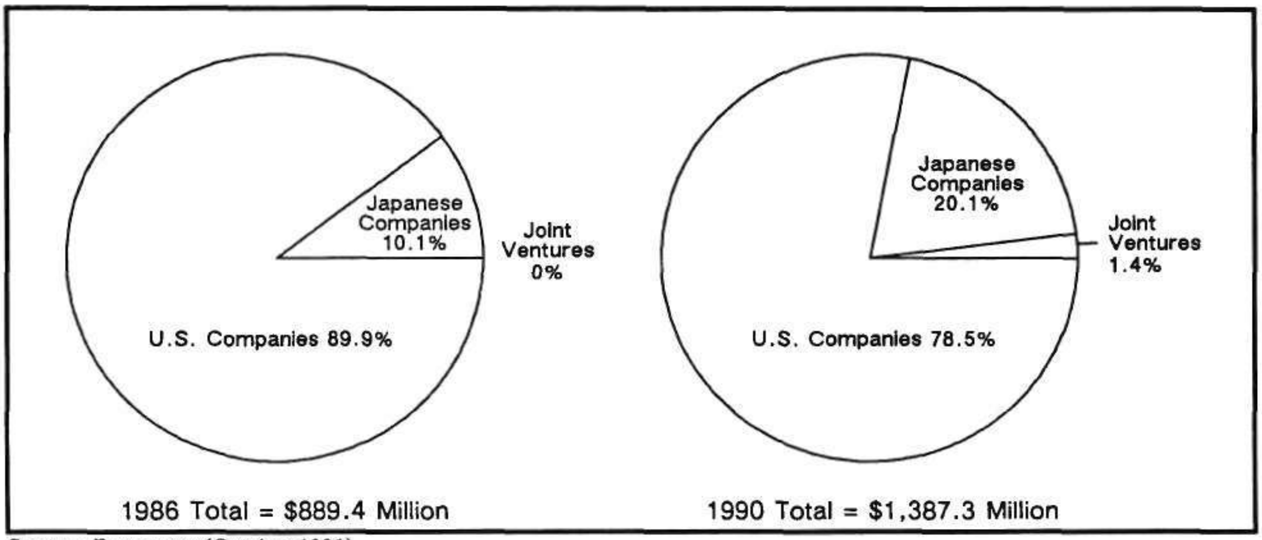
Source: Dataquest (October 1991)

Figure 2
Semiconductor Equipment Market Share—Japanese Market (Ownership)



Source: Dataquest (October 1991)

Figure 3
Semiconductor Equipment Market Share—U.S. Market (Ownership)



Source: Dataquest (October 1991)

Semiconductor production lines in the United States have approximately 400 fabrication lines, twice the number in Japan, as they mainly produce ASICs. In terms of profitability, it is difficult for the Japanese equipment makers, which have sales and maintenance bases for fabs generally in volume production, to do the same in the U.S. market characterized by small-lot production. As a result, only a few leading Japanese makers have marketing bases in the United States.

The second factor is the difference in the expected level of commercialization of wafer fab equipment. Unlike "back-end" testing and assembly equipment with relatively low maintenance requirements, leading-edge front-end equipment needs to be "perfected" through process technology by semiconductor chipmakers. Less-than-perfect equipment, if sold in the U.S. market, may result in demand for strong maintenance support and even spur a wave of litigation if it is found to be defective. Thus, it is safer for Japanese equipment makers to obtain acceptance by Japanese customers before supplying U.S. customers. Even then, there are some other hurdles to clear, including the burden of the product liability insurance and preparation of operation manuals. Finally, the slow movement of equipment makers in exploring overseas markets, compared with aggressive semiconductor makers, prevents them from introducing leading-edge products to Japan and the United States simultaneously.

Leading Makers in Major Segments

Japanese semiconductor equipment makers have been boosting their worldwide market shares year after year. The semiconductor equipment market consists of a variety of equipment, and each market segment is served by companies that vary greatly in size. In a sense, this is the market where any company, regardless of size, can dominate if excellent products are developed, although it is very difficult for everyone to stay at the top all the time. This fact is evident from analysis of regional market shares in major wafer fab equipment, which indicate that a leading worldwide manufacturer does not necessarily hold major shares in all regional markets; only Applied Materials Inc. and Nikon have achieved that status (see Table 1). Clearly, this situation is a result of the technology-oriented nature of the industry and lack of ability on the side of the Japanese makers to introduce new products to Japan and the United States simultaneously.

Looking into market segments, steppers—major lithography equipment—are dominated by Japanese makers such as Canon and Nikon. Although the market was originally dominated by GCA, the financial difficulty of that company and a shift to lens-based technology provided opportunities for Japanese camera manufacturers to enter and win the marketplace. The same trend is observed in the dry etching market, where Applied Materials maintained its number one

Table 1
1990 Major Semiconductor Equipment Manufacturer Ranking

Equipment	Region	Number 1	Number 2	Number 3
Stepper	Worldwide	Nikon	Canon	Hitachi
	United States	Nikon	GCA*	ASM Lithography
	Japan	Nikon	Hitachi	Canon
Dry Etch	Worldwide	Applied Materials	Hitachi	Lam Research
	United States	Applied Materials	Lam Research	Drytek/Tegal
	Japan	Tokyo Electron	Hitachi	Applied Materials
CVD	Worldwide	Applied Materials	Novellus Systems	Kokusai Electric
	United States	Applied Materials	Novellus Systems	Silicon Valley Group
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PVD	Worldwide	ANELVA	Varian Associates	Material Research
	United States	Varian Associates	Material Research	ANELVA
	Japan	ANELVA	ULVAC Japan	Material Research

*A unit of General Signal
Source: Dataquest (October 1991)

position everywhere; but it was down to third place in the 1990 Japanese market, next to Tokyo Electron and Hitachi. Another important move is the emergence of U.S.-Japan joint ventures in various market segments (including MRC/Sony, Sumitomo/Eaton Nova, TEL/Varian, and Ulvac/BTU), suggesting that the industry is awash with strategic alliances and is on the way to a world without boarders.

The Semiconductor Material Market

The increasing presence of Japanese makers is visible even in the indispensable silicon wafer market, which is dominated by Shin-Etsu Semiconductor and several other Japanese companies. After Monsanto Electronics Materials—once the largest wafer manufacturer in the United States—had sold its wafer business to Huels of Germany, the U.S. wafer market depended for its entire supply on foreign sources.

Supply capacities of wafer makers have not increased for some time, but demand has grown steadily as a result of new fab lines being added each year; thus, the worldwide wafer market experienced a tightening of supply in 1990. Now that Japanese and German makers hold a 95 percent share of the world market, if they fail to fulfill the responsibility for stable supply, wafers are likely to become a major source of trade friction with the United States for the alleged "control" of semiconductor production.

The future wafer business will require R&D efforts on higher-grade and larger wafers to meet ever-increasing integration of semiconductor devices. This involves a high-risk investment for wafer makers that are expected to satisfy the demand from a global perspective. Finally, wafer prices are suspected as another source of friction; prices in Japan are about 30 percent higher than in other markets. Some might see this situation as dumping by Japanese makers in overseas markets. However, it is due to a difference in specifications because Japanese fab lines—mainly producing memories—are using higher-grade wafers.

Major Issues

Major issues facing the semiconductor equipment industry are twofold, involving both cost and supply. Dataquest analyzes these issues within the framework of the Japanese equipment makers and their challenges.

Price Difference

The difference in prices of semiconductor equipment for overseas markets is partly due to additional spare parts—about 10 percent more than those for equipment shipped to the domestic market—and partly due to product liability insurance costs. Furthermore, specifications differ from one user to another in order to meet their diverse needs. Naturally, each piece of equipment is priced differently, even for the same model or type and in the same country.

Timely Supply

Semiconductor equipment is basically custom made, not ready made. Increasing complexity of equipment designed for higher device integration is another reason for small-lot production.

As mentioned earlier, supply of the most advanced equipment by Japanese makers to the United States market is delayed, because it is developed jointly with Japanese semiconductor manufacturers that receive the first round of supply. In this sense, Japanese equipment makers are right to some degree in saying that their responsibilities to U.S. customers lie in the local customer support system including the technical staff and the supply of field-verified products. Also, the U.S. market environment, with its high risk of litigation, urges Japanese makers to supply "perfected" products.

Dataquest Perspective

Semiconductor equipment has surfaced as a new source of trade friction between Japan and the United States because of its significance in creating key technologies that shape the future of the semiconductor industry. Certainly, Japanese equipment makers enjoy an advantageous position by being located in a production base of DRAMs, which are technology drivers. Nevertheless, as their livelihood lies in developing products to meet increasingly sophisticated needs of semiconductor makers, the equipment makers capable of satisfying such needs should obtain the major share in any market.

Since the semiconductor equipment market is picked out as another "imbalance," further efforts to promote communication between the industries in the two countries, including the standardization of equipment, will be important. Japanese manufacturers should be encouraged by the success of their joint ventures in Japan and consider more aggressive expansion into overseas markets. Because Japanese equipment makers hold a majority of the worldwide semiconductor equipment market, they are expected to pursue a "mutually beneficial" strategy worldwide, including the U.S. market, that is conducive to sustainable growth of the semiconductor industry. ■

By Kazunori Hayashi
Kunio Achiwa

Product Analysis

Flash Memories: A Challenge to DRAMs?

Recently, flash memories have received the attention of semiconductor makers and users as nonvolatile memories having capacity emulating DRAMs. As a solution for overerase and a limited number of reloadings become feasible, flash memories are expected to replace magnetic storage and tapes in the near future. Some industry observers even predict that they will grow to a market size similar to DRAMs.

This analysis reviews advantages and disadvantages of flash memories and examines their market outlook from cost and other aspects.

Present Flash Memory Market

At the outset, flash memories were developed by several memory makers relying on different approaches and processes in terms of the number of reloadings, supply voltage, block erasing, and other aspects. With the recent standardization of these technical features, flash memories are expected to grow into a major market rivaling DRAMs. Flash memories are expected to replace EPROMs, EEPROMs, and magnetic disks and to extend into electronic still cameras, IC cards, and other fast-growing system markets.

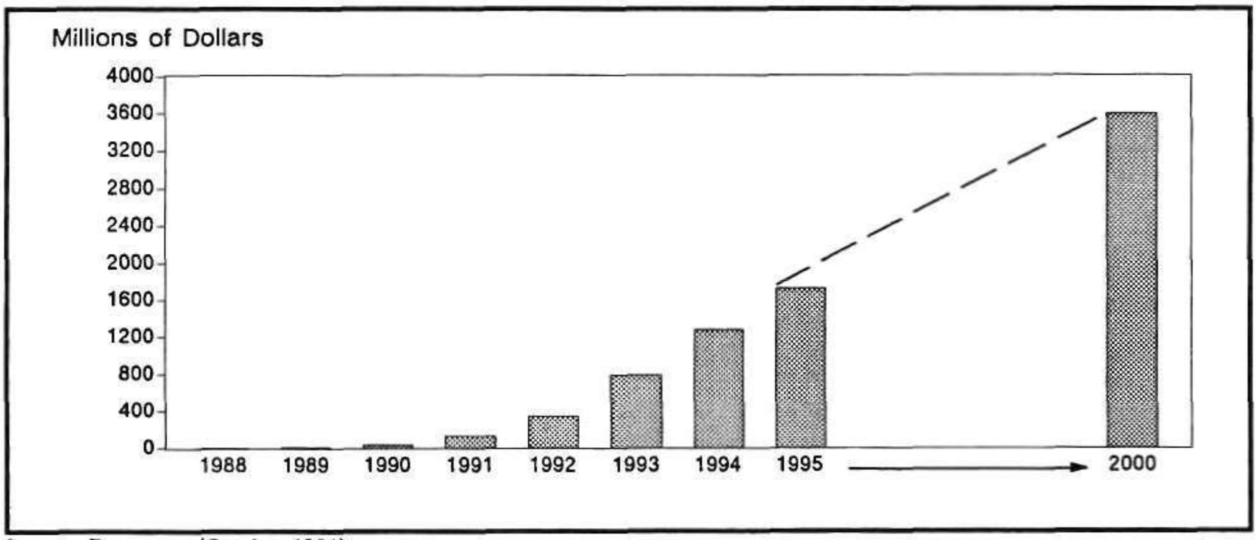
Currently, flash memories are incorporated into printers, copiers, and disk controllers, while being commercialized as a storage medium for some PCs. The worldwide flash memory market was ¥5 billion (U.S.$35 million) in 1990 (see Figure 1). Intel Corporation accounted for 90 percent of this market, followed by Toshiba Corporation, Texas Instruments Inc., and Atmel Corporation.

Flash Memory Applications

Replacing EPROMs and EEPROMs

In terms of their functions and characteristics, the first major application of flash memories is to replace EPROMs, EEPROMs, and one-time programmables (OTPs). EPROMs and EEPROMs are widely used as nonvolatile memories in system products using microcontrollers. EPROMs, while achieving a high degree of integration

Figure 1
Worldwide Flash Memory Forecast
(Millions of Dollars)



Source: Dataquest (October 1991)

because they have one transistor/cell, take relatively long data reloading time. On the other hand, EEPROMs are capable of reloading data in a system electronically, but have a low degree of integration as a result of having two transistors/cell. Flash memories have advantages of both devices and can be used to write system control programs for printers, factory automation equipment, and cellular phones. Also, they can be used to store error data for copiers and facsimiles.

In terms of cost, flash memories can easily replace EPROMs that use windowed packages, as their chip sizes are the same. Furthermore, flash memories can be reloaded 10,000 to 100,000 times, compared to approximately 100 times for EPROMs. In terms of per-bit cost, flash memories will cross over SRAMs, then EEPROMs, and EPROMs in about 1995 (see Figure 2). The crossing with DRAM costs will take longer, however; although cell size can be reduced in DRAMs, flash memories cannot be reduced to DRAM size because of the additional circuits required.

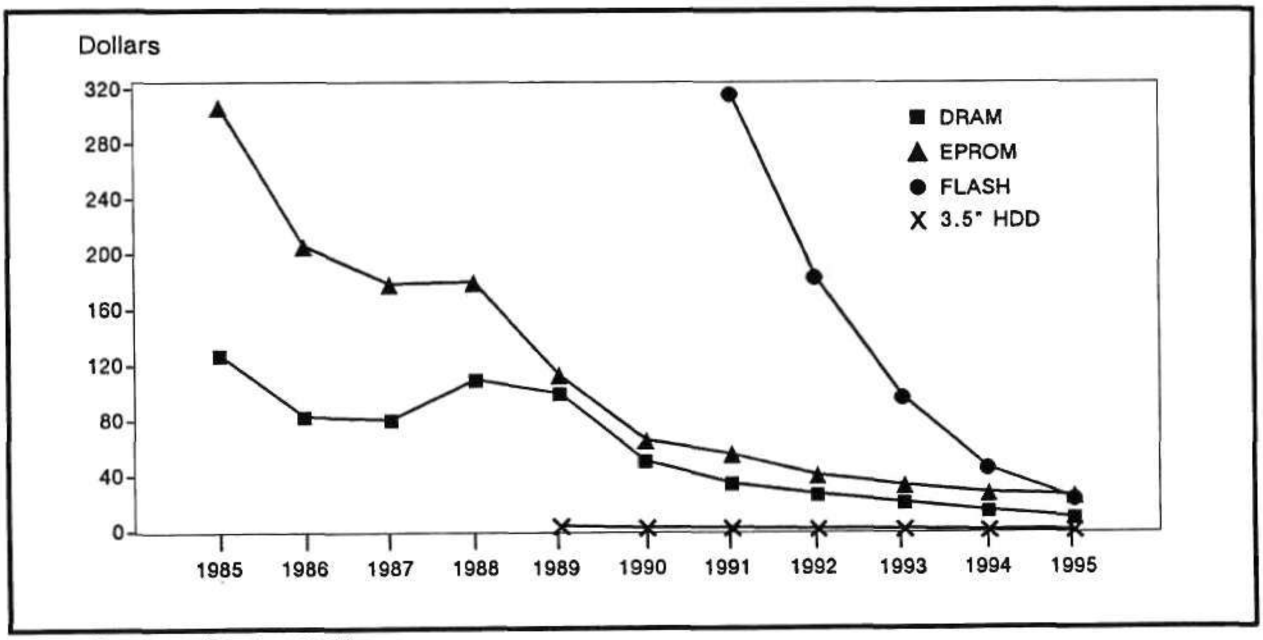
Replacing Magnetic Media

The next target for replacement is a gigantic memory medium market. Flash memories offer the following advantages over magnetic storage:

- High-speed access
- Portability
- Possibility of further size and weight reduction due to absence of magnetic head and motor
- High reliability

Nevertheless, flash memories have a problem in comparatively high per-bit cost, which, as Dataquest sees it, will not cross over that of magnetic media before the year 2000. This is partly because the per-bit price of semiconductor memories is not going down as fast as in the past, whereas the per-bit price of small magnetic disk units is falling at a pace similar to ICs in recent years. (Up to 1986, the per-bit cost of memory ICs was cut in quarters every three years, but it decreased much slower thereafter.) Another unfavorable factor for flash memories is impressive downsizing of magnetic storage; a 2.5-inch hard disk drive of less than 15mm thick has recently been introduced. Also, to replace floppy disk drives, flash memories should have a sector-by-sector erasing capability. For flash memories to be used as memory cards in portable PCs, supply voltage needs to be standardized to 5V so as to reduce power units. Although these problems can be technically overcome, certain cost impacts will be inevitable. Thus it is reasonable to expect that flash memories will be used in portable PCs,

Figure 2
Memory and Hard Disk Drive Forecast
(per Megabyte)



Source: Dataquest (October 1991)

which cannot physically accommodate magnetic disk drives, and in systems that require low power consumption and high-speed access. However, it will be a long time before flash memories replace magnetic storage in mainframes and workstations.

Flash memories will certainly accelerate market acceptance of IC memory cards, which will enable system makers to develop smaller products—one strategic feature to cope with increasing competition. As a result, expanded memory boards are likely to be replaced with IC memory cards; PCs will be equipped with IC memory card slots.

Dataquest Perspective

Although flash memories can be developed into large-capacity products in terms of process technology, they have problems in productivity, reliability, and cost-effectiveness. Under these circumstances, Dataquest expects flash memories to take over the existing storage devices as follows:

- EPROMs/EEPROMs—Replacement will start in about 1993.
- Magnetic storage—Depending on whether the stated problems can be overcome and development capabilities achieved to meet diverse needs of future users (e.g., sector erasing size, method and speed, and package), 4Mb or larger flash memories will replace magnetic storage in notebook PCs and palmtops in approximately 1995.
  - We expect shipments of these PCs to reach 13 million units, most of which will be equipped with IC memory card slots, consuming 2MB to 4MB equivalent flash memories on the average. Thus, this market alone will amount to 50 million to 100 million 4Mb flash memories.
  - On the other hand, laptop or higher-end PCs will continue to use magnetic storage until 2000, when the per-bit cost of flash memories will cross over that of hard disk drives.

In conclusion, Dataquest believes that flash memories will grow to the size of the present EPROM market. Nevertheless, the flash memory segment is not likely to show such dramatic growth as to challenge the gigantic DRAM market. ■

By Akira Minamikawa

Company Analysis

Hitachi Ltd.: Diversifying a Sleeping Giant

Hitachi Ltd. was founded in 1910 and initially emphasized the development of heavy electrical equipment and industrial machinery. Over the years, the company continued to expand and diversify the scope of its business activities, resulting in Hitachi's growth into one of the largest and most diversified companies in the world.

Business Performance in Fiscal Year 1990

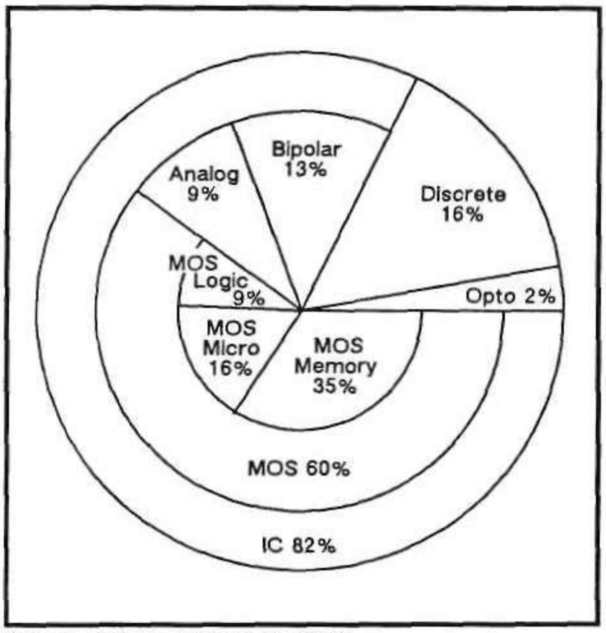
Hitachi recorded ¥7,737 billion sales in fiscal year (FY) 1990, which was the highest revenue among Japan's electronics companies. Although the sales of some Japanese electronics companies stalled in FY 1990, Hitachi achieved a constant revenue increase in both total sales and net income. The FY 1990 growth of 9.1 percent, while exceeding the rates of most of Hitachi's Japanese competitors, fell 2 percent short of its double-digit growth in FY 1989. Hitachi attributes its sluggish 1990 performance mostly to a softening in computer and semiconductor sales. To its credit, although Hitachi decreased its operating income, it managed to maintain its net income per sales ratio (a gauge of productivity) at the same level it attained during the previous year. Furthermore, Hitachi frequently ranks at or near the top of Japanese corporations that generate supplemental income from financial activities outside of their primary business ventures.

Hitachi Semiconductor

During 1990, Hitachi recorded $3,893 million in semiconductor revenue, ranking the company third among global competitors behind NEC Corporation and Toshiba Corporation. In Japan's domestic market, Hitachi captured the number two position previously occupied by Toshiba.

Figure 1 illustrates Hitachi's semiconductor product mix in 1990. As with most Japanese semiconductor manufacturers, Hitachi's semiconductor revenue is heavily dependent on commodity MOS memories, which accounted for more than one-third of its total semiconductor business. DRAMs contributed about 18 percent to total semiconductor revenue, translating to approximately 51 percent of Hitachi's MOS memory sales. About half of all DRAMs sold by Hitachi in 1990 were of the 4Mb variety. Although this figure was sufficient to propel Hitachi into the position of leading market supplier of 4Mb parts, 1990 saw a rapid erosion of 4Mb DRAM prices as demand fell short of both supply and booking projections. The result of these events was that while Hitachi's market share held firm, the DRAM business was not profitable during 1990.

Figure 1
Hitachi's 1990 Semiconductor Product Mix



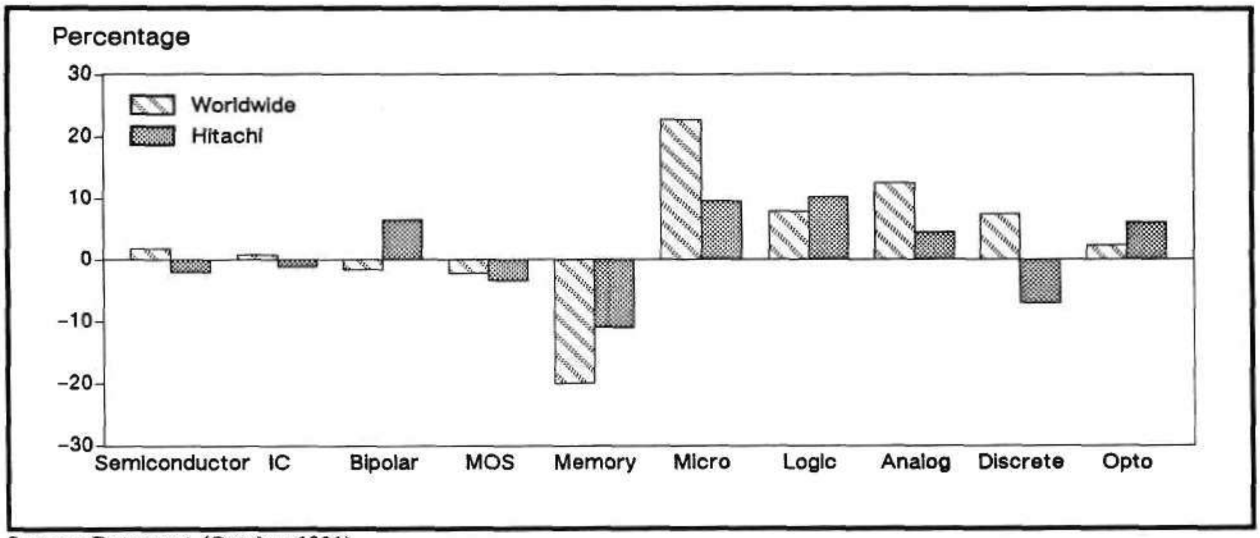
Source: Dataquest (October 1991)

Figure 2 compares Hitachi's semiconductor growth rates broken down by product category against corresponding product growth rates in the worldwide market for FY 1990. Whereas Hitachi weathered the 1990 MOS memory decline better than the industry as a whole, it appears to have failed to capitalize on the worldwide growth in the MOS microprocessor segment of the business.

Semiconductor Investment

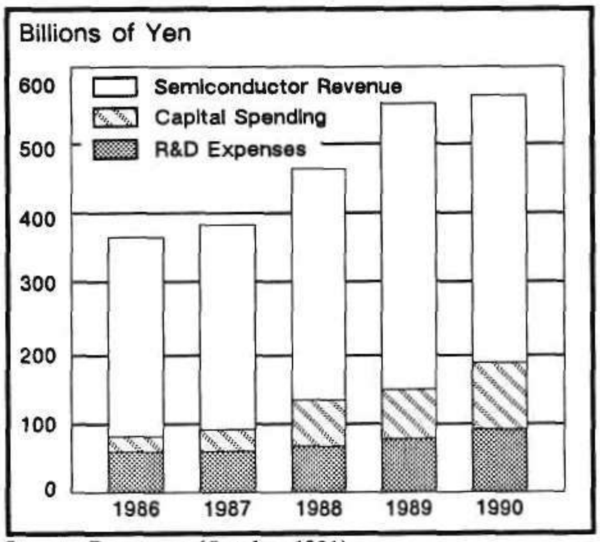
Figure 3 illustrates Hitachi's semiconductor capital spending and R&D expense trends against overall semiconductor revenue for the past five years. Capital spending and R&D costs have been steadily increasing to the point where Hitachi reinvested approximately one-third of its semiconductor revenue in 1990. In 1986, because of the semiconductor business downturn,

Figure 2
Hitachi's 1990 Growth Rate Compared with Worldwide Market



Source: Dataquest (October 1991)

Figure 3
Hitachi's Semiconductor Revenue and Investment



Source: Dataquest (October 1991)

Hitachi cut its capital spending to ¥22 billion or about 6 percent of revenue. Analysts believe that this action resulted in Toshiba's forging ahead in the 1Mb DRAM race, and Hitachi has consequently been spending heavily to maintain a lead in the 4Mb competition.

In terms of R&D, Hitachi has been investing about 14 to 15 percent of semiconductor revenue. Although advanced MOS memory research captures the most attention, Hitachi's research encompasses a wider range of subjects than most of Japan's leading electronics companies. Many Japanese companies have been criticized for overemphasizing applications and not contributing sufficiently to fundamental advances through basic research; however, Hitachi has a corporate charter mandating that at least 1 percent of the corporate R&D expense be dedicated to funding basic research. In FY 1990, basic research accounted for over ¥4 billion. As a direct result of these policies regarding R&D investments, Hitachi filed more patents in the United States than any single institution during the past three years.

Hitachi has been investing more than 20 percent of total corporate capital spending on semiconductor manufacturing capabilities. Since Hitachi's semiconductor sales accounted for only 7.2 percent of total corporate revenue during 1990, a relatively small figure compared with competitors like NEC and Toshiba, Hitachi's commitment to gaining semiconductor market share is clear. Few companies have sufficiently deep pockets to be able to back this commitment with Hitachi's level of investment.

Dataquest Perspective

Hitachi, a leading supplier of everything from home appliances to heavy machinery and from semiconductors to supercomputers, is undeniably both vertically and horizontally diversified. During FY 1990, Hitachi's Information and Communication Systems and Electronic Devices Division generated 32.8 percent of the company's total revenue—a percentage that has been increasing steadily during the past few years. Key to the continued success of this division is the leading-edge semiconductor technology in which Hitachi is investing for the future. ■

By Junko Matsubara

In Future Issues

The following topics will be featured in future issues of Semiconductors Japan *Dataquest Perspective:*

- Japanese semiconductor R&D expense
- Digital signal processing (DSP) marketing trends
- Japanese semiconductor alliance update

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Dataquest Perspective

Semiconductors
Japan

Vol. 1, No. 1 October 28, 1991

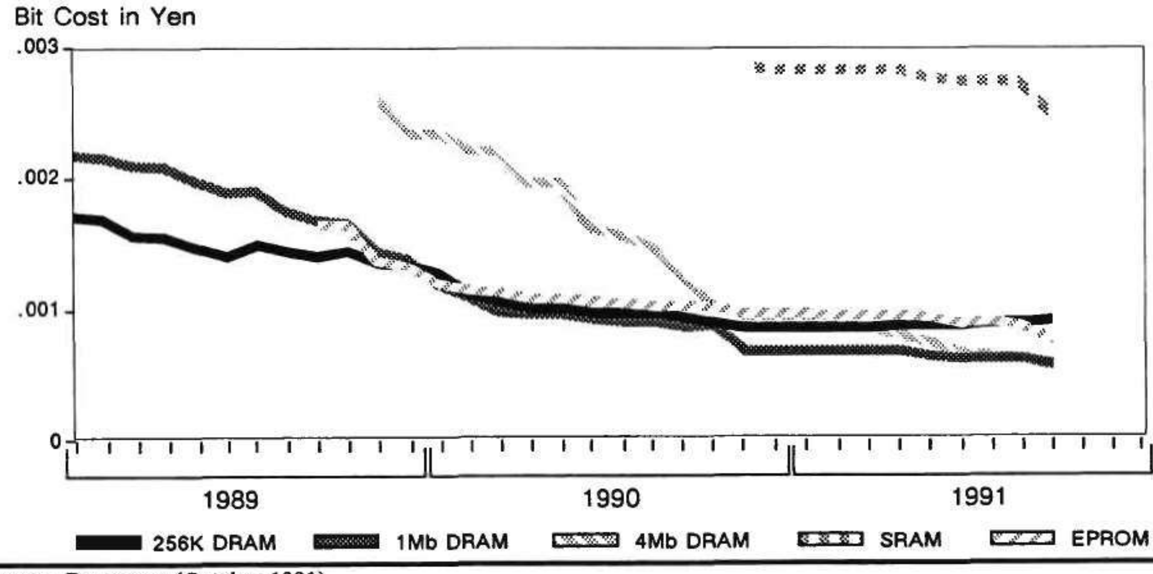
Pricing Update

DQ Monday Report: Volume Mean Pricing

Family	United States	Japan	Europe	Taiwan	Hong Kong	Korea
DRAM 1Mbx1-8	3.93	4.11	3.92	4.40	4.40	3.80
DRAM 256Kx1-8	1.70	1.72	1.65	1.43	1.50	1.10
DRAM 4Mbx1-8	15.13	15.87	16.20	18.25	18.40	15.00
EPROM 1Mb, 170ns	3.95	4.86	3.65	4.75	4.00	3.80
EPROM 2Mb, 170ns	7.85	11.38	7.10	8.75	8.00	7.30
SRAM 1Mb, 128Kx8	14.88	16.05	13.40	17.10	18.70	NA
SRAM 256K, 32Kx8	4.08	4.07	3.45	4.25	4.20	3.30
SRAM 64K, 8Kx8	1.90	1.53	1.65	1.60	1.50	1.20
68020-16	34.75	47.78	29.00	47.25	47.50	NA
80286-16	12.50	13.44	13.00	11.50	12.80	13.50
80386DX-25	152.50	167.97	160.00	189.00	193.00	NA
80386SX-16	50.00	64.95	55.00	58.50	63.20	55.00
R3000-25	127.00	147.45	132.00	NA	NA	NA

Note: These figures correspond with the *DQ Monday Report* dated October 7, 1991, and reflect prices in U.S. dollars.
NA = Not available
Source: Dataquest (October 1991)

Memory Bit Price in Japan



Source: Dataquest (October 1991)

Market Analysis

Semiconductor Equipment Market: Fear of New Trade Friction?

The U.S.-Japan Semiconductor Trade Arrangement has just been settled; however, another episode of trade friction is about to occur. This time, the target is upstream—semiconductor manufacturing equipment. Historically, the semiconductor equipment market has been dominated by the U.S. companies, but now significant portions of major wafer process equipment are Japanese made. Today the semiconductor market cannot do without advanced semiconductor equipment, particularly development of leading-edge devices. Thus, whether or not a chipmaker has the latest equipment can determine its success in the market.

The semiconductor equipment industry is highly competitive, and nearly 300 manufacturers—greatly varied in size—are flocking to serve the world market. This situation is in sharp contrast to the semiconductor market, which is dominated by electronics giants such as NEC Corporation and Toshiba Corporation. Also, the semiconductor equipment industry is characterized by a highly customized production process and full-time maintenance base. This article reviews recent changes in the semiconductor equipment market and the challenges facing the major Japanese manufacturers.

The Semiconductor Equipment Industry

Background

In Japan, approximately 550 companies are engaged in the semiconductor production business, including equipment and materials as well as distribution. Within this highly varied structure, the semiconductor equipment market has the following characteristics. First of all, complexity of semiconductor manufacturing process has led to segmentation and specialization of equipment makers according to major processes. Interestingly, these market segments vary greatly in terms of size of players. For instance, the stepper market is dominated by large companies—including Canon, Hitachi Ltd., and Nikon Corporation—whereas smaller companies are playing large roles in other segments. In terms of production, the wafer fab equipment market is highly customized to meet diverse needs of users; thus, small-lot production is the norm of the industry. Furthermore, customers are demanding. Sizable R&D and capital expenditure are required to catch up with production technology, which continues to advance; and the full-time maintenance base is required from the initial installation.

In 1990, the worldwide semiconductor equipment market amounted to approximately $5,027 million (see Figure 1). In the worldwide semiconductor device market, Japanese chipmakers moved ahead of their U.S. counterparts in share in 1986 and held a 50 percent share in 1990. The same trend was observed in the semiconductor equipment market with some time lag. In 1988, Japanese manufacturers achieved a 44.8 percent share to surpass the U.S. manufacturers; in 1990, they had a majority of the market. The U.S.-Japan trade friction regarding semiconductor devices surfaced in 1985 and developed into a major political issue between the two countries. The semiconductor equipment industry, which has been following in the footsteps of the semiconductor device industry, cannot watch this friction from a distance. This situation calls for more detailed analysis of semiconductor equipment industries in the two countries, particularly their major characteristics and differences.

Japanese Semiconductor Equipment Market

The Japanese semiconductor equipment market, which bottomed out in 1986, has been expanding steadily and recorded an annual 6 percent growth in 1990 when the semiconductor device market stagnated. During this period, U.S. manufacturers grew in share but below the market growth rate. Nevertheless, joint ventures by U.S. and Japanese companies boosted their share, and the combined share of U.S. equipment makers and joint ventures remained at a 20 percent level (see Figure 2).

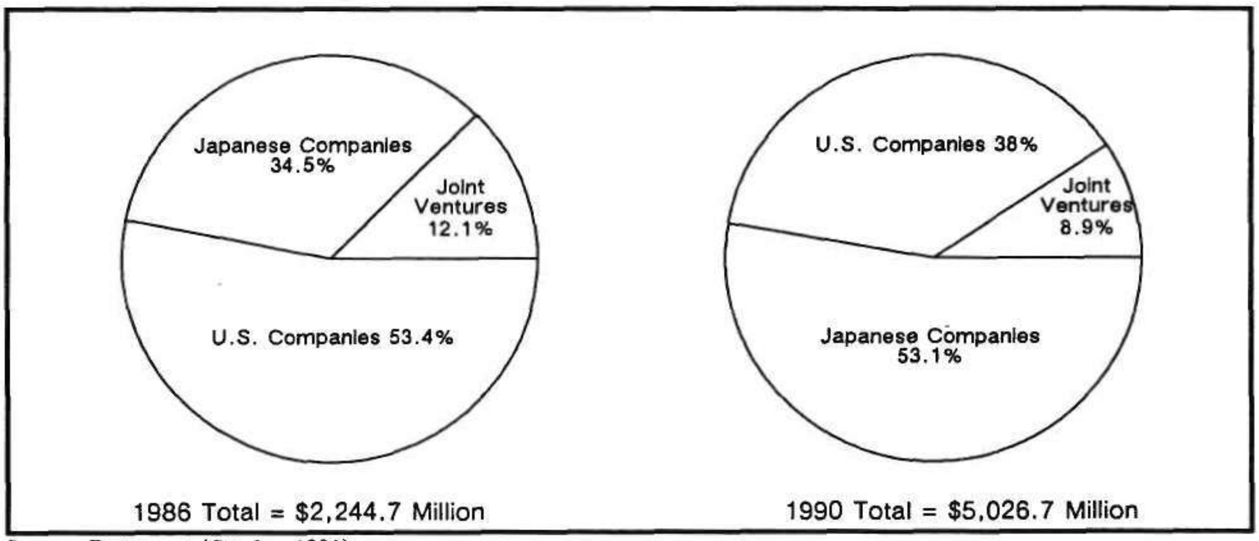
Originally, the U.S. equipment makers sold their products in Japan through sales representatives, but they faced difficulties in equipment modification to meet the needs of users, a long period required from installation to acceptance, and maintenance requirements. Meanwhile, Japanese equipment makers grew rapidly to threaten the U.S. companies' dominance—culminating in the 1985 and 1986 semiconductor recession, through which Japanese equipment manufacturers managed to survive and serve customers.

In contrast, leading U.S. manufacturers resorted to reduction in scale, mergers, and acquisitions, losing the confidence of Japanese device makers. It is easy to lose confidence in the equipment industry because a semiconductor maker can suffer a considerable loss if equipment breakdown stops a fab line for a full day. In this sense, the semiconductor industry is "equipment intensive," and relationships with equipment makers must be built upon reliability.

U.S. Semiconductor Equipment Market

The U.S. semiconductor equipment market is dominated by domestic manufacturers, which hold a nearly 80 percent share, and Japanese manufacturers have the rest (see Figure 3). There are several reasons for this low penetration of the U.S. market by Japanese companies. The first factor is the difference in products.

Figure 1
Semiconductor Equipment Market Share—Worldwide (Ownership)



Source: Dataquest (October 1991)

Figure 2
Semiconductor Equipment Market Share—Japanese Market (Ownership)

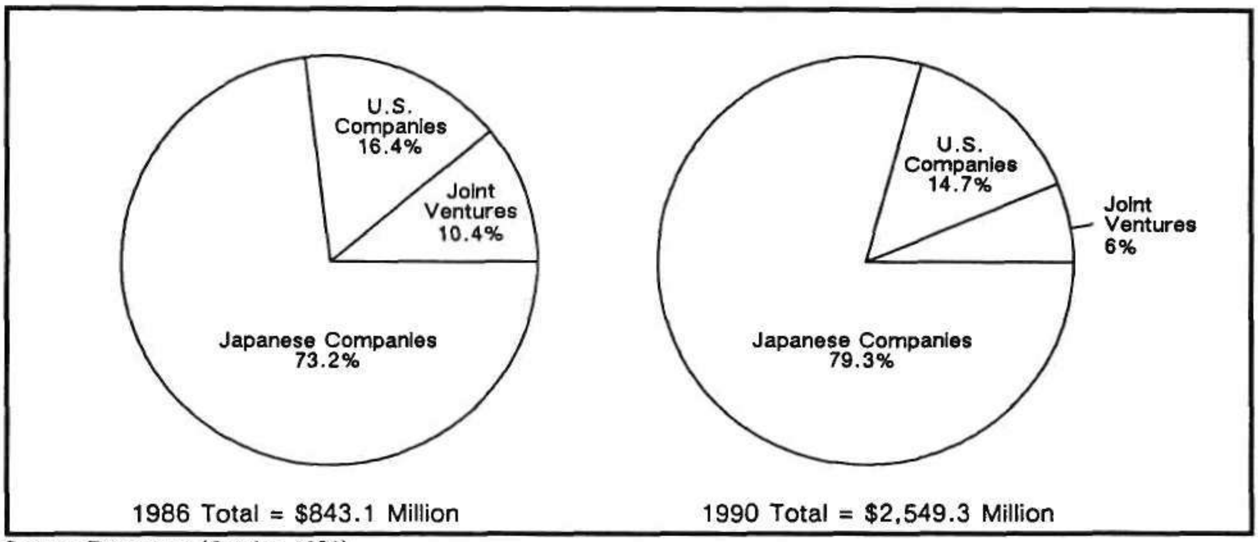


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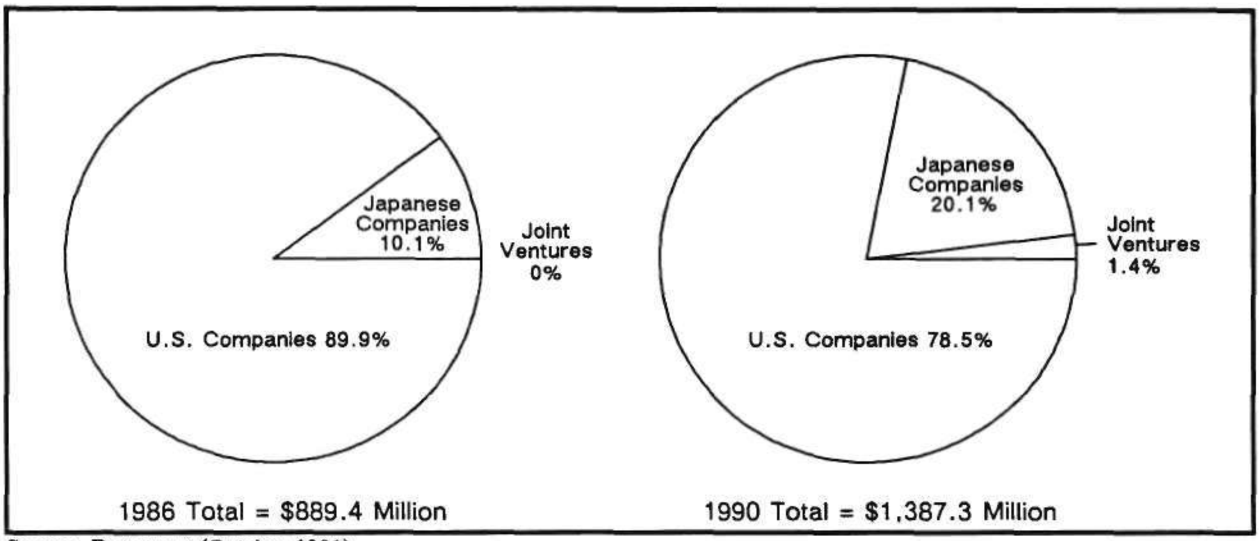
Figure 3
Semiconductor Equipment Market Share—U.S. Market (Ownership)



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Semiconductor production lines in the United States have approximately 400 fabrication lines, twice the number in Japan, as they mainly produce ASICs. In terms of profitability, it is difficult for the Japanese equipment makers, which have sales and maintenance bases for fabs generally in volume production, to do the same in the U.S. market characterized by small-lot production. As a result, only a few leading Japanese makers have marketing bases in the United States.

The second factor is the difference in the expected level of commercialization of wafer fab equipment. Unlike "back-end" testing and assembly equipment with relatively low maintenance requirements, leading-edge front-end equipment needs to be "perfected" through process technology by semiconductor chipmakers. Less-than-perfect equipment, if sold in the U.S. market, may result in demand for strong maintenance support and even spur a wave of litigation if it is found to be defective. Thus, it is safer for Japanese equipment makers to obtain acceptance by Japanese customers before supplying U.S. customers. Even then, there are some other hurdles to clear, including the burden of the product liability insurance and preparation of operation manuals. Finally, the slow movement of equipment makers in exploring overseas markets, compared with aggressive semiconductor makers, prevents them from introducing leading-edge products to Japan and the United States simultaneously.

Leading Makers in Major Segments

Japanese semiconductor equipment makers have been boosting their worldwide market shares year after year. The semiconductor equipment market consists of a variety of equipment, and each market segment is served by companies that vary greatly in size. In a sense, this is the market where any company, regardless of size, can dominate if excellent products are developed, although it is very difficult for everyone to stay at the top all the time. This fact is evident from analysis of regional market shares in major wafer fab equipment, which indicate that a leading worldwide manufacturer does not necessarily hold major shares in all regional markets; only Applied Materials Inc. and Nikon have achieved that status (see Table 1). Clearly, this situation is a result of the technology-oriented nature of the industry and lack of ability on the side of the Japanese makers to introduce new products to Japan and the United States simultaneously.

Looking into market segments, steppers—major lithography equipment—are dominated by Japanese makers such as Canon and Nikon. Although the market was originally dominated by GCA, the financial difficulty of that company and a shift to lens-based technology provided opportunities for Japanese camera manufacturers to enter and win the marketplace. The same trend is observed in the dry etching market, where Applied Materials maintained its number one

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PVD	Worldwide	ANELVA	Varian Associates	Material Research
	United States	Varian Associates	Material Research	ANELVA
	Japan	ANELVA	ULVAC Japan	Material Research

*A unit of General Signal
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position everywhere; but it was down to third place in the 1990 Japanese market, next to Tokyo Electron and Hitachi. Another important move is the emergence of U.S.-Japan joint ventures in various market segments (including MRC/Sony, Sumitomo/Eaton Nova, TEL/Varian, and Ulvac/BTU), suggesting that the industry is awash with strategic alliances and is on the way to a world without boarders.

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Supply capacities of wafer makers have not increased for some time, but demand has grown steadily as a result of new fab lines being added each year; thus, the worldwide wafer market experienced a tightening of supply in 1990. Now that Japanese and German makers hold a 95 percent share of the world market, if they fail to fulfill the responsibility for stable supply, wafers are likely to become a major source of trade friction with the United States for the alleged "control" of semiconductor production.

The future wafer business will require R&D efforts on higher-grade and larger wafers to meet ever-increasing integration of semiconductor devices. This involves a high-risk investment for wafer makers that are expected to satisfy the demand from a global perspective. Finally, wafer prices are suspected as another source of friction; prices in Japan are about 30 percent higher than in other markets. Some might see this situation as dumping by Japanese makers in overseas markets. However, it is due to a difference in specifications because Japanese fab lines—mainly producing memories—are using higher-grade wafers.

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Timely Supply

Semiconductor equipment is basically custom made, not ready made. Increasing complexity of equipment designed for higher device integration is another reason for small-lot production.

As mentioned earlier, supply of the most advanced equipment by Japanese makers to the United States market is delayed, because it is developed jointly with Japanese semiconductor manufacturers that receive the first round of supply. In this sense, Japanese equipment makers are right to some degree in saying that their responsibilities to U.S. customers lie in the local customer support system including the technical staff and the supply of field-verified products. Also, the U.S. market environment, with its high risk of litigation, urges Japanese makers to supply "perfected" products.

Dataquest Perspective

Semiconductor equipment has surfaced as a new source of trade friction between Japan and the United States because of its significance in creating key technologies that shape the future of the semiconductor industry. Certainly, Japanese equipment makers enjoy an advantageous position by being located in a production base of DRAMs, which are technology drivers. Nevertheless, as their livelihood lies in developing products to meet increasingly sophisticated needs of semiconductor makers, the equipment makers capable of satisfying such needs should obtain the major share in any market.

Since the semiconductor equipment market is picked out as another "imbalance," further efforts to promote communication between the industries in the two countries, including the standardization of equipment, will be important. Japanese manufacturers should be encouraged by the success of their joint ventures in Japan and consider more aggressive expansion into overseas markets. Because Japanese equipment makers hold a majority of the worldwide semiconductor equipment market, they are expected to pursue a "mutually beneficial" strategy worldwide, including the U.S. market, that is conducive to sustainable growth of the semiconductor industry. ■

By Kazunori Hayashi
Kunio Achiwa

Product Analysis

Flash Memories: A Challenge to DRAMs?

Recently, flash memories have received the attention of semiconductor makers and users as nonvolatile memories having capacity emulating DRAMs. As a solution for overerase and a limited number of reloadings become feasible, flash memories are expected to replace magnetic storage and tapes in the near future. Some industry observers even predict that they will grow to a market size similar to DRAMs.

This analysis reviews advantages and disadvantages of flash memories and examines their market outlook from cost and other aspects.

Present Flash Memory Market

At the outset, flash memories were developed by several memory makers relying on different approaches and processes in terms of the number of reloadings, supply voltage, block erasing, and other aspects. With the recent standardization of these technical features, flash memories are expected to grow into a major market rivaling DRAMs. Flash memories are expected to replace EPROMs, EEPROMs, and magnetic disks and to extend into electronic still cameras, IC cards, and other fast-growing system markets.

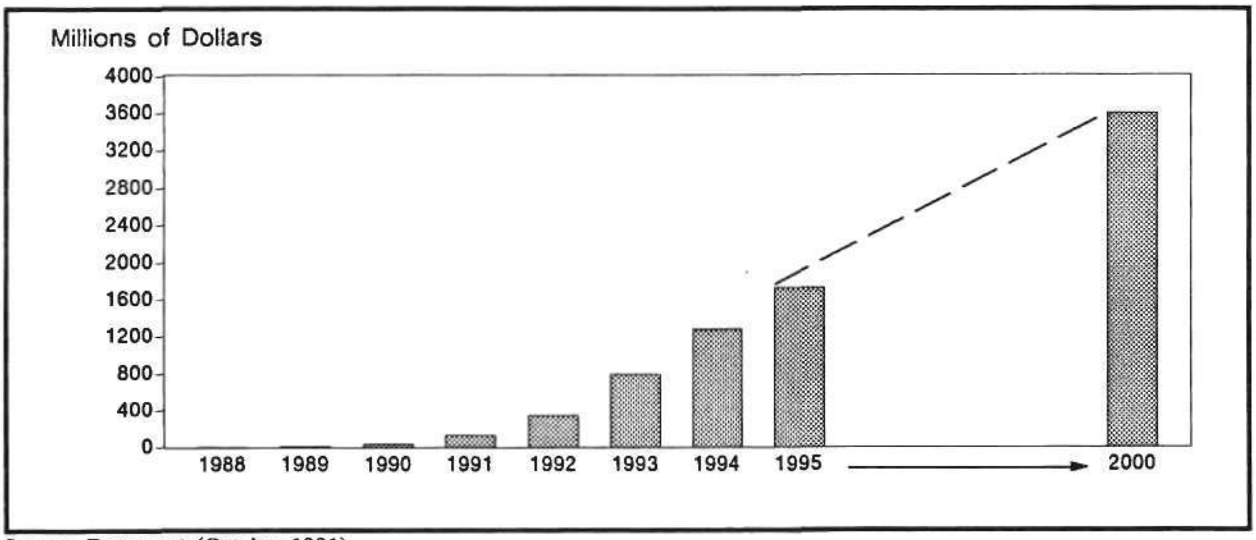
Currently, flash memories are incorporated into printers, copiers, and disk controllers, while being commercialized as a storage medium for some PCs. The worldwide flash memory market was ¥5 billion (U.S.$35 million) in 1990 (see Figure 1). Intel Corporation accounted for 90 percent of this market, followed by Toshiba Corporation, Texas Instruments Inc., and Atmel Corporation.

Flash Memory Applications

Replacing EPROMs and EEPROMs

In terms of their functions and characteristics, the first major application of flash memories is to replace EPROMs, EEPROMs, and one-time programmables (OTPs). EPROMs and EEPROMs are widely used as nonvolatile memories in system products using microcontrollers. EPROMs, while achieving a high degree of integration

Figure 1
Worldwide Flash Memory Forecast
(Millions of Dollars)



Source: Dataquest (October 1991)

because they have one transistor/cell, take relatively long data reloading time. On the other hand, EEPROMs are capable of reloading data in a system electronically, but have a low degree of integration as a result of having two transistors/cell. Flash memories have advantages of both devices and can be used to write system control programs for printers, factory automation equipment, and cellular phones. Also, they can be used to store error data for copiers and facsimiles.

In terms of cost, flash memories can easily replace EPROMs that use windowed packages, as their chip sizes are the same. Furthermore, flash memories can be reloaded 10,000 to 100,000 times, compared to approximately 100 times for EPROMs. In terms of per-bit cost, flash memories will cross over SRAMs, then EEPROMs, and EPROMs in about 1995 (see Figure 2). The crossing with DRAM costs will take longer, however; although cell size can be reduced in DRAMs, flash memories cannot be reduced to DRAM size because of the additional circuits required.

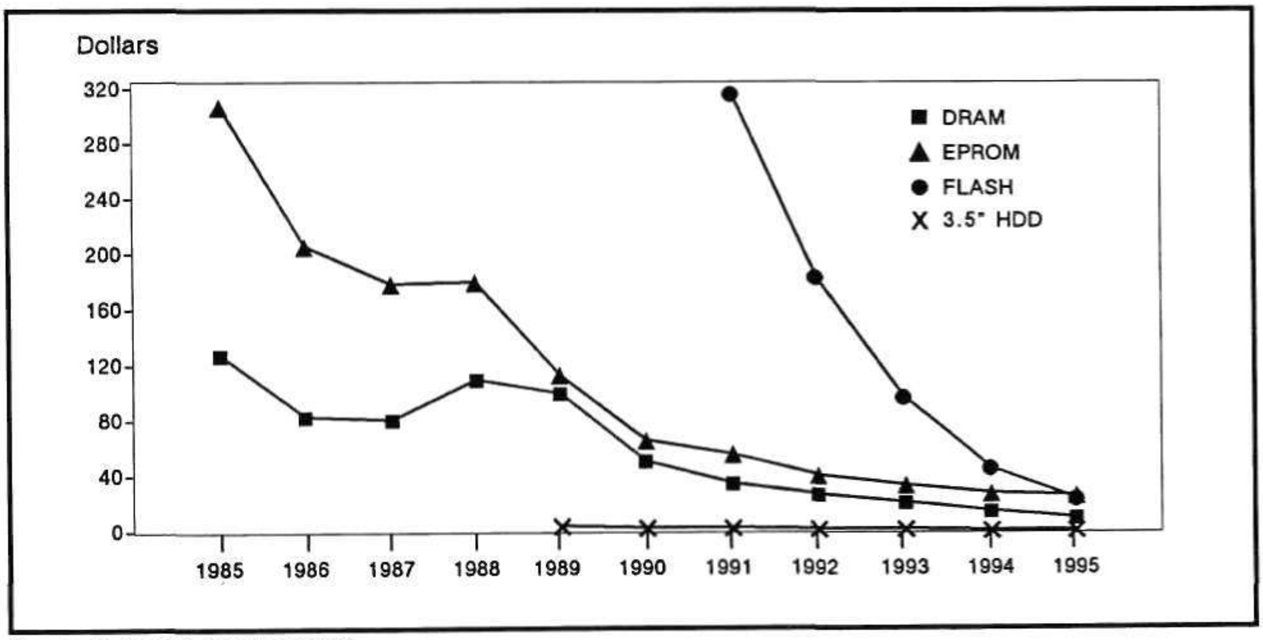
Replacing Magnetic Media

The next target for replacement is a gigantic memory medium market. Flash memories offer the following advantages over magnetic storage:

- High-speed access
- Portability
- Possibility of further size and weight reduction due to absence of magnetic head and motor
- High reliability

Nevertheless, flash memories have a problem in comparatively high per-bit cost, which, as Dataquest sees it, will not cross over that of magnetic media before the year 2000. This is partly because the per-bit price of semiconductor memories is not going down as fast as in the past, whereas the per-bit price of small magnetic disk units is falling at a pace similar to ICs in recent years. (Up to 1986, the per-bit cost of memory ICs was cut in quarters every three years, but it decreased much slower thereafter.) Another unfavorable factor for flash memories is impressive downsizing of magnetic storage; a 2.5-inch hard disk drive of less than 15mm thick has recently been introduced. Also, to replace floppy disk drives, flash memories should have a sector-by-sector erasing capability. For flash memories to be used as memory cards in portable PCs, supply voltage needs to be standardized to 5V so as to reduce power units. Although these problems can be technically overcome, certain cost impacts will be inevitable. Thus it is reasonable to expect that flash memories will be used in portable PCs,

Figure 2
Memory and Hard Disk Drive Forecast
(per Megabyte)



Source: Dataquest (October 1991)

which cannot physically accommodate magnetic disk drives, and in systems that require low power consumption and high-speed access. However, it will be a long time before flash memories replace magnetic storage in mainframes and workstations.

Flash memories will certainly accelerate market acceptance of IC memory cards, which will enable system makers to develop smaller products—one strategic feature to cope with increasing competition. As a result, expanded memory boards are likely to be replaced with IC memory cards; PCs will be equipped with IC memory card slots.

Dataquest Perspective

Although flash memories can be developed into large-capacity products in terms of process technology, they have problems in productivity, reliability, and cost-effectiveness. Under these circumstances, Dataquest expects flash memories to take over the existing storage devices as follows:

- EPROMs/EEPROMs—Replacement will start in about 1993.
- Magnetic storage—Depending on whether the stated problems can be overcome and development capabilities achieved to meet diverse needs of future users (e.g., sector erasing size, method and speed, and package), 4Mb or larger flash memories will replace magnetic storage in notebook PCs and palmtops in approximately 1995.
  - We expect shipments of these PCs to reach 13 million units, most of which will be equipped with IC memory card slots, consuming 2MB to 4MB equivalent flash memories on the average. Thus, this market alone will amount to 50 million to 100 million 4Mb flash memories.
  - On the other hand, laptop or higher-end PCs will continue to use magnetic storage until 2000, when the per-bit cost of flash memories will cross over that of hard disk drives.

In conclusion, Dataquest believes that flash memories will grow to the size of the present EPROM market. Nevertheless, the flash memory segment is not likely to show such dramatic growth as to challenge the gigantic DRAM market. ■

By Akira Minamikawa

Company Analysis

Hitachi Ltd.: Diversifying a Sleeping Giant

Hitachi Ltd. was founded in 1910 and initially emphasized the development of heavy electrical equipment and industrial machinery. Over the years, the company continued to expand and diversify the scope of its business activities, resulting in Hitachi's growth into one of the largest and most diversified companies in the world.

Business Performance in Fiscal Year 1990

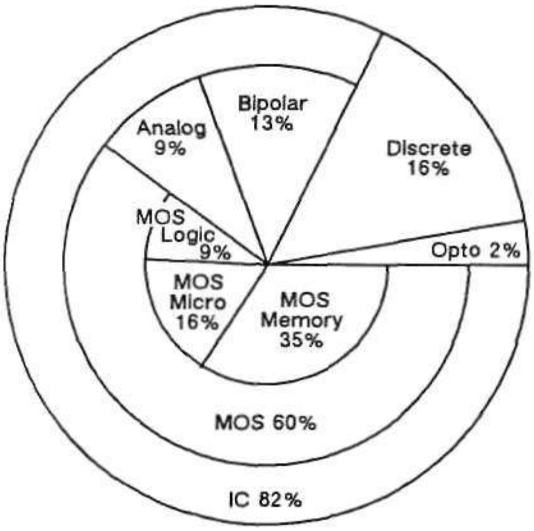
Hitachi recorded ¥7,737 billion sales in fiscal year (FY) 1990, which was the highest revenue among Japan's electronics companies. Although the sales of some Japanese electronics companies stalled in FY 1990, Hitachi achieved a constant revenue increase in both total sales and net income. The FY 1990 growth of 9.1 percent, while exceeding the rates of most of Hitachi's Japanese competitors, fell 2 percent short of its double-digit growth in FY 1989. Hitachi attributes its sluggish 1990 performance mostly to a softening in computer and semiconductor sales. To its credit, although Hitachi decreased its operating income, it managed to maintain its net income per sales ratio (a gauge of productivity) at the same level it attained during the previous year. Furthermore, Hitachi frequently ranks at or near the top of Japanese corporations that generate supplemental income from financial activities outside of their primary business ventures.

Hitachi Semiconductor

During 1990, Hitachi recorded $3,893 million in semiconductor revenue, ranking the company third among global competitors behind NEC Corporation and Toshiba Corporation. In Japan's domestic market, Hitachi captured the number two position previously occupied by Toshiba.

Figure 1 illustrates Hitachi's semiconductor product mix in 1990. As with most Japanese semiconductor manufacturers, Hitachi's semiconductor revenue is heavily dependent on commodity MOS memories, which accounted for more than one-third of its total semiconductor business. DRAMs contributed about 18 percent to total semiconductor revenue, translating to

Figure 1
Hitachi's 1990 Semiconductor Product Mix



Source: Dataquest (October 1991)

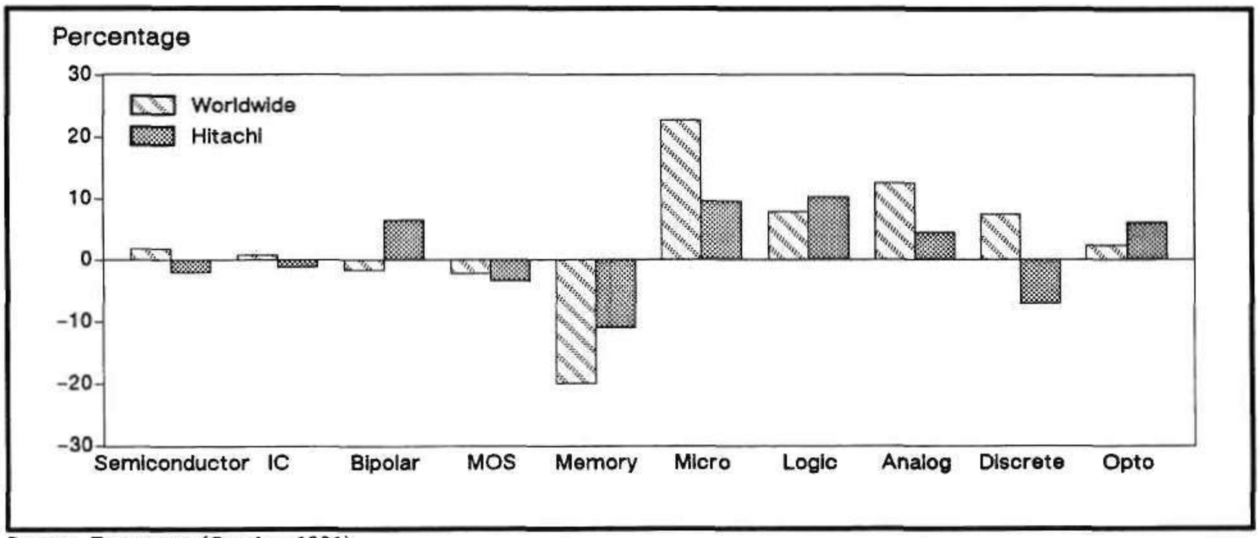
approximately 51 percent of Hitachi's MOS memory sales. About half of all DRAMs sold by Hitachi in 1990 were of the 4Mb variety. Although this figure was sufficient to propel Hitachi into the position of leading market supplier of 4Mb parts, 1990 saw a rapid erosion of 4Mb DRAM prices as demand fell short of both supply and booking projections. The result of these events was that while Hitachi's market share held firm, the DRAM business was not profitable during 1990.

Figure 2 compares Hitachi's semiconductor growth rates broken down by product category against corresponding product growth rates in the worldwide market for FY 1990. Whereas Hitachi weathered the 1990 MOS memory decline better than the industry as a whole, it appears to have failed to capitalize on the worldwide growth in the MOS microprocessor segment of the business.

Semiconductor Investment

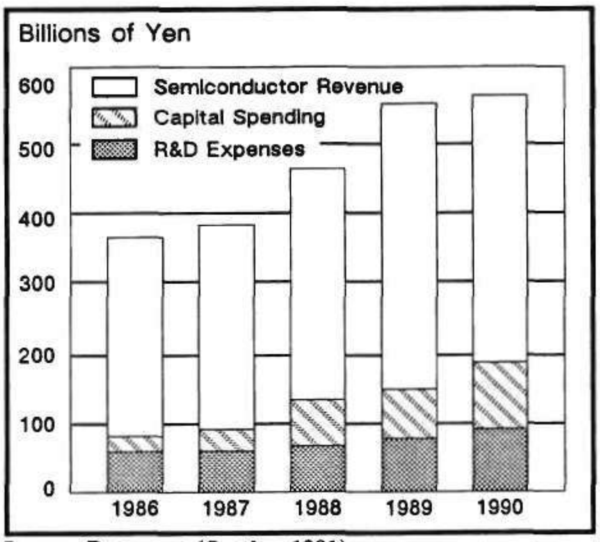
Figure 3 illustrates Hitachi's semiconductor capital spending and R&D expense trends against overall semiconductor revenue for the past five years. Capital spending and R&D costs have been steadily increasing to the point where Hitachi reinvested approximately one-third of its semiconductor revenue in 1990. In 1986, because of the semiconductor business downturn,

Figure 2
Hitachi's 1990 Growth Rate Compared with Worldwide Market



Source: Dataquest (October 1991)

Figure 3
Hitachi's Semiconductor Revenue and Investment



Source: Dataquest (October 1991)

Hitachi cut its capital spending to 22 billion or about 6 percent of revenue. Analysts believe that this action resulted in Toshiba's forging ahead in the 1Mb DRAM race, and Hitachi has consequently been spending heavily to maintain a lead in the 4Mb competition.

In terms of R&D, Hitachi has been investing about 14 to 15 percent of semiconductor revenue. Although advanced MOS memory research captures the most attention, Hitachi's research encompasses a wider range of subjects than most of Japan's leading electronics companies. Many Japanese companies have been criticized for overemphasizing applications and not contributing sufficiently to fundamental advances through basic research; however, Hitachi has a corporate charter mandating that at least 1 percent of the corporate R&D expense be dedicated to funding basic research. In FY 1990, basic research accounted for over ¥4 billion. As a direct result of these policies regarding R&D investments, Hitachi filed more patents in the United States than any single institution during the past three years.

Hitachi has been investing more than 20 percent of total corporate capital spending on semiconductor manufacturing capabilities. Since Hitachi's semiconductor sales accounted for only 7.2 percent of total corporate revenue during 1990, a relatively small figure compared with competitors like NEC and Toshiba, Hitachi's commitment to gaining semiconductor market share is clear. Few companies have sufficiently deep pockets to be able to back this commitment with Hitachi's level of investment.

Dataquest Perspective

Hitachi, a leading supplier of everything from home appliances to heavy machinery and from semiconductors to supercomputers, is undeniably both vertically and horizontally diversified. During FY 1990, Hitachi's Information and Communication Systems and Electronic Devices Division generated 32.8 percent of the company's total revenue—a percentage that has been increasing steadily during the past few years. Key to the continued success of this division is the leading-edge semiconductor technology in which Hitachi is investing for the future. ■

By Junko Matsubara

In Future Issues

The following topics will be featured in future issues of Semiconductors Japan *Dataquest Perspective:*

- Japanese semiconductor R&D expense
- Digital signal processing (DSP) marketing trends
- Japanese semiconductor alliance update

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Dataquest Perspective

Semiconductors
Japan

Vol. 0, No. 2 **September 30, 1991**

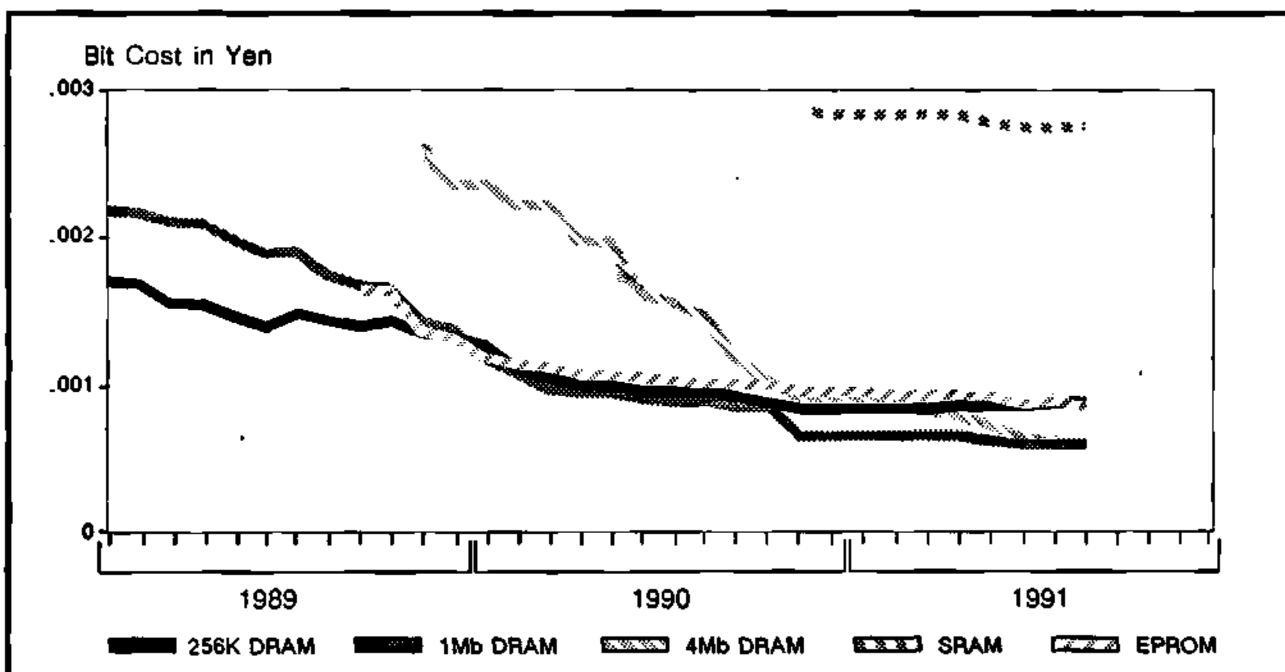
Pricing Update

DQ Monday Report: Volume Mean Pricing

Family	United States	Japan	Europe	Taiwan	Hong Kong	Korea
DRAM 1Mbx1-8	4.08	4.24	3.95	4.75	4.80	3.90
DRAM 256Kx1-8	1.70	1.69	1.65	1.50	1.55	1.10
DRAM 4Mbx1-8	15.13	17.19	15.50	18.45	21.00	15.50
EPROM 1Mb, 170ns	4.00	5.08	4.00	5.50	4.00	3.80
EPROM 2Mb, 170ns	7.93	12.43	8.00	9.30	8.00	7.30
SRAM 1Mb, 128Kx8	15.13	15.91	13.60	17.50	19.00	NA
SRAM 256K, 32Kx8	4.10	4.06	3.70	4.33	4.80	3.30
SRAM 64K, 8Kx8	2.00	1.54	1.65	1.65	1.50	1.20
68020-16	35.00	50.46	31.00	47.25	49.50	NA
80286-16	12.00	14.26	13.00	12.90	12.80	13.50
80386DX-25	152.50	179.16	170.00	210.00	193.00	NA
80386SX-16	50.00	65.81	55.00	62.00	63.20	55.00
R3000-25	127.50	149.91	132.00	NA	NA	NA

NA = Not available
Note: These figures correspond with the *DQ Monday Report* dated September 9, 1991. Prices shown are in U.S. dollars.
Source: Dataquest (September 1991)

Figure 1
Memory Bit Price in Japan



Source: Dataquest (September 1991)

Market Analysis

Japanese Semiconductor Industry Pulse—September 1991: Asian Market is Growing

This report is a monthly update that monitors changes in the Japanese semiconductor markets. The intention of this publication is to present indicators in the semiconductor industry. The data for the graphs are sourced from both the Japanese Ministry of International Trade and Industry (MITI) and Ministry of Finance (MOF) (see Figures 1 through 4). Please note that export and import figures include ICs only. The commentary and analyses are solely those of Dataquest.

Production

According to the MITI flash report, total Japanese semiconductor production for June was ¥266,630 million, representing a 9.3 percent increase from the previous month and 7.7 percent growth from June 1990. On a product-line basis, MOS IC production was ¥183,713 million,

Figure 1
Japanese IC Production

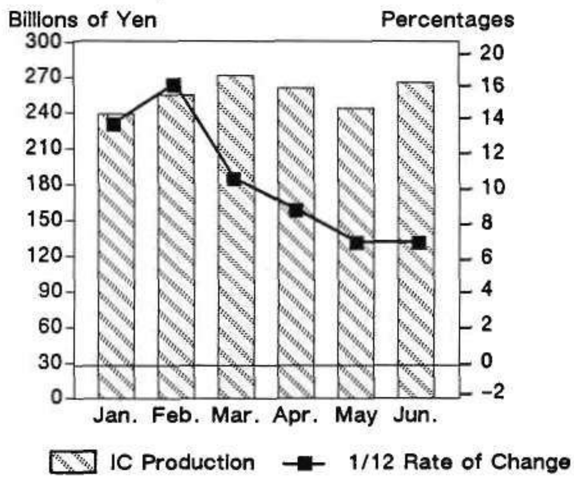


Figure 2
Japanese IC Inventory

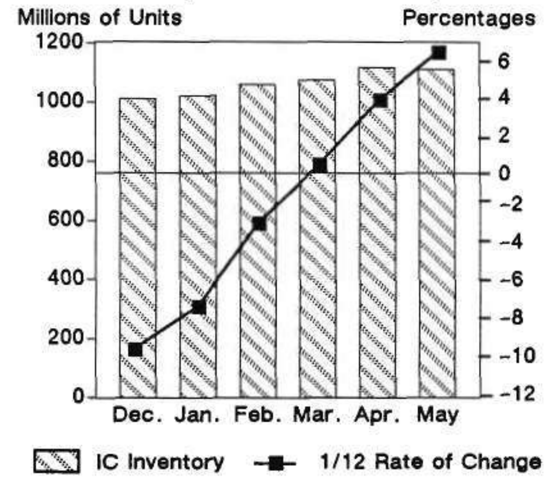


Figure 3
Japanese IC Exports

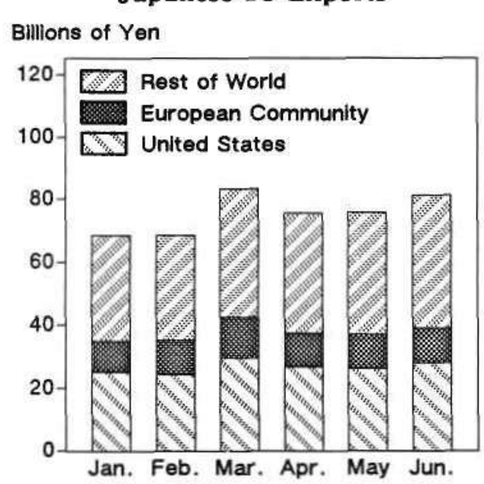
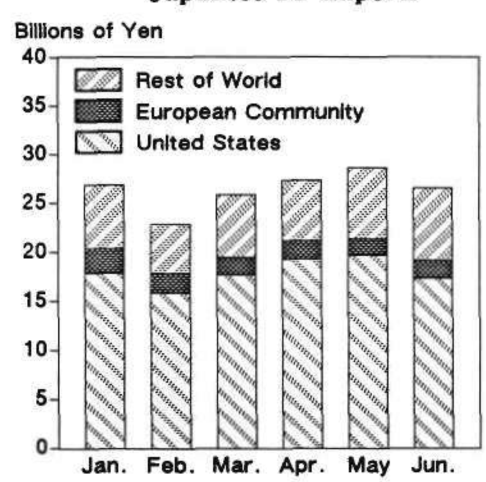


Figure 4
Japanese IC Imports



Source: MITI, MOF, Dataquest (September 1991) for a 9.5 percent increase from May 1991 and a 7.5 percent increase from June 1990. Bipolar digital IC production was ¥20,596 million, up 22.3 percent from May 1991 but down 3.7 percent from June 1990. Analog IC production was ¥62,321 million, representing 5.0 percent growth from May 1991 but 12.8 percent growth from June 1990.

Inventory

According to MITI's final statistics report, Japanese IC inventory in May 1991 was 1,111 million units, a 0.7 percent decrease from the previous month but a 6.6 percent increase from May 1990. On a product-line basis, MOS IC inventory stood at 474 million units, a decrease of 1.2 percent from the previous month but a 9.3 percent increase from May 1990. Bipolar digital IC inventory was 182 million units, up 1.8 percent from the previous month and up 9.8 percent from May 1990. Analog IC inventory was 454 million units, a decrease of 1.1 percent from the previous month but a growth of 2.7 percent from May 1990.

Exports

According to the MOF trade report, Japanese total packaged IC exports in June were ¥81.2 billion, representing a 7.0 percent increase from the previous month but a 3.5 percent decline from June 1990. On a regional basis, exports to the United States amounted to ¥27.9 billion, up 7.3 percent from the previous month but down 6.5 percent from June 1990. Exports to the European Community (EC) were 11.2 billion, increasing 2.2 percent from the previous month but decreasing 20.8 percent from June 1990. Exports to the other regions were ¥42.0 billion, representing an increase of 8.2 percent from the previous month and 4.8 percent from June 1990.

Imports

The MOF trade report states that Japan's June 1991 importation of packaged ICs was ¥26.6 billion. This figure represents a 7.0 percent decrease from the previous month but 0.1 percent growth from June 1990. On a regional basis, IC imports from the United States were ¥17.4 billion, a decrease of 11.8 percent from the previous month and an increase of 6.8 percent from June 1990. IC imports from the EC were ¥1.8 billion, increasing 8.1 percent from the previous month but declining 17.2 percent from June 1990. IC imports from the other regions were ¥7.4 billion, representing a 2.6 percent increase from the previous month and a 28.8 percent increase from June 1990.

Dataquest Perspective

Japanese IC production for June grew 7.7 percent from June 1990; MOS ICs and analog ICs increased 7.5 percent and 12.8 percent, respectively, from June 1990. However, MOS memory has been declining continuously since December 1990 as a result of the 4Mb DRAM price erosion and sluggish PC market. On the other hand, the analog IC market has been experiencing double-digit growth for six months.

Although imports have not grown greatly, imports from other countries have been increasing steadily, especially those from Asia and Europe. Japan imports mainly MOS memory from Asia and MOS micro, MOS memory, and analog devices from Europe. Thus, there are good opportunities for Asian and European companies in the Japanese market.

Dataquest expects Japanese exports to Asia to grow constantly, making the Asian market more important for the Japanese semiconductor industry.

A big change has not been seen in exports, but exports of MOS logic and analog to Asia grew, unlike those to the United States and Europe. Dataquest expects Japanese exports to Asia to grow constantly, making the Asian market more important for the Japanese semiconductor industry. We do not expect exports to Europe to experience a large increase, however, because of the local content restrictions. ■

By Akira Minamikawa

Company Analysis

The Japanese Electronics Companies: Fiscal Year 1990 Financial Analysis

The majority of Japanese electronics companies ended their fiscal year (FY) for 1990 on March 31, 1991. Following last year's format, Dataquest will publish two reports concerning the yearly financial performance of Japan's top electronics companies. The first, a newsletter published earlier this year, was entitled "Electronics Companies' Fiscal Year 1990 Financial Results" (see JSIS newsletter number 1991-16). The purpose of this *Dataquest Perspective* article is to provide an update to that newsletter as well as to generate a more detailed financial profile of a few of Japan's top electronics companies. This article examines the financial reports of five Japanese electronics companies: Hitachi Ltd., Matsushita Electric Industrial Co. Ltd., Mitsubishi Electric Corporation, NEC Corporation, and Toshiba Corporation. The financial figures of these companies will be compared to the 1990 financial results of AT&T and Intel Corporation in order to yield some insight into the differences in business operating modes between Japanese and U.S. corporations.

Semiconductor Industry Stagnation

Forecasts for fiscal year 1990 in Japan were generally pessimistic because worldwide economic and political conditions were expected to have a greater impact on the domestic economy. A stock market collapse earlier in the year and steadily rising interest rates for most of the year gave good indications of a slowing Japanese economy. The military conflict in the Middle East reinforced these economic forecasts, leading many analysts to predict that Japan's economy would enter a recession by the middle of FY 1990. Despite the indicators and predictions, however, Japan avoided a recession during FY 1990.

Table 1 depicts the financial performance of our five Japanese and two U.S. companies under scrutiny. All five Japanese companies listed here reported their all-time high corporate sales in FY 1990. However, in terms of net income, NEC and Toshiba showed negative growth, with NEC's net income dropping 36.2 percent from FY 1989. This drop in income exceeded all others. Although Hitachi, Matsushita, and Mitsubishi increased their net income, in comparison with last year's double-digit growth, these growth rates were not impressive.

. . . most Japanese companies now expect very little growth or even negative growth in both total sales and net income.

From a historical perspective, FY 1990 appeared to be at the bottom of a four- or five-year business cycle—the so-called "Silicon Cycle." Absolute semiconductor revenue for Mitsubishi and NEC declined from the previous year, while all five companies showed a decrease in the ratio of semiconductor revenue to total corporate sales revenue. The net margins for major memory manufacturers such as NEC suffered from rapid memory price erosion, particularly in the DRAM markets. A weak U.S. economy also played a role in the slowdown of Japanese electronics exports during 1990.

Although Japanese semiconductor sales declined 2.1 percent, the semiconductor applications market in Japan grew 8.5 percent in calendar year 1990. Both Hitachi and Matsushita are known to be well-diversified companies. Because semiconductor-to-total-corporate sales ratios at both Hitachi and Matsushita were rather small compared with the remaining three companies, a vigorous consumer applications market allowed Hitachi and Matsushita to elude the adverse affects of a global semiconductor industry downturn.

It is interesting to note that although all five companies showed a decline in operating income margin from last year, Hitachi and Matsushita maintained the same level of net income margin as produced in the previous year. This fact indicates that both companies had income or positive cash flow from stock dividends and ventures outside of their primary businesses relative to their interest payments—implying that either their extra income was

Table 1
Electronics Companies' Financial Results—Fiscal Year 1990 (Billions of Yen)

	Hitachi	Matsushita	Mitsubishi	NEC	Toshiba	AT&T[1]	Intel[2]
Total Sales	7,737	6,599	3,316	3,699	4,695	5,369	565
Total Net Income	230	259	80	54	121	394	94
Change of Net Income (%)	9.1	9.9	3.9	-36.2	-8.3	1.4	66.3
Total Asset	8,526	8,761	3,318	3,930	5,530	6,304	774
Operating Income Margin (%)	6.5	7.2	6.3	5.8	5.6	12.9	21.9
Net Income/Total Sales (%)	3.0	3.9	2.4	1.5	2.6	7.3	16.6
Semiconductor Sales[3]	561	280	334	705	680	124	457
S/C Sales/Total Sales (%)	7.2	4.2	10.1	19.1	14.5	2.3	80.9
Foreign Sales/Total Sales (%)	24.0	45.0	22.6	23.4	31.0	NA	46.0
Corporate R&D/Sales (%)	6.3	5.8	5.5	7.6	6.4	6.5	13.2
Sales/Employee (¥M)	25.113	31.299	34.635	31.347	31.704	19.617	23.630
Net Income/Employee (¥M)	0.747	1.228	0.833	0.461	0.816	1.439	3.917
5-Year CAGR							
Sales (%)	8.7	9.1	12.0	10.2	9.2	2.2	32.7
Net Income (%)	23.6	13.3	-65.6	38.0	37.1	10.2	NM

[1]AT&T's fiscal year ended December 31, 1990.
[2]Intel's fiscal year ended December 29, 1990.
[3]Semiconductor sales are estimated by calendar year.
Source: Dataquest (September 1991)

NA = Not available
NM = Not meaningful

particularly high, and thus as productive as their primary business, or that their cost of capital was unusually low. It is probably no coincidence that Hitachi and Matsushita recently were listed as major recipients of stock loss compensation in the highly publicized scandal now rocking the Japanese financial community.

Higher interest rates have had an impact on the capital spending trends of most Japanese electronics companies.

In terms of productivity, the sales-per-employee figures of the five Japanese companies exceeded those of both AT&T and Intel. In contrast to their high relative productivity figures, the five companies all had significantly lower net income per employee. Specifically, NEC's net income per employee was less than one-eighth the level attained by the very profitable Intel during FY 1990. This low net income per employee has become a virtual hallmark of Japanese companies and is possibly a reflection of the emphasis all Japanese companies place on competitive pricing to gain market share. Evidently, this norm of the Japanese business community does not appear to threaten consumer confidence in stock purchases by the buying public.

Financial Ratios

Table 2 compares selected financial ratios of the five sample Japanese companies with the corresponding approximate U.S. electronics industry average figures. The U.S. average ratios and formulas were sourced from both the Dun & Bradstreet Business Credit Service and Robert Morris Associates.

The Japanese companies have much smaller current ratios and quick ratios than those of the

Table 2
Five Japanese Companies' Financial Ratios—Fiscal Year 1990

	Hitachi	Matsushita	Mitsubishi	NEC	Toshiba	U.S. Industry Average
Liquidity Ratio						
Current Ratio	1.56	1.39	1.28	1.18	1.22	2.40
Quick Ratio	1.12	1.09	0.92	0.65	0.84	1.20
Sales/NWC	3.76	5.38	6.78	10.51	7.17	4.10
NWC/Total Assets	0.24	0.14	0.15	0.09	0.12	NA
Leverage Ratio						
Debt-Equity Ratio	0.41	0.30	0.94	1.07	0.98	NA
Fixed/Worth	0.58	0.28	0.77	1.13	0.85	0.50
Efficiency Ratio						
Total Asset Turnover	0.95	0.79	1.02	0.97	0.88	1.20
Net Profit Margin (%)	5.4	6.3	5.9	5.4	6.6	NA
Profitability Ratio						
Return on Sales (%)	7.3	9.1	5.5	3.6	5.5	3.7
Return on Asset (%)	6.6	6.8	5.5	3.4	4.7	5.5
Return on Equity (%)	8.2	7.5	10.1	6.2	10.3	10.8
Market Value Ratio						
Earnings per Share	66.0	117.12	34.19	35.35	35.72	361.44*
Payout Ratio	0.14	0.11	NA	0.14	NA	0.53*

*AT&T's FY 1990 figures
Source: Dataquest (September 1991)

NA = Not available
NWC = Net Working Capital

average U.S. company. These smaller ratios mean that companies generally have less capacity to serve their current obligations compared with their U.S. counterparts. FY 1990 saw an additional drop in the current and quick ratios of all five companies from the previous year's results, indicating that Japanese companies have spread their resources rather thin relative to their U.S. competitors. Only Hitachi and Matsushita have quick ratios that are close to those of the U.S. average. By U.S. standards, these small current or quick ratios usually indicate an insufficient "cushion" between their current obligations and their ability to pay; thus, a company in the United States would be considered in jeopardy with such low liquidity. In Japan, however, these low current and quick ratios do not seem to bother either the stockholders or the financial institutions. Both stockholders and financial firms seem to have long-term faith in the companies that do business in this manner.

The recent stock market scandal may color this traditional perspective and could potentially change both the relationship between companies and financial institutions and the target or ideal balance sheet in Japan.

The stockholders in Japan have grown accustomed to lower dividends than the returns on average-yield U.S. stocks. On the Tokyo Stock Exchange, the average Japanese stock yields roughly one-tenth of the return available on U.S. and some European stocks. It seems that Japanese investors have simultaneously been acclimated to the lower dividend payouts while still maintaining strong confidence in the ability of large corporations to achieve long-time capital gains. However, recently the stock portfolios held by institutional stockholders (such as life insurance firms) have generally grown in size to about 13 percent of all stocks listed on the Tokyo Stock Exchange, and with the change in stockholder profile has come added pressure to increase yields on all stocks. Pressured by these shareholders as well as by foreign-based stockholders, Japan's Ministry of Finance has induced many publicly traded Japanese corporations to change their business practices with regard to profit sharing.

Fiscal Year 1991: Driving Forces

Higher interest rates have had an impact on the capital spending trends of most Japanese electronics companies. The recent downturn in the semiconductor industry has already caused Japanese companies to scale down capital spending plans for FY 1991. Recent stock market scandals involving several banking institutions have resulted, in part, in scarce investment capital availability. In addition, the steep drops in stock prices on the Tokyo Stock Exchange, beginning in February 1990, have limited the use of equity financing as an effective means of raising capital. A lower Japanese central bank rate and a stable yen/dollar exchange rate are considered critical in order to improve the availability of capital for investments in semiconductor endeavors, which have now reached the point where capital investment requirements for each successive generation of product are growing faster than either the company sales or net income can sustain.

Commodity DRAM prices are considered a key indicator and hence a driving force for the Japanese semiconductor industry. Although major chipmakers have been ready to mass produce 4Mb DRAMs, the demand for 4Mb DRAMs has stalled. While the need for 1Mb DRAMs is stable, the industry is ramping up 16Mb DRAM manufacturing capabilities in anticipation of meeting extrapolated historical demand trends. This ramp-up and the scarcity of capital are placing a burden on the resources of many Japanese companies. As a result of these pressures, we anticipate a proliferation of semiconductor-related alliances and joint ventures during FY 1991.

Dataquest Perspective

An analysis of the financial balance sheets of the five Japanese companies Dataquest surveyed here places these companies in two categories. Constituting the first group, Hitachi and Matsushita have pursued a more conservative financial approach to conducting their business ventures. In contrast, NEC, Toshiba, and Mitsubishi constitute the second group of somewhat smaller companies that have employed more aggressive—and, hence, riskier—financial strategies.

Dataquest believes that the Japanese companies will continue to use diversification to reduce dependence on singular markets and to use joint ventures and alliances as a means of minimizing the risk involved in semiconductor chip manufacturing.

Although AT&T's size, based on total sales, positions it near the average of the five Japanese companies, all of the Japanese companies had significantly lower operating income margins and net-income-to-total-sales ratios. Furthermore, the average productivity of the five Japanese companies was some 57 percent higher than AT&T's productivity (30 percent higher than Intel's productivity) as measured by sales per employee. This view of Japanese companies as more productive and at the same time able to operate with minimal profit performance, by U.S. standards, gives Japanese companies the luxury of functioning without risk of company devaluation or stock price depreciation. This long-term perspective is evidence of a fundamentally different orientation by the investors in Japan, giving Japanese companies a competitive advantage over foreign competitors.

Although Dataquest forecast that the 1991 semiconductor market would grow 9 percent both worldwide and in the Japanese market, most Japanese companies now expect very little growth or even negative growth in both total sales and net income. Dataquest believes that the Japanese companies will continue to use diversification to reduce dependence on singular markets and to use joint ventures and alliances as a means of minimizing the risk involved in semiconductor chip manufacturing. ■

by Junko Matsubara

Technology Analysis

Diversifying DRAMs

Introduction

DRAM, one technology that drives the semiconductor industry, has been moving toward larger capacities, higher speeds, and lower power consumption. The coming "silicon-on-chip" era is encouraging development of memory that is specialized according to applications, a clear indication that the direction of memory technology is closely associated with the diversification of IC products. In fact, 4Mb DRAMs, which have recently entered the full-scale production stage, are offered in 300 or more types and further growth of product lines is expected for 16Mb DRAMs.

Forecasting the future for these diverse DRAMs requires that Dataquest be aware of technological trends in each major application. This article examines the future product mix in DRAMs based on development trends in PCs and workstations, which use a diversity of DRAMs and consume a large amount of memory (see Figure 1).

Development Trends in Major Applications and Bit Increases

Today's PCs consume a large amount of RAM in the main memory and frame buffer memory in the display control. Because PC main memory capacity ranges from 1Mb to 2Mb, use of 4Mb × 1 DRAMs is not very economical. Considering the increasing demand for lower power consumption by the entire system as well as for optimum available memory, ×8 and ×16 versions are expected to offer advantages. On the other hand, 640 × 400-pixel display units use video RAMs (256 Kb × 4 buffer memories), which appear to be sufficient for further advancement in resolution and coloring.

Desktop PCs emphasize improved performance and will increasingly adopt graphical user interfaces (GUIs). Main memory therefore will increase to 6MB to 8MB in 1994, and ×8 versions of 4Mb or 16Mb DRAMs likely will be used. However, laptop PCs are popular for their space-saving features and not for their portability. As a result, power saving and weight reducing are major priorities for improvement, while performance falls behind that of desktop PCs. If this trend continues, main memory for laptop machines will be mainly 4MB to 8MB in 1994 and will use ×8 or ×16 versions of 4Mb or 16Mb DRAMs.

Better system performance results in increasing demand for DRAMs optimized for specific applications. We will see more of this trend in the future.

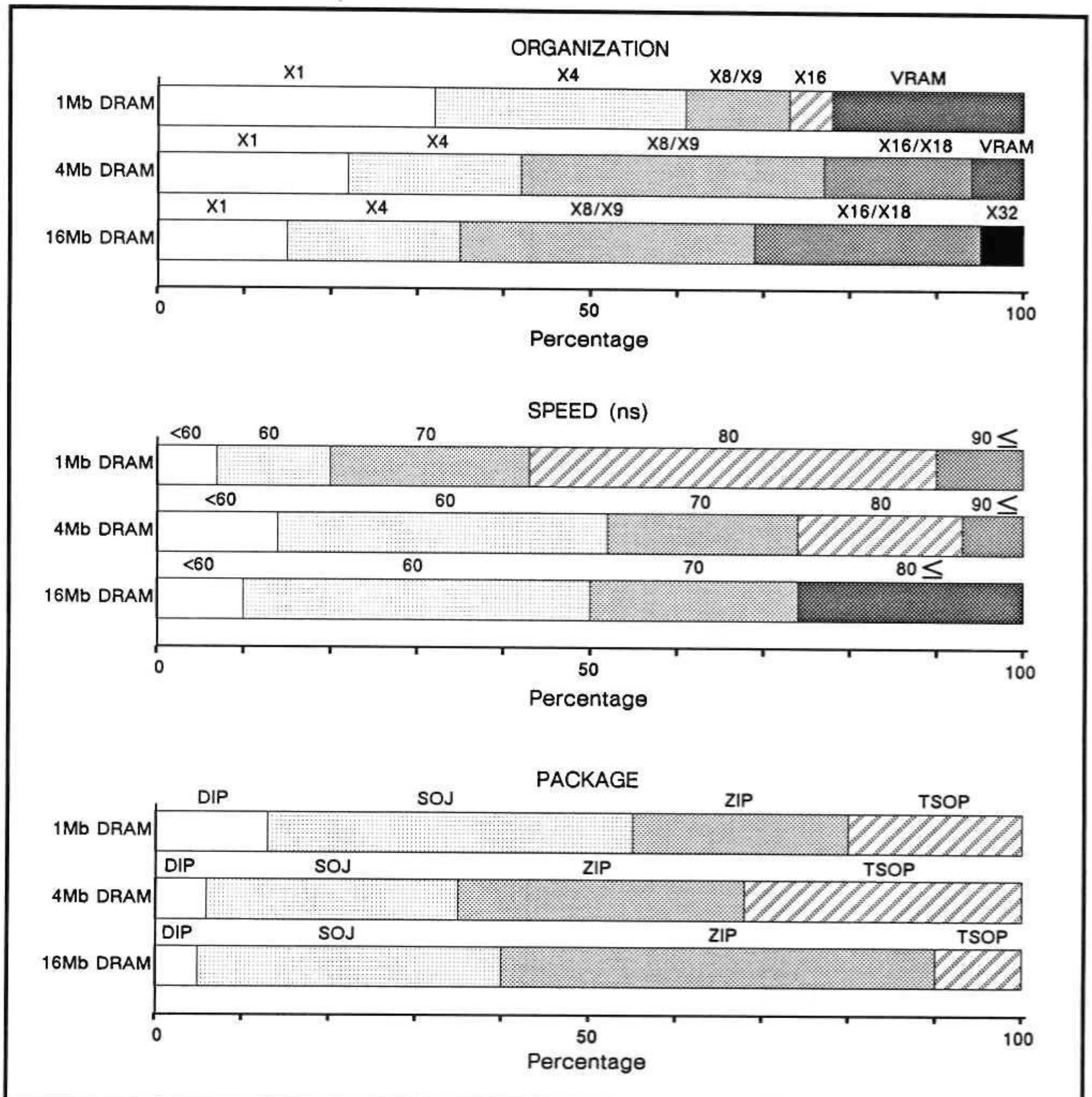
Development trends in notebook-size PCs will continue to be in size (including thickness) and weight reduction, and in increased battery-operable time and performance. Main memory in ×8 or ×16 versions of 4Mb or 16Mb DRAMs will minimize the need for additional memory. In particular, price-sensitive small system makers intend to use as little main memory as possible for the basic model while increasing memory capacity according to application software. In this connection, they want to minimize the basic unit of additional memory. Also, the use of multibit memories will allow for interleave design, in addition to decreased power consumption, and thus will lead to simplified circuits.

Dataquest believes that development of workstations will be in two different paths: a main stream of high-performance and multifeature products for engineering applications, and low-cost and downsized products that are expected to grow rapidly for office applications. Because most operation systems for workstations are based on UNIX, which offers virtually unlimited memory space, increased main memory is directly related to increased system performance. Thus it is better to have as much memory as possible. Dataquest expects main memory of workstations to be boosted in 1994 to 100MB for engineering applications and to 20MB to 30MB for office applications. The workstations will consume ×4 and ×8 versions of 16Mb DRAMs and offer low per-bit costs, particularly in workstations for office applications.

Smaller Packaging

Dataquest does not expect much need for smaller packages in desktop PCs and workstations, which will mainly use zigzag in-line packages (ZIP) or small-outline J-lead (SOJ) packages for both 4Mb and 16Mb DRAMs. On

Figure 1
Diversification of DRAMs in the 1994 Japanese Market



Source: Dataquest (September 1991)

the other hand, laptop PCs will not use ZIP because of height restrictions; 4Mb and 16Mb will be used in SOJ or thin small-outline package (TSOP) types. Dataquest expects 4Mb DRAMs in TSOP packages to be mainly used for notebook PCs, with SOJ types being used for low-cost versions.

In addition, the use of very thin TSOP packages for 4Mb and 16Mb DRAMs is expected to grow for IC card applications, which are a major element in the reduction of package size.

Access Time Diversification

More and more workstations use reduced-instruction-set computing (RISC) processors for speed increases. RISC architecture requires memory faster than that for traditional complex-instruction-set computing (CISC). As a result, RISC-based workstations use cache memories while not requiring particularly high speeds for DRAMs. This trend applies to desktop PCs using 32-bit MPUs. For instance, memory with an access time of 30ns or less is required to access Intel Corporation's 80386 (clock frequency of 20 MHz) without waiting (25ns or less for 25 MHz). This means that cache memories are needed that do not demand very high access times for DRAMs.

Dataquest believes that DRAMs will become more and more diversified as they go through generations and applications.

The increase in battery-operable hours is the most important consideration when developing notebook PCs, which thus may use slower central processing units (CPUs). As a result, notebook PCs will not require high-speed DRAMs and this market will mainly consume 60ns to 70ns versions.

Application-Specific DRAMs

Better system performance results in increasing demand for DRAMs optimized for specific applications. We will see more of this trend in the future. A typical example is in video RAMs, which have high-speed image data input/output terminals. If a frame buffer is formed by standard DRAMs, the CPU has to update memory data between periods of output to the display. This practice is not suitable for high-speed processing, and the CPU has to be capable of accessing memory all the time. Increased memory capacity is inevitable with further improvement in display resolution and coloring. Dataquest expects video RAMs to account for about one-fourth of 1Mb DRAMs in 1994.

Dataquest Perspective

Dataquest has examined the diversification of DRAMs from various angles. The results of our examination point to the following:

- 4Mb and 16Mb DRAMs will be widely used for PCs and workstations, and ×8 or more versions will account for nearly 60 percent of the total consumption.
- In terms of access time, 80ns products will be most widely used for 1Mb DRAMs and 60ns for 4Mb and 16Mb DRAMs.
- TSOP and SOJ packages will account for half of the total, reflecting continued trends in reducing the size and weight of system products.
- A shift of generation in video RAMs is not likely to occur in the near future because present products allow for the currently available display units, and further advancement in resolution and coloring will be handled by 1Mb versions.

Based on these findings, Dataquest believes that DRAMs will become more and more diversified as they go through generations and applications. ■

by Akira Minamikawa

In Future Issues

The following topics will be featured in future issues of Semiconductors Japan *Dataquest Perspective:*

- October *Japanese Semiconductor Industry Pulse*
- Japanese semiconductor capital spending and trade problems
- Here Comes Flash Memory

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Company Summary

All major Japanese semiconductor producers, including Nippon Telegraph and Telephone (NTT), are profiled in this binder. Each profile is organized into three subject areas: general corporate background, specific semiconductor-related details, and financial statements. Subcategories in each of these areas are outlined as follows:

- Corporate
  - Financial
  - Background
  - Strategy
  - Organization
  - Operations
- Semiconductor Segment
  - Revenue—worldwide and regional
  - Market share—worldwide and regional
  - Products and technology
  - Investments
  - Facility locations
  - Alliances and agreements
  - Distribution channels
- Financial Statements

The companies covered in this section and their fiscal year-end dates are as follows:

Company	Fiscal Year End
Fuji Electric Co., Ltd.	March 31
Fujitsu Limited	March 31
Hitachi, Ltd.	March 31
Matsushita Electric Industrial Co., Ltd.	March 31
Mitsubishi Corporation	March 31
NEC Corporation	March 31
NTT Corporation	March 31
Oki Electric Industry Company, Limited	March 31
Ricoh	March 31
Rohm Company Ltd.	March 31
Sanken Electric Co., Ltd.	March 31
Sanyo Electric Co., Ltd.	November 30
Seiko-Epson	Private Company
Sharp Corporation	March 31
Sony Corporation	March 31
Toshiba Corporation	March 31

The following information was used in the company profiles:

- Total corporate revenue is based on the Japanese fiscal year (except Sanyo), which runs from April 1 to March 31
- Semiconductor revenue is based on the calendar year, from which Dataquest derives its estimates.
- The following companies changed their fiscal year-end date in 1987:
  - Matsushita—November 20 to March 31
  - Sony—October 31 to March 31

  (In the years prior to 1987, the numbers were adjusted to March 31 fiscal year for comparison purposes.)
- Because of the change in accounting methods, some companies have revised their historical financial figures. Dataquest has retained the latest numbers reported by each company.
- The yen per US$1 exchange rate used to compute company revenue is based on an average over both the fiscal year and calendar year (see Table 0).

Tables 1 through 7 and Figures 1 and 2 summarize the corporate revenue of the 15 major semiconductor companies covered in this section.

Table 0

Exchange Rates—Yen per US$1

	Calendar Year	Japanese Fiscal Year
1981	221	228
1982	249	249
1983	237	236
1984	237	245
1985	238	221
1986	168	160
1987	144	138
1988	130	128
1989	138	

Source: Dataquest
April 1990

Table 1

Total Consolidated Corporate Revenue of Major Japanese Semiconductor Manufacturers (Billions of Yen)

Company	Japanese Fiscal Year 1984	1985	1986	1987	1988	CAGR 1984-1988
Fuji Electric*	381.2	526.3	539.5	557.2	680.2	8.9%
Fujitsu	1,562.3	1,691.8	1,789.4	2,046.8	2,387.4	11.2%
Hitachi	5,013.3	5,010.5	5,543.2	5,717.0	6,401.4	6.3%
Matsushita	4,734.2	5,117.6	4,647.1	5,067.2	5,504.3	3.8%
Mitsubishi	2,034.8	2,109.5	2,107.5	2,368.3	2,716.8	7.5%
NEC	2,258.4	2,334.7	2,449.7	2,714.7	3,082.8	8.1%
Oki	417.5	392.6	407.4	451.4	555.5	7.4%
Ricoh	545.5	593.9	592.4	674.2	729.4	7.5%
Rohm	103.0	97.8	107.2	117.6	146.1	9.1%
Sanken	62.4	63.4	66.3	81.0	97.5	11.8%
Sanyo	1,420.7	1,500.1	1,181.1	1,186.4	1,236.8	(3.4%)
Seiko-Epson	N/A	N/A	N/A	N/A	N/A	N/A
Sharp	1,105.4	1,149.1	1,038.4	1,077.8	1,238.4	2.9%
Sony	1,327.9	1,433.8	1,456.5	1,555.2	2,145.4	12.7%
Toshiba	3,342.8	3,373.0	3,307.6	3,572.4	3,800.9	3.3%

*Fuji Electric's fiscal year 1984 is nonconsolidated. Its CAGR is between 1985 and 1988.
N/A = Not Available

Source: Company Annual Report
Dataquest
April 1990

Table 2

Total Consolidated Corporate Revenue of Major Japanese Semiconductor Manufacturers (Millions of Dollars)

Company	Japanese Fiscal Year 1984	1985	1986	1987	1988	CAGR 1984-1988
Fuji Electric*	1,556	2,381	3,372	4,038	5,314	30.7%
Fujitsu	6,377	7,655	11,184	14,832	18,652	30.8%
Hitachi	20,462	22,672	34,645	41,427	50,011	25.0%
Matsushita	19,323	23,157	29,045	36,719	43,002	22.1%
Mitsubishi	8,305	9,545	13,172	17,161	21,225	26.4%
NEC	9,218	10,564	15,311	19,672	24,084	27.1%
Oki	1,704	1,777	2,546	3,271	4,340	26.3%
Ricoh	2,227	2,687	3,702	4,886	5,699	26.5%
Rohm	420	443	670	852	1,142	28.4%
Sanken	255	287	414	587	762	31.5%
Sanyo	5,799	6,788	7,382	8,597	9,663	13.6%
Seiko-Epson	N/A	N/A	N/A	N/A	N/A	N/A
Sharp	4,512	5,199	6,490	7,810	9,675	21.0%
Sony	5,420	6,488	9,103	11,270	16,761	32.6%
Toshiba	13,644	15,262	20,672	25,887	29,694	21.5%

*Fuji Electric's fiscal year 1984 is nonconsolidated. Its CAGR is between 1985 and 1988.
N/A = Not Available

Source: Company Annual Report
Dataquest
April 1990

Table 3

Estimated Worldwide Semiconductor Revenue of Major Japanese Semiconductor Manufacturers (Billions of Yen)

Company	1984	1985	Calendar Year 1986	1987	1988	1989*	CAGR 1984-1989
Fuji Electric	41.5	37.3	34.2	36.3	45.0	51.2	4.3%
Fujitsu	282.0	242.6	227.5	259.3	338.9	405.9	7.6%
Hitachi	486.1	397.7	360.2	377.0	455.8	542.3	2.2%
Matsushita	220.0	215.6	196.4	209.8	244.8	258.2	3.3%
Mitsubishi	228.5	157.4	187.5	214.8	300.6	362.8	9.7%
NEC	533.5	472.2	436.7	485.0	590.6	685.0	5.1%
Oki	85.8	73.1	71.5	93.7	123.1	155.3	12.6%
Ricoh	N/A	N/A	9.2	9.4	11.1	12.6	N/A
Rohm	59.7	58.9	69.0	74.6	93.7	102.1	11.3%
Sanken	38.4	37.1	37.4	42.3	49.8	53.4	6.8%
Sanyo	107.8	106.8	102.7	122.5	140.8	156.2	7.7%
Seiko-Epson	27.3	22.1	27.6	35.3	40.4	50.8	13.2%
Sharp	79.8	78.1	72.3	85.0	134.7	169.7	16.3%
Sony	40.1	59.9	76.5	82.2	123.5	148.6	30.0%
Toshiba	370.0	349.4	380.9	436.2	571.3	674.7	12.8%

*Preliminary
N/A = Not Available

Source: Dataquest
April 1990

Table 4

Estimated Worldwise Semiconductor Revenue of Major Japanese Semiconductor Manufacturers (Millions of Dollars)

Company	Calendar Year 1984	1985	1986	1987	1988	1989*	CAGR 1984-1989
Fuji Electric	175	157	204	252	346	371	18.6%
Fujitsu	1,190	1,019	1,354	1,801	2,607	2,941	21.7%
Hitachi	2,051	1,671	2,144	2,618	3,506	3,930	14.3%
Matsushita	928	906	1,169	1,457	1,883	1,871	19.3%
Mitsubishi	964	661	1,116	1,492	2,312	2,629	24.4%
NEC	2,251	1,984	2,599	3,368	4,543	4,964	19.2%
Oki	362	307	426	651	947	1,125	27.2%
Ricoh	N/A	N/A	55	65	85	91	N/A
Rohm	252	247	411	518	721	740	30.1%
Sanken	162	156	223	294	383	387	24.0%
Sanyo	455	449	611	851	1,083	1,132	24.2%
Seiko-Epson	115	93	164	245	311	368	28.2%
Sharp	337	328	430	590	1,036	1,230	32.4%
Sony	169	252	455	571	950	1,077	53.9%
Toshiba	1,561	1,468	2,267	3,029	4,395	4,889	29.5%

*Preliminary
N/A = Not Available

Source: Dataquest
April 1990

Table 5

Total Semiconductor Revenue as a Percentage of Total Corporate Revenue for Major Japanese Semiconductor Manufacturers

	Calendar Year					Average
Company	1984	1985	1986	1987	1988	1984-1988
Fuji Electric	11.1	7.6	6.4	6.6	6.9	7.7
Fujitsu	19.1	14.6	12.9	13.1	14.7	14.9
Hitachi	10.0	7.9	6.6	6.6	7.3	7.7
Matsushita	5.0	4.3	4.1	4.2	4.5	4.4
Mitsubishi	11.7	7.5	8.9	9.3	11.4	9.8
NEC	25.0	20.4	18.0	18.3	19.7	20.3
Oki	21.5	18.3	17.7	21.3	23.2	20.4
Ricoh	N/A	N/A	1.5	1.4	1.6	0.9
Rohm	62.9	59.4	65.6	64.9	67.4	64.1
Sanken	65.0	58.8	56.9	54.7	53.3	57.8
Sanyo	7.6	7.2	8.1	10.3	11.5	9.0
Seiko-Epson	N/A	N/A	N/A	N/A	N/A	N/A
Sharp	7.4	6.9	6.8	8.0	11.2	8.0
Sony	3.1	4.3	5.3	5.4	6.2	4.8
Toshiba	11.6	10.4	11.4	12.4	15.3	12.2

Note: For comparison, Japanese fiscal year numbers were converted to calendar year numbers.
N/A = Not Available

Source: Dataquest
April 1990

Table 6

Preliminary Estimated 1989 Semiconductor Revenue By Geographic Region for Major Japanese Semiconductor Manufacturers (Billions of Yen)

Company	United States	Japan	Europe	Rest of World	Total
Fuji Electric	2.8	42.6	3.0	3.2	51.6
Fujitsu	73.0	282.2	30.1	20.4	405.7
Hitachi	80.3	370.5	39.7	51.9	542.5
Matsushita	15.9	208.5	13.0	20.7	258.1
Mitsubishi	58.0	248.7	28.3	27.9	362.8
NEC	101.6	480.0	58.2	45.7	685.4
Oki	46.6	86.5	9.5	12.6	155.3
Ricoh	0.4	11.7	0.1	0.1	12.4
Rohm	5.4	82.8	3.2	10.8	102.1
Sanken	0.7	36.7	0.7	15.5	53.5
Sanyo	3.5	128.1	1.5	23.0	156.1
Seiko-Epson	8.7	39.2	1.1	1.8	50.8
Sharp	11.5	138.0	3.7	16.4	169.6
Sony	5.5	122.5	6.9	13.5	148.5
Toshiba	159.8	375.6	57.0	82.0	674.4

Columns may not add to totals shown because of rounding.

Source: Dataquest
April 1990

Table 7

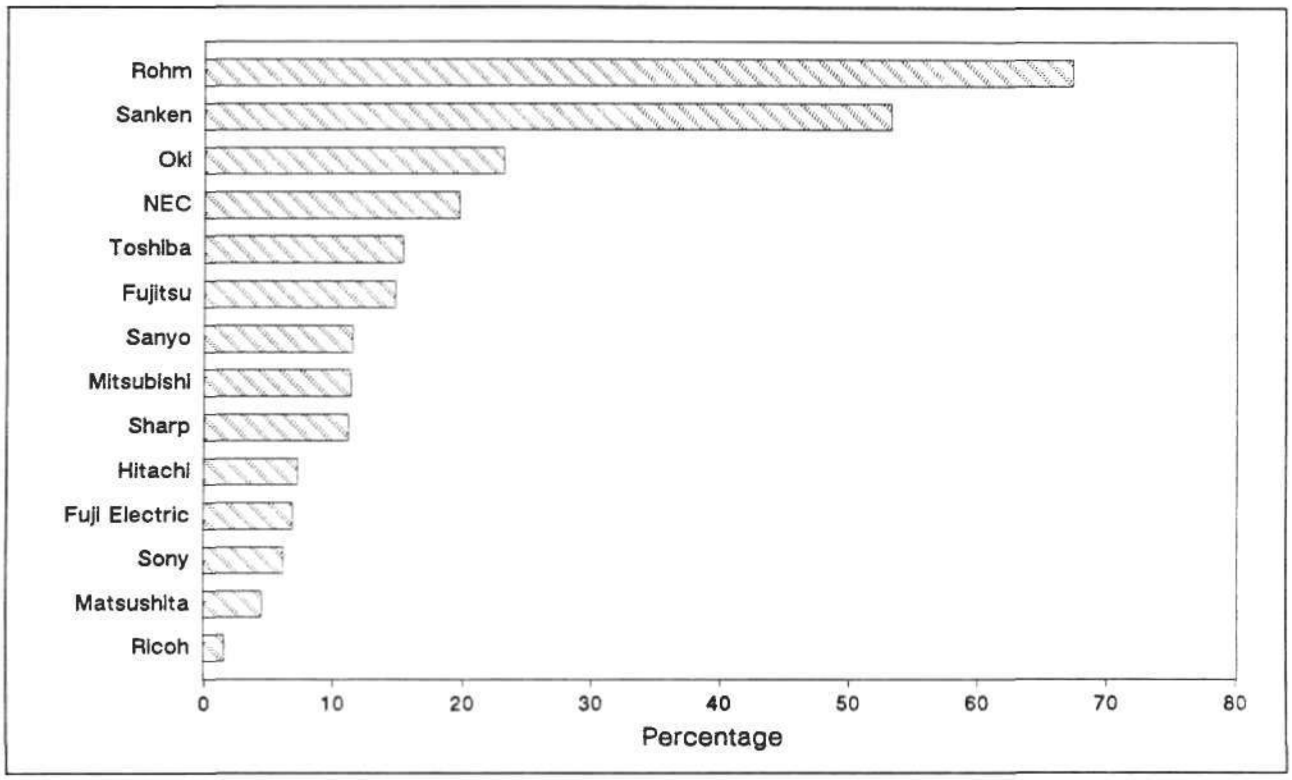
Preliminary Estimated 1989 Semiconductor Revenue By Geographic Region for Major Japanese Semiconductor Manufacturers (Millions of Dollars)

Company	United States	Japan	Europe	Rest of World	Total
Fuji Electric	20	309	22	23	374
Fujitsu	529	2,045	218	148	2,940
Hitachi	582	2,685	288	376	3,931
Matsushita	115	1,511	94	150	1,870
Mitsubishi	420	1,802	205	202	2,629
NEC	736	3,478	422	331	4,967
Oki	338	627	69	91	1,125
Ricoh	3	85	1	1	90
Rohm	39	600	23	78	740
Sanken	5	266	5	112	388
Sanyo	25	928	11	167	1,131
Seiko-Epson	63	284	8	13	368
Sharp	83	1,000	27	119	1,229
Sony	40	888	50	98	1,076
Toshiba	1,158	2,722	413	594	4,887

Source: Dataquest
April 1990

Figure 1

Major Japanese Semiconductor Manufacturers Ranked by Semiconductor Revenue as a Percent of Total Corporate Revenue 1989 (Preliminary Estimates)



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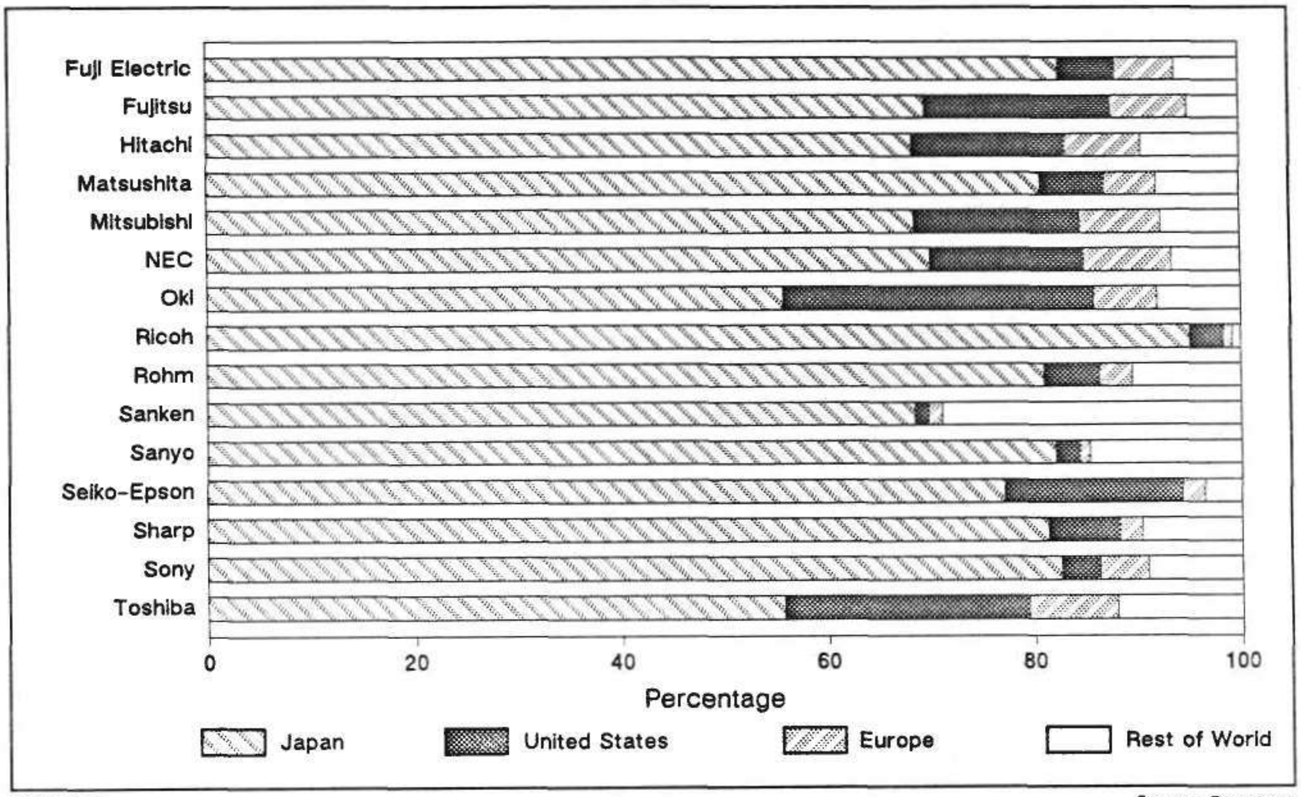
Source: Dataquest
April 1990

Figure 2

Preliminary Estimated 1989 Semiconductor Revenue by Geographic Region for Major Japanese Semiconductor Manufacturers



0006600-2

Source: Dataquest
April 1990

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JAPANESE SEMICONDUCTOR INDUSTRY SERVICE

COMPANY BACKGROUNDERS

Fuji Electric Co., Ltd.

12-1 Yurakucho 1-chome, Chyoda-ku
Tokyo 100, Japan
Telephone: Tokyo 211-7111
Telex: J22331 FUJIELEA or FUJIELEB
Fax: (03) 215-8321
Dun's Number: 05-667-2785

Date Founded: 1923

CORPORATE STRATEGIC DIRECTION

Since its founding in 1923, Fuji Electric Co., Ltd., has been supplying high-quality products to a wide variety of industries. Expanding outward while maintaining its base as a heavy electrical manufacturer, the Company has achieved leading market positions in products such as uninterruptible power supplies, inverters, high-voltage silicon diodes, and vending machines.

Fuji Electric's business is organized into five divisions: Heavy Electrical; Systems; Electronic Devices; Motors, Drives, and Controls; and Vending Machines and Specialty Appliances. The Heavy Electrical Division manufactures thermal power plant equipment, hydroelectric power plant equipment, nuclear power plant equipment, electric motors, transformers, computer control equipment, and other heavy electrical equipment. This division was responsible for approximately 37.3 percent of total revenue, or ¥286.7 billion (US$2.0 billion) for fiscal year ended March 1990.

The Systems Division was responsible for 11.0 percent of total revenue, or ¥84.5 billion (US$593.4 million) for year ended March 1990. Products in this division include industrial measuring instruments and instrumentation, remote control equipment, analyzers, radiation monitoring equipment, microcomputers, microcontrollers, video sensors, laser devices, industrial robots, automated transport systems, and clean room systems.

The Electronic Devices Division accounted for 13.8 percent of total revenue, or ¥106.1 billion (US$744.5 million) for year ended March 1990. Products include power transistors, high-voltage silicon diodes, thyristors, application-specific ICs (ASICs), LSIs, hybrid ICs, surge absorbers, semiconductors, sensors, photoconductive drums for copiers, printers, hard-disk drives, magnetic recording disks, and watt-hour meters.

Products in the Motors, Drives, and Controls Division include induction motors, variable-speed controlled motors, brake and geared motors, pumps, fans and blowers, inverters, servomotor systems, small precision motors, magnetic contractors, and molded case circuit breakers. This division accounted for 20.5 percent of total revenue, or ¥157.6 billion (US$1.1 billion) for year ended March 1990.

The Vending Machines and Specialty Appliances Division accounted for 17.4 percent of revenue, totaling ¥133.7 billion (US$938.7 million) for fiscal year ended March 1990. Products include vending machines, coin and currency mechanisms, bill validators, beverage dispensers, tea servers, open freezer and refrigerating showcases, and the Hotel Vendor System.

Consolidated revenue totaled ¥768.6 billion (US$5.4 billion) for fiscal year ended March 1990, which was a 13.0 percent increase over the previous year's figure of ¥680.2 billion (US$5.3 billion). (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) This increase was fueled by a 15.7 percent increase in revenue from the Electronic Devices Division and a 13.7 percent increase in Systems Division revenue.

Net income increased 46.2 percent to ¥13.9 billion (US$97.6 million) in year ended March 1990, from ¥9.5 billion (US$74.2 million). The increase is partially due to the continued expansion of the Japanese economy, supported by stable personal consumption and brisk investment in plants and equipment by the private sector. However, increased effectiveness on the part of the Company's sales organization, shorter lead times for new products, and improved manufacturing capabilities all contributed to the increase in net income.

R&D increased 17.6 percent to ¥28.7 billion (US$201.4 million) during year ended March 1990 from ¥24.4 billion (US$190.3) in the previous year. These figures respectively represented 3.7 percent and 3.6 percent of revenue. The R&D focus was on integrated circuits and fuel cells.

Capital expenditure totaled ¥25.3 billion (US$177.6 million), representing 3.3 percent of revenue for year ended March 1990. This is an increase of 14.5 percent over the previous year's total of ¥22.1 billion (US$172.3 million). Part of the investment went toward constructing computer-integrated manufacturing (CIM) facilities that will enable the Company to manufacture and ship magnetic switches within 24 hours after receiving an order. Other product lines singled out for concentrated investment included the TWIN BREAKER, magnetic recording disks, and vending machines. Fuji Electric Co. employed 19,830 people at the close of March 1990.

More detailed information is available in Table 1, which appears after "Business Segment Strategic Direction" and presents corporate highlights. Information on revenue by region and distribution channel is not available. Tables 2 and 3, comprehensive financial statements, are at the end of this backgrounder.

BUSINESS SEGMENT STRATEGIC DIRECTION

Systems

In the Systems Division, information systems and instrumentation and control posted growth in all major product areas: distributed control systems, MICREX microcontrollers, the Ace and FASMIC G series of 32-bit superminicomputers, pressure and differential pressure transmitters, electromagnetic and ultrasonic flowmeters, compact controllers, and general-purpose temperature controllers.

Industrial equipment posted significant increases in orders due to large capital investments by semiconductor and precision equipment manufacturers. Uninterruptible power supply orders increased nearly 33 percent. Factory automation and control components also posted increases. The Company offers a complete lineup of equipment, systems, and personal computers for both flexible manufacturing and CIM.

Electronic Devices

The Company strategy for the integrated circuit (IC) market stresses technology specialization and the development of niche markets. Recent successes include such devices as autofocusing ICs for cameras and high-voltage driver ICs for flat-panel displays and thermal printheads. During the past year, the Company implemented a strategy of augmenting its custom IC activities with the production of application-specific standard product ICs in order to increase the Company's client base.

Dataquest estimates that Fuji Electric captured less than 1 percent of the total worldwide semiconductor market for calendar year 1989. However, Dataquest estimates that Fuji Electric ranked ninth and had 3.7 percent of the worldwide total discrete market based on ¥41.0 billion (US$287.0 million) in revenue for calendar year 1989.

The Company's computer peripherals products are 3.5-inch hard-disk drives and 3.5- and 5.25-inch thin-film sputtered magnetic recording disks. Both segments exhibited strong growth in the past year.

Further Information

For further information about the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Corporate Highlights* (Millions of Dollars)

	1988	1989	1990
Three-Year Revenue	$4,037.1	$5,303.6	$5,394.8
Percent Change	-	31.37	1.72
Capital Expenditure	$109.4	$172.3	$177.6
Percent of Revenue	2.71	3.25	3.29
R&D Expenditure	$163.7	$190.3	$201.4
Percent of Revenue	4.06	3.59	3.73
Number of Employees	NA	19,248	19,830
Revenue ($K)/Employee	-	$276	$272
Net Income	$48.6	$74.2	$97.6
Percent Change	-	52.77	31.59
Exchange Rate (US$1=¥)	¥138.03	¥128.25	¥142.47

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available
*No fiscal 1986 and 1987 information is available because consolidated reports were not generated during those years.

Source: Fuji Electric Co., Ltd.
Annual Reports and Forms 10-K
Dataquest (1990)

1990 SALES OFFICE LOCATIONS

North America—4
Europe—3
Asia/Pacific—34
ROW—3

MANUFACTURING LOCATIONS

North America

Fuji Cone, Inc., United States
Paper cones for stereo speakers
Fuji Copian Corp., United States
Printer ribbon cartridges
Fuji Foods Inc., United States
Soup mixes, flavors
Fuji High-Tech, Inc., United States
Power supplies for magnetic disk equipment
Fuji Koki America Inc., United States
Expansion valves for automotive air-conditioning systems
U.S. Fuji Electric, United States
Photoconductive drums for copiers

Asia/Pacific

Chiba Factory (Japan)
Transformers, cubicle-type gas-insulated switchgears, medium and small power supply equipment, fuel cells, and solar power generation systems
Fukiage Factory (Japan)
Magnetic starters and contactors, circuit breakers, control relays, programmable controllers, and data transmission instruments
Kawasaki Factory (Japan)
Hydraulic and thermal power generation equipment, large rotating electric machinery, and circuit breakers
Kobe Factory (Japan)
Controls and switchgears, power supplies, and control equipment for motors
Matsumoto Factory (Japan)
Semiconductor elements and devices, photoconductive drums, solar cells, coin-handling and bill-validator mechanisms, external computer memories, watt-hour meters, demand meters, etc.
Mie Factory (Japan)
Vending machines, automatic servers, freezing and refrigerating showcases, hotel vending systems, solar equipment, small and precision motors, ring blowers, servo systems, medical treatment equipment, etc.
Ohtawara Factory (Japan)
Earth leakage circuit breakers, molded-case circuit breakers, timers, proximity switches, optical sensors, gas detectors, etc.
Suzuka Factory (Japan)
Medium-size motors and generators, induction furnaces, heating systems, compressors, and fans
Tokyo Factory (Japan)
Measuring instruments and analyzing equipment

ROW

Fuji Electric Nordeste, Brazil
Instrument panels and industrial instruments

SUBSIDIARIES

North America

Fuji Electric Corp. of America (United States)
Fuji Hi-Tech, Inc. (United States)
U.S. Fuji Electric Inc. (United States)

Europe

Fuji Electric GmbH (Germany)

Asia/Pacific

Fuji Electric Singapore Pte., Ltd. (Singapore)
Fuji/GE Private Ltd. (Singapore)
Hong Kong Fuji Denki Co., Ltd. (Hong Kong)

ROW

Fuji Electric do Brasil Industria E Comercio Ltda. (Brazil)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

Astro Technology
Astro Technology will market a powerful new chip placer from Fuji in the United Kingdom.

Korean FA Systems Co., Ltd. (KFA)
Fuji will invest in KFA. Fuji hopes that the move will allow it to cope with an increasing demand for factory automation (FA) system software.

1989

IIMAK
IIMAK is licensed to sell and manufacture thermal transfer products and ribbons in North America.

BASF
The companies have a joint partnership to build a facility for 3.5-inch microfloppy disks for the North American market.

MERGERS AND ACQUISITIONS

1989

Crosfield Electronics
Fuji Photo Film and Du Pont agreed to acquire the electronic prepress division of Crosfield Electronics.

KEY OFFICERS

Hideo Abe
Chairman and representative director

Takeshi Nakao
President and representative director

Yoshiihiko Nakazato
Executive vice president and representative director

PRINCIPAL INVESTORS

Information is not available.

FOUNDERS

Information is not available.

Table 2
Comprehensive Financial Statement*
Fiscal Year Ending March
(Millions of US Dollars, except Per Share Data)

Balance Sheet	1988	1989	1990
Total Current Assets	$3,594.5	$4,361.0	$4,205.6
Cash	781.3	816.4	682.7
Receivables	1,141.1	1,522.9	1,512.2
Marketable Securities	430.1	538.2	511.3
Inventory	912.1	1,166.4	1,149.6
Other Current Assets	329.9	317.2	349.8
Net Property, Plants	$750.7	$913.9	$937.4
Other Assets	$313.5	$331.3	$329.9
Total Assets	$4,658.8	$5,606.2	$5,472.9
Total Current Liabilities	$3,101.4	$3,768.3	$3,793.8
Long-Term Debt	$554.5	$560.6	$425.9
Other Liabilities	$139.2	$216.9	$212.5
Total Liabilities	$3,795.2	$4,545.8	$4,432.2
Total Shareholders' Equity	$863.6	$1,060.4	$1,040.7
Common Stock	305.9	351.7	326.7
Other Equity	275.4	325.3	308.0
Retained Earnings	282.3	383.4	405.9
Total Liabilities and Shareholders' Equity	$4,658.8	$5,606.2	$5,472.9

Income Statement	1988	1989	1990
Revenue	$4,037.1	$5,303.6	$5,394.8
Cost of Sales	$3,187.3	$4,159.4	$4,197.3
R&D Expense	$163.7	$190.3	$201.4
SG&A Expense	$736.7	$898.5	$928.7
Capital Expense	$109.4	$172.3	$177.6
Pretax Income	$144.4	$221.0	$232.1
Pretax Margin (%)	3.58	4.17	4.30
Effective Tax Rate (%)	NA	NA	NA
Net Income	$48.6	$74.2	$97.6
Shares Outstanding, Millions	678.8	699.7	709.1
Per Share Data			
Earnings	$0.07	$0.11	$0.14
Dividend	$0.04	$0.05	$0.05
Book Value	$1.27	$1.52	$1.47
Exchange Rate (US$1=¥)	¥138.03	¥128.25	¥142.47

NA = Not available
*No fiscal 1986 and 1987 information is available because consolidated reports were not generated during those years.

Source: Fuji Electric Co., Ltd.
Annual Reports and Forms 10-K
Dataquest (1990)

Table 3
Comprehensive Financial Statement*
Fiscal Year Ending March
(Millions of Yen, except Per Share Data)

Balance Sheet	1987	1988	1989
Total Current Assets	¥496,150.0	¥559,303.0	¥599,168.0
Cash	107,838.0	104,697.0	97,259.0
Receivables	157,512.0	195,315.0	215,439.0
Marketable Securities	59,362.0	69,024.0	72,842.0
Inventory	125,898.0	149,587.0	163,787.0
Other Current Assets	45,540.0	40,680.0	49,841.0
Net Property, Plants	¥103,626.0	¥117,211.0	¥133,556.0
Other Assets	¥43,273.0	¥42,487.0	¥46,997.0
Total Assets	¥643,049.0	¥719,001.0	¥779,721.0
Total Current Liabilities	¥428,090.0	¥483,286.0	¥540,509.0
Long-Term Debt	¥76,538.0	¥71,896.0	¥60,673.0
Other Liabilities	¥19,218.0	¥27,821.0	¥30,274.0
Total Liabilities	¥523,846.0	¥583,003.0	¥631,456.0
Total Shareholders' Equity	¥119,203.0	¥135,998.0	¥148,265.0
Common Stock	42,225.0	45,102.0	46,551.0
Other Equity	38,013.0	41,725.0	43,884.0
Retained Earnings	38,965.0	49,171.0	57,830.0
Total Liabilities and Shareholders' Equity	¥643,049.0	¥719,001.0	¥779,721.0

Income Statement	1987	1988	1989
Revenue	¥557,244.0	¥680,192.0	¥768,602.0
Cost of Sales	¥439,937.0	¥533,440.0	¥597,989.0
R&D Expense	¥22,600.0	¥24,400.0	¥28,700.0
SG&A Expense	¥101,685.0	¥115,234.0	¥132,312.0
Capital Expense	¥15,100.0	¥22,100.0	¥25,300.0
Pretax Income	¥19,937.0	¥28,341.0	¥33,072.0
Pretax Margin (%)	3.58	4.17	4.30
Effective Tax Rate (%)	NA	NA	NA
Net Income	¥6,702.0	¥9,513.0	¥13,906.0
Shares Outstanding, Millions	678.8	699.7	709.1
Per Share Data			
Earnings	¥10.18	¥13.73	¥19.69
Dividend	¥6.00	¥6.00	¥7.00
Book Value	¥175.61	¥194.37	¥209.09

Table 3 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending in Month
(Millions of Yen, except Per Share Data)

Key Financial Ratios	1987	1988	1989
Liquidity			
Current (Times)	1.16	1.16	1.11
Quick (Times)	0.86	0.85	0.81
Fixed Assets/Equity (%)	86.93	86.19	90.08
Current Liabilities/Equity (%)	359.13	355.36	364.56
Total Liabilities/Equity (%)	439.46	428.68	425.90
Profitability (%)			
Return on Assets	-	1.40	1.86
Return on Equity	-	7.46	9.78
Profit Margin	1.20	1.40	1.81
Other Key Ratios			
R&D Spending % of Revenue	4.06	3.59	3.73
Capital Spending % of Revenue	2.71	3.25	3.29
Employees	NA	19,248	19,830
Revenue (¥K)/Employee	NA	$35,338	$38,760
Capital Spending % of Assets	2.35	3.07	3.24
Exchange Rate (US$1=¥)	138.03	128.25	142.47

NA = Not available
*No fiscal 1986 and 1987 information is available because consolidated reports were not generated during those years.

Source: Fuji Electric Co., Ltd.
Annual Reports and Forms 10-K
Dataquest (1990)

Fujitsu Limited

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Telephone: 03-3216-3211
Fax: 03-3216-9365
Dun's Number: 08-292-1644

Date Founded: 1935

CORPORATE STRATEGIC DIRECTION

Fujitsu Limited, founded in 1935 as a spin-off of the Communications Division of Fuji Electric Company Ltd., is a multinational Japanese firm. Fujitsu designs, manufactures, and markets computers and information processing systems, telecommunications equipment, and electronic devices. To organize and unify such a diverse product offering, Fujitsu has segmented its corporate structure into the above-mentioned main divisions, as well as a category called "Other Operations," which includes electronic products such as car stereos, CD players, and digital audiotape players.

Although worldwide economic growth was slower than expected because of the Gulf War and a slowdown in U.S. and European economies, Fujitsu experienced a significant growth in business. The company had an increase of almost 18 percent in total revenue from $17.8 billion* in fiscal year 1990 to $21.0 billion in fiscal 1991. To achieve this growth, Fujitsu, as a total systems supplier, endeavored to offer a wide range of products from large-scale systems to personal equipment.

Almost 70 percent of Fujitsu's revenue was derived from the Computers and Information Processing Systems Division. The greatest focus in this division was on M Series general-purpose computers, UNIX open systems, and advanced value-added software services. Also showing considerable growth was the demand for office machines and personal equipment.

In the telecommunications field, Fujitsu supplied synchronous digital hierarchy (SDH) equipment to Nippon Telegraph and Telephone Corporation (NTT) in Japan and pioneered synchronous optical transmission (SONET) systems in the United States. In addition, the optical submarine cable system between the United Kingdom and Germany came nearer to completion, while the system between Japan and the United States went into operation.

Since the 1Mb DRAM market remained depressed in the world marketplace, business in electronic devices was difficult. Fujitsu, however, expanded the sales of its products in ASICs, microprocessors, and compound semiconductors.

According to Fujitsu, significant changes are occurring in the industry in downsizing, networks, and open systems. The company believes that these changes will define the technology that will be developed in the 1990s. Although downsizing has reduced their size and weight, products are being created with greater power and performance.

Fujitsu has continued to develop products that directly support International Service Digital Network (ISDN) and to offer Corporate Information Network System (COINS), which can be tailored to meet individual company needs. In addition, Fujitsu announced Multi-environment Information Systems Solution by Domain Concept (MISSION/DC), a domain-based mainframe concept that gives users the flexibility necessary to structure the systems they need. Fujitsu also announced a new approach to network system construction that offers a user-friendly connection to Fujitsu mainframes from workstations and PCs. This product is called MESSAGE 90s.

In the field of open systems, Fujitsu is promoting worldwide standardization of the UNIX operating system across industries, offering a full lineup of UNIX products from workstations to supercomputers. The company also developed the first operating system for mainframes and supercomputers to use UNIX System V Release 4. Other computers across the

*All dollar amounts are in U.S. dollars.

Fujitsu product line will be developed to run under this operating system.

In 1990, Fujitsu took a major step toward increasing its global presence by acquiring an 80 percent share in ICL plc, a computer unit of STC plc. In January 1991, as the first joint project between the two companies, Fujitsu began the marketing of DS/90 UNIX server systems, developed by ICL and distributed through Fujitsu's overseas marketing network.

Research and development costs were 11.1 percent of revenue in fiscal 1991. This increase represents $2.3 billion as compared to $2.1 billion for 1990. R&D continues to be an important part of Fujitsu's future strategy. During fiscal 1991, the R&D funds were used to maintain the company's position as a pioneer in the competitive field of electronics. Future R&D products produced by Fujitsu will be more powerful and targeted at customer networks, especially at the low end such as hand-held PCs and cellular telephones.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 through 7, at the end of this backgrounder, present comprehensive financial information.

BUSINESS SEGMENT STRATEGIC DIRECTION

Computers and Data Processing

The Computers and Information Processing Systems Division's net sales increased approximately 23.1 percent to $14.6 billion in fiscal 1991, accounting for 69 percent of the company's total net sales. This increase was mainly due to well-received mainframe systems, including the new M-1800 group of very-large-scale general-purpose computers, and to the strong performance of office machines and personal equipment in the domestic market, as well as the contribution of ICL.

Computer Systems

Within the computer systems product line, Fujitsu offers products from supercomputers to general-purpose computers. In August 1991, Fujitsu introduced two new models of the VP2000 Series supercomputers. The new systems, the VP2400/40 and VP2200/40, feature a four-scalar processor, two-vector processor configuration, which enables enhanced high-speed program processing.

In September 1990, Fujitsu announced the M-1800 Model Group of large-scale computers, which consists of five models. This was the first product introduction within the framework of MISSION/DC. Fujitsu plans to have the MISSION/DC be a major influence on its future product introductions.

According to Dataquest, in the worldwide business supercomputer market, Fujitsu ranks first with a 56.03 percent market share for 1990; in the worldwide technical supercomputer market, it ranks fourth with a 9.39 percent market share. In the worldwide business mainframe market, Fujitsu ranks fourth, with a 5.01 percent market share. In the worldwide technical mainframe market, it also ranks fourth with a 7.44 percent market share. Finally, in the worldwide business midrange market, Fujitsu ranks fifth with 5.56 percent of the market share.

Office Automation

Within the office automation product line, Fujitsu offers small business computers, workstations, word processors, and personal computers, including business, hypermedia, desktop, portable, and laptop. In the worldwide personal computer market, including desktop, portable, laptop, and notebooks, Fujitsu had less than 1 percent of the market share in each of these categories.

VAN Services

Within the VAN services product line, Fujitsu offers industry VANs, local VANs, corporate VANs, and personal communications services. During fiscal 1991, Fujitsu expanded the FENICS VAN service network, enhanced database services, and started FENICS-INS packet-switched services. To respond to the expansion of international VAN services in Asia, Fujitsu started a data switching service between Japan and Singapore. In addition, the NIFTY-Serve personal computer communications service was expanded to include English-to-Japanese machine translation, electronic mail, facsimile, and other services. As of March 31, 1991, this service has more than 260,000 subscribers.

Computer Storage

Fujitsu built its reputation in the rigid disk drive market with solutions for high-end computers. The company produces rigid disk drives in a variety of sizes from 2.5-inch to 14-inch. According to Dataquest, during 1990 Fujitsu ranked eighth in the worldwide overall total rigid disk drive market with a 2.9 percent market share. In the 8- to 14-inch worldwide rigid disk drive market, it ranked fourth with a 13.8 percent market share.

In September 1990, Fujitsu announced the M2671P, an 8-inch disk drive that provides 2.6GB of storage and offers a data transfer rate of 4.78 MB/sec. and a seek time of less than 12ms.

In September 1991, Fujitsu introduced a line of high-capacity, low-profile, 2.5-inch rigid disk drives. This product line consists of three disk drives all backed by a 150,000 hour mean time between failures rating, a comprehensive warranty program, and capacities of 45MB, 67MB, and 90MB. All four drives feature an average seek time of 18ms, burst data transfer rates of up to 6 MB/sec., and an average latency of 8.3ms.

Fujitsu also produces tape drives in 1/2-inch reel-to-reel, start-stop, and streaming. During calendar 1990, according to Dataquest, Fujitsu ranked fourth in the 1/2-inch worldwide tape drive market with a 9.0 percent market share. It also ranked fifth in the 1/2-inch worldwide reel-to-reel worldwide tape drive market with a 7.3 percent market share.

Electronic Printers

The company manufactures and markets line-impacted, fully formed printers, serial impact dot matrix printers, baud printers, and laser printers. According to Dataquest, during 1990 the company had less than 1 percent of the total worldwide printer market.

Software

Within the software product line, Fujitsu offers operating system software, application software, translation support systems, and architectures. In May 1991, MESSAGE 90s was introduced as a new approach to system construction. Its function is to help organizations process information effectively and set up systems quickly through linked software products. This product line allows the use of hardware and software from other vendors to be used in Fujitsu systems. For example, NEC or IBM PCs can run LOTUS 1-2-3 seamlessly in a Fujitsu-based network.

During fiscal 1991, Fujitsu strengthened System Development Architecture and Support facilities, with the SDEM90 standard method of system development and the C-NAP II/CASE technical support tool for analyzing system requirements. Also, to expand the computer-integrated manufacturing business, the company started consulting and basic planning services to support system structuring in the fields of production and product distribution.

Telecommunications

The Telecommunications Division's product line is ISDN systems, COINS, mobile communication, switching systems, and transmission systems. In fiscal 1991, the division recorded net sales of $3.1 billion, an increase of approximately 13 percent over fiscal 1990. Net sales of the division accounted for 15 percent of total net sales.

ISDN

NTT's new ISDN service INS net 64/1500 is achieving acceptance, and many users are applying the network to fit their applications. In fiscal 1991, the packet communications mode in INS net was approved and the new INS-P service was started. In addition, demand increased for the ISDN-compatible systems, which support the entire scope of these ISDN services.

COINS

COINS is a corporate information network system that is receiving significant interest from companies as a multimedia network with excellent economy and extendability. It integrates data, voice, and images. By the end of March 1991, Fujitsu had strengthened COINS to implement ISDN communications forms by adding 1.5Mb line-switching and packet-switching functions to conventional private ISDN functions.

Mobile Communication

Demand increased sharply for small, lightweight cellular telephones in the field of mobile communication. NTT is promoting development of very small and lightweight cellular telephones. Fujitsu is participating in this development under contract with NTT. In the U.S. cellular telephone handset market, Fujitsu ranked sixth with a 7.2 percent market share.

Switching Systems

Within the switching systems product line, Fujitsu offers central office switching systems and digital PBX switching systems. During fiscal 1991, Fujitsu developed and delivered a prototype of the next-generation node system for the D-70. For digital PBXs, the company added application packages to the series. Fujitsu also released the cost-effective E-100 Series of information switching systems. In the U.S. PBX systems market, with 1,000 plus lines (new), Fujitsu ranked sixth with a 2.5 percent market share. In the 101 to 400 lines (new) segment, the company ranked eighth with a market share of 2.5 percent.

Transmission Systems

Within the transmission systems product line, Fujitsu offers digital communications equipment and earth station systems for satellite communication. The company implemented SDH, an international standard that will open communications environments and enable ISDN and other new services to be used more efficiently. In Japan, NTT is actively promoting the conversion to SDH, while Fujitsu is delivering many transmission systems and radio equipment that comply with SDH.

Electronic Devices

The Electronic Devices Division includes IC memories, ASICs, compound semiconductors, and other electronic devices. Dataquest estimates that Fujitsu ranked sixth in the worldwide semiconductor market, with 4.9 percent of the market share and revenue totaling $2.9 billion during calendar year 1990. This includes captive sales, which are excluded from the Electronic Devices Division's sales, as reported in the annual report. Net sales within this division decreased by 1.0 percent from $2.49 billion to $2.47 billion. The division accounted for 12.0 percent of total net sales. The semiconductor product line can be segmented into IC memories (MOS and bipolar technology), ASICs (MOS and bipolar technology), large-scale integrations (LSIs), and electronic components.

IC Memories

In fiscal 1991, Fujitsu increased its production of 4Mb DRAMs. The company also started delivering samples of 16Mb DRAMs, which will be the next generation of computer memory. In February 1991, Fujitsu announced a prototype of a 64Mb DRAM that uses new photo lithography exposure technology. This new technology will make mass production possible. Also, in February 1991, Fujitsu announced the 4Mb BiCMOS ECL SRAM, with an access time of 7ns.

ASICs

In fiscal 1991, demand rose for faster and larger-scale CMOS gate arrays. To meet this demand, Fujitsu released 15 new products, 7 of which feature a gate delay of 0.5ns and contain up to 14,000 gates. The remaining eight feature a gate delay of 0.35ns and contain up to 102,000 gates. In the worldwide total ASIC market, Fujitsu ranked number one with a market share of 13.0 percent.

Compound Semiconductors

During fiscal 1991, the compound semiconductor market developed a strong demand for low-noise high electron mobility transistors (HEMTs) for satellite broadcasting receivers. Fujitsu developed and released a super HEMT that can capture very weak signals because of dramatic improvements in gain and signal-to-noise ratio. Fujitsu also developed and released a GaAs gate array that features high-speed, large-scale integration and low power consumption. To respond to future increases in demand for HEMTs, GaAs FETs, and GaAs ICs, Fujitsu constructed a plant targeted for GaAs products.

Other Electronic Devices

In fiscal 1991, in response to rising use in home electrical appliances, telephones, and office machines, Fujitsu added application specific microcontrollers to its market offerings. Fujitsu also developed a 16-bit microcontroller that performs full 16-bit processing with an instruction cycle of 100ns. In addition, significant releases included a 16-inch plasma display with a resolution of 1280 × 1024 pixels and a membrane keyboard with a small footprint and low profile.

Other Operations

Other operations range from products such as car stereos to automatic vehicle monitors. Although in fiscal 1991, this division accounted for only 4 percent of total net sales, it increased approximately 16 percent to $885.

Further Information

For further information pertaining to the company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Millions of U.S. Dollars)

	1987	1988	1989	1990	1991
Five-Year Revenue	11,218	14,830	18,616	17,839	21,043
Percent Change	46.71	32.19	25.53	(4.17)	17.96
Capital Expenditure	814	1,209	1,825	2,105	2,231
Percent of Revenue	7.25	8.16	9.81	11.80	10.60
R&D Expenditure	1,043	1,378	1,925	2,093	2,336
Percent of Revenue	9.30	9.29	10.34	11.73	11.10
Number of Employees	89,293	94,825	104,503	115,000	145,000
Revenue ($K)/Employee	126	156	178	155	145
Net Income	135	305	545	607	585
Percent Change	(23.00)	125.24	78.74	11.29	(3.55)
Exchange Rate (U.S.$1=¥)	159.51	138.02	128.25	142.93	141.21

1991 Fiscal Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Fujitsu Limited
Annual Reports
Dataquest (December 1991)

Table 2
Revenue by Geographic Region (Percent)

Region	1987	1988	1989	1990	1991
Japan	78.06	77.89	77.87	76.13	75.17
International	21.94	22.11	22.13	23.87	24.83

Source: Fujitsu Limited
Annual Reports
Dataquest (December 1991)

1991 SALES OFFICE LOCATIONS

North America—3
Europe—4
Asia/Pacific—90
Japan—82
ROW—3

MANUFACTURING LOCATIONS

North America

Fujitsu America
Communications and information processing equipment, development of software
Fujitsu Business Communications Systems
Communications equipment
Fujitsu Microelectronics
Semiconductor devices
Intellistor Inc.
Development of information processing equipment

Europe

Fujitsu Espana (Spain)
Communications and information processing equipment
Fujitsu Microelectronics (Ireland)
Semiconductor devices
Fujitsu Microelectronics (United Kingdom)
Development of ASICs

Asia/Pacific

FKL-Dongwa (South Korea)
Magnetic floppy disk drive heads
Fuji Electrochemical (Japan)
Ferrites, electronic equipment, dry batteries
Fuji Facom (Japan)
Development of computer systems for control
Fujitsu (Singapore)
Electronic parts (digital switching systems)
Fujitsu Australia (Australia)
Digital key telephones, digital PBXs
Fujitsu Automation (Japan)
Automation equipment
Fujitsu Buhin (Japan)
Electronic parts
Fujitsu Component (Malaysia)
Electronic parts (relays, keyboards, connectors)
Fujitsu Computer Technology (Japan)
Development of LSIs, software for information processing equipment
Fujitsu Denso (Japan)
Communications/electronic equipment
Fujitsu General (Japan)
Home electric appliances, communications equipment, data processing equipment
Fujitsu Isotec (Japan)
Printers
Fujitsu Kasei (Japan)
Plastic products for communications equipment
Fujitsu Kiden (Japan)
Data processing equipment, indicators, molds
Fujitsu Microelectronics Asia (Singapore)
Semiconductor devices
Fujitsu Microelectronics (Malaysia)
Semiconductor devices
Fujitsu Miyagi Electronics (Japan)
Semiconductor devices
Fujitsu Peripherals (Japan)
Peripherals
Fujitsu TEN (Japan)
Car radios, stereos
Fujitsu Thailand (Thailand)
Magnetic disk drive heads, magnetic heads for printers
Fujitsu Tohoku Electronics (Japan)
Semiconductor devices
Fujitsu VLSI (Japan)
Development of semiconductor devices
Fujitsu Yamanashi Electronics (Japan)
Semiconductor devices
Hasegawa Electric (Japan)
Communications equipment
Kyushu Fujitsu Electronics (Japan)
Semiconductor devices
Nihon Dengyon (Japan)
Radio and digital communications equipment
PFU Ltd. (Japan)
Microcomputers, peripherals
Shinano Fujitsu (Japan)
Electronic parts
Shinko Electric Industries (Japan)
Semiconductor parts
Takamisawa Electric (Japan)
Switching systems, parts
Towa Electron (Japan)
Capacitors, hybrid ICs
Yamagata Fujitsu (Japan)
Magnetic disk drives

SUBSIDIARIES

North America

Fujitsu America Inc. (United States)
Fujitsu Business Communications Systems Inc. (United States)
Fujitsu Canada Inc. (Canada)
Fujitsu Component of America Inc. (United States)
Fujitsu Computer Packaging Technologies Inc. (United States)
Fujitsu Computer Products of America Inc. (United States)
Fujitsu Customer Service of America Inc. (United States)
Fujitsu Imaging Systems of America Inc. (United States)
Fujitsu Microelectronics Inc. (United States)
Fujitsu Network Switching of America Inc. (United States)
Fujitsu Network Transmission Systems Inc. (United States)
Fujitsu Systems of America Inc. (United States)
Fujitsu Systems Business of America Inc. (United States)
Intellistor Inc. (United States)
Poqet Computer Corp. (United States)

Europe

Fujitsu Deutschland GmbH (Germany)
Fujitsu Espana S.A. (Spain)
Fujitsu Europe Ltd. (England)
Fujitsu Europe Telecom R&D Centre Limited (United Kingdom)
Fujitsu Finance (U.K.) plc (United Kingdom)
Fujitsu International Finance (Netherlands) B.V. (Netherlands)
Fujitsu Italia S.p.A. (Italy)
Fujitsu Microelectronics Ireland Ltd. (Ireland)
Fujitsu Microelectronics Italia S.r.l. (Italy)
Fujitsu Microelectronics Ltd. (England)
Fujitsu Mikroelektronik GmbH (Germany)
Fujitsu Nordic AB (Sweden)
Fulcrum Communications Limited (United Kingdom)

Asia/Pacific

Beijing Fujitsu Systems Ltd. (China)
Fuji Electrochemical Co. Ltd. (Japan)
Fujitsu Advanced Printing and Publishing Co. Ltd. (Japan)
Fujitsu Aichi Engineering Limited (Japan)
Fujitsu Australia Ltd. (Australia)
Fujitsu Australia Software Technology Pty. Ltd. (Australia)
Fujitsu Australia Wholesale Pty. Ltd. (Australia)
Fujitsu Automation Limited (Japan)
Fujitsu Basic Software Corporation (Japan)
Fujitsu Business Systems (Japan) Ltd. (Japan)
Fujitsu Communications Systems (Japan)
Fujitsu Component (Malaysia) Sdn. Bhd. (Malaysia)
Fujitsu Computer Technologies (Japan)
Fujitsu Dai-ichi Communication Software Limited (Japan)
Fujitsu Dai-ichi System Engineering Limited (Japan)
Fujitsu Denso Ltd. (Japan)
Fujitsu Devices Inc. (Japan)
Fujitsu Digital Technology Limited (Japan)
Fujitsu Distribution Systems Engineering Limited (Japan)
Fujitsu Documents Service Limited (Japan)
Fujitsu Electronics (Singapore) Pte. Ltd. (Singapore)
Fujitsu FACOM Information Processing Corporation (Japan)
Fujitsu Financial Information Systems Limited (Japan)
Fujitsu Fudosan Ltd. (Japan)
Fujitsu Hong Kong Ltd. (Hong Kong)
Fujitsu Isotec Limited (Japan)
Fujitsu Kansai Communication Systems Limited (Japan)
Fujitsu Kansai System Engineering Limited (Japan)
Fujitsu Kasei Ltd. (Japan)
Fujitsu Keihin Systems Engineering Limited (Japan)
Fujitsu Kiden Ltd. (Japan)
Fujitsu Korea Ltd. (Korea)
Fujitsu Kosan Limited (Japan)
Fujitsu Kyushu Communication Systems Limited (Japan)
Fujitsu Kyushu Systems Engineering Ltd. (Japan)
Fujitsu Laboratories Ltd. (Japan)
Fujitsu Lease (Japan)
Fujitsu Logistics Limited (Japan)
Fujitsu Microelectronics Asia Pte. Ltd. (Singapore)
Fujitsu Microelectronics (Malaysia) Sdn. Bhd. (Malaysia)
Fujitsu Microelectronics Pacific Asia Ltd. (Hong Kong)
Fujitsu Minami-Kyushu Systems Engineering Limited (Japan)
Fujitsu Miyagi Electronics Ltd. (Japan)
Fujitsu Nagano Systems Engineering Limited (Japan)
Fujitsu Network Engineering Limited (Japan)
Fujitsu New Zealand Holdings Ltd. (New Zealand)
Fujitsu New Zealand Ltd. (New Zealand)
Fujitsu OA Limited (Japan)
Fujitsu Office Machines Limited (Japan)

Fujitsu Oita Software Laboratories Limited (Japan)
Fujitsu Peripherals Limited (Japan)
Fujitsu Program Laboratories Limited (Japan)
Fujitsu Shikoku Infortec Limited (Japan)
Fujitsu Shizuoka Engineering Limited (Japan)
Fujitsu (Singapore) Pte. Ltd. (Singapore)
Fujitsu Sinter Limited (Japan)
Fujitsu Social Science Laboratory Limited (Japan)
Fujitsu Social Systems Engineering Limited (Japan)
Fujitsu Supplies Limited (Japan)
Fujitsu System Integration Laboratories Ltd. (Japan)
Fujitsu Systems Construction (Japan)
Fujitsu Systems Consulting (Japan)
Fujitsu Technosystems Limited (Japan)
Fujitsu TEN Limited (Japan)
Fujitsu (Thailand) Co. Ltd (Thailand)
Fujitsu Tohoku Electronics Ltd. (Japan)
Fujitsu Tohoku Systems Engineering Limited (Japan)
Fujitsu Tokia Systems Engineering Limited (Japan)
Fujitsu Trading Ltd. (Japan)
Fujitsu VLSI Limited (Japan)
Fujitsu Quantum Devices Ltd. (Japan)
Gunma Fujitsu Limited (Japan)
Hasegawa Electric Co. Ltd. (Japan)
Ishikawa Fujitsu Software Limited (Japan)
Iwaka Densi Ltd. (Japan)
Kyushu Fujitsu Electronics Ltd. (Japan)
Nihon Dengyo Limited (Japan)
Okinawa Fujitsu Systems Engineering Limited (Japan)
PFU Limited (Japan)
Shimane Fujitsu (Japan)
Shinano Fujitsu Ltd. (Japan)
Shin-Etsu Fujitsu (Japan)
Shinko Electric Industries Co. Ltd. (Japan)
Ten Onkyo Ltd. (Japan)
Totalizator Engineering Limited (Japan)
Toyama Fujitsu (Japan)
Yamagata Fujitsu Limited (Japan)
Yonago Fujitsu (Japan)

ROW

Fujitsu de Brasil Limitada (Brazil)
Fujitsu Vitonia Computadores e Servicos Ltda (Brazil)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1991

EPWING Consortium

The EPWING Consortium was created with Sony Corporation and several publishing houses to establish a standard for CD-ROM electronic books.

Hitachi Ltd., Sony Corporation, Texas Instruments Japan Ltd.

Fujitsu Ltd., Hitachi Ltd., Sony Corporation, and Texas Instruments Japan Ltd. signed an agreement to codevelop the MUSE decoder integrated circuits. MUSE is the standard high-definition television format in Japan. The cooperative efforts by the four companies is expected to accelerate the development of a small, low-cost, next generation MUSE decoder.

Texas Instruments

Fujitsu and Texas Instruments signed a five-year global semiconductor patent cross-licensing agreement. The deal encompasses most of the semiconductor patents by the two firms except the Texas Instruments Kilby patent.

Cadence Design Systems

Cadence Design Systems and Fujitsu have signed a joint development agreement to produce ASIC software tools.

Quotient plc

Quotient plc and Fujitsu signed a joint development agreement to produce financial software systems.

KBS2 Corp.

KBS2 Corp. and Fujitsu signed a joint development agreement to develop crashworthiness software.

Rodime plc

Rodime plc entered into a nonexclusive royalty-free patent cross-licensing agreement with Fujitsu Ltd. The agreement is for the use of Rodime patents that apply to 3.5-inch drives.

Cincom Systems

Cincom Systems and Fujitsu will combine business efforts in the Canadian market to offer high-performance software.

McDonnell Douglas Information Systems International (MDISI)

MDISI and Fujitsu have made an agreeement to port the PRO-IV 4GL software package developed by MDISI to Fujitsu's K Series office computers. The two firms will then market the software.

1990

Novell K.K.

A joint marketing venture to sell Netware products in Japan was formed with Novell and six partners, Fujitsu being one of them.

Isuzu
The two companies have formed an automotive electronics venture and currently are attempting to get General Motors to join.

Matsushita Electric Industrial
The two companies plan to strengthen their business relationship by mutually supplying their computers on an OEM basis. Fujitsu will supply Matsushita with its high-end laptop and desktop 32-bit PCs; Matsushita will supply Fujitsu with the M550 and M600 series of 32-bit desktop personal computers.

Poqet Computer
Fujitsu will produce and market Poqet Computer's pocket-size computer under license. Fujitsu's stake in Poqet Computer has grown gradually over the last two years because of mutual agreement and investments into R&D and manufacture of Poqet's product lineup.

Nokia Data Systems Oy
An agreement has been made whereby Nokia will act as an OEM of digital PBX systems (the F-620 and F-640) for Fujitsu.

Matsushita Electric Industrial
The two companies plan to strengthen their business relationship by mutually supplying their computers on an OEM basis.

UNIX International
Fujitsu has joined a new marketing group comprising 21 other high-tech companies. The group will promote UNIX's System V release 4 and further standard developments.

Molecular Design Ltd. and IBM
Fujitsu has formed a relationship with the two companies to ensure that Molecular Design software for managing and communicating scientific information will run on their computers.

Mitsui Bank Research Institute
The two companies have agreed to establish a system consulting service.

MEDIAGENIC
MEDIAGENIC has agreed to develop entertainment software for the Fujitsu FM TOWNS.

Daisy/Cadnetix Inc.
The companies jointly produced an ASIC design kit developed for the DAZIX design environment on the Sun-4 family of workstations running on UNIX.

Vitesse Semiconductor Corporation
The companies have entered into an alternate source agreement with regard to Vitesse's Fury gallium arsenide (GaAs) VLSI gate-array family.

1989

Japan Tobacco Inc.
Fujitsu formed a tie-up agreement with Japan Tobacco whereby Fujitsu will market two of Japan Tobacco's software modules.

The Australian National University in Canberra
The two organizations signed an R&D agreement for two three-year projects. One project is to develop a small image processing system; the other is to develop software for parallel processors.

Vitesse Semiconductor
The two companies agreed to jointly develop GaAs gate arrays.

Southern New England Telecommunications Systems
Southern New England Telecommunications agreed to market Fujitsu's ISDN telecommunications equipment in the United States on an exclusive basis. The list of products includes digital telephones and terminal adapters.

NTT Data Communications Systems
The two companies will jointly market their respective logic chip design software products as a total CAE design system.

Sony Corporation
The two companies jointly developed a trial common rule to develop CD-ROM XA software for their personal computers.

Bell Atlantic Optical Network (SONET)
Fujitsu agreed to sell Bell Atlantic's transmission products under a two-year, $2 million contract. Fujitsu will provide its FLM 50/150 Fiber LOOP Multiplexer for deployment in Bell Atlantic areas.

Poqet Computer Corporate
An agreement provides Poqet with funding and credit guarantees; the companies made a cooperative technology agreement allowing for mutual adaptation of technologies and joint development of new technology.

Sun Microsystems Inc.
Sun and Fujitsu will jointly develop a high-speed RISC chip.

1988

Telecom Australia
Telecom Australia agreed to sell Fujitsu's digital PBXs in Australia; the companies established a sales joint-venture, Information Switching Technology.

Daisy Systems
Fujitsu's FAME was made available on Daisy's Advansys Series of CAD/CAE systems.

Hitachi Ltd.
The two companies agreed to cooperate on the development of a 32-bit MPU and peripheral LSI family based on TRON architecture.

MERGERS AND ACQUISITIONS

Fulcrum Communications Ltd.
British Telecommunications plc sold the manufacturing division of Fulcrum Communications to Fujitsu Ltd. but will retain a 25.1 percent interest in the new company. The company makes and markets public switched telephone network equipment such as call monitoring and logging products, call queueing, exchange monitoring, and fiber-optic tools.

Nokia Data
Nokia Data, which is one of Europe's largest computer companies, was purchased by ICL Ltd. (80 percent owned by Fujitsu). ICL Ltd. will pay $402.3 million for the company and will assume about $174.9 million of Nokia's debt. Nokia's parent corporation, Nokia Corporation, will receive a 5 percent stake in ICL Ltd.

Poqet Computer Corporation
Fujitsu increased its stake to 85 percent in Poqet Computer Corporation for $37 million. In 1988, Fujitsu had purchased a 28 percent equity stake in the firm. Fujitsu has been working with Poqet Computer to develop Japanese versions of pocket computers.

Softway
Fujitsu acquired a 40 percent interest in Softway, an Australian software company. Both companies will collaborate on UNIX systems development. Continental Venture Capital, Softway, and Techway staff also hold a 20 percent interest in the company.

Hal Computer Systems Inc.
Fujitsu Ltd. acquired a 44 percent interest totaling $40.2 million in Hal Computer Systems. The company is developing a family of high-performance open systems based on the SPARC architecture and UNIX System V Release 4.

ICL plc
Fujitsu purchased 80 percent of ICL, a subsidiary of STC plc. The merger increases Fujitsu's global presence and makes it the second largest computer manufacturer in the world.

KEY OFFICERS

Takuma Yamamoto
Chairman and representative director

Matami Yasufuku
Vice chairman and representative director

Tadashi Sekizawa
President and representative director

Kazuo Watanabe
Vice president and representative director

Mikio Ohtsuki
Executive vice president

Motojiro Shiromizu
Executive director

Mamoru Mitsugi
Executive director

Tokio Tatsuta
Executive director

Eigo Kato
Executive director

Matsuro Umezu
Executive director

Ryoichi Sugioka
Executive director

PRINCIPAL INVESTORS

Fuji Electric Co. Ltd.—13.5 percent
Asahi Mutual Life Insurance Company—6.5 percent

FOUNDERS

Information is not available.

Table 3
Balance Sheet
Fiscal Year Ending March 31
(Millions of U.S. Dollars)

Balance Sheet	1987	1988	1989	1990	1991
Cash	1,125	1,764	2,379	1,833	2,906
Receivables	2,904	3,645	4,615	5,104	6,025
Marketable Securities	137	648	189	225	159
Inventory	2,562	3,354	3,734	4,097	5,038
Other Current Assets	307	408	452	265	599
Total Current Assets	7,035	9,818	11,369	11,523	14,726
Net Property, Plants	3,424	4,289	5,481	5,777	6,947
Other Assets	2,067	2,678	3,617	3,489	4,792
Total Assets	12,527	16,784	20,467	20,789	26,465
Total Current Liabilities	4,991	7,059	8,581	8,979	11,939
Long-Term Debt	2,117	2,185	2,467	2,368	4,091
Other Liabilities	1,153	1,548	1,924	1,849	2,225
Total Liabilities	8,261	10,792	12,973	13,197	18,256
Converted Preferred Stock	NA	NA	NA	NA	NA
Common Stock	2,115	3,364	4,252	4,219	4,350
Other Equity	71	92	110	110	123
Retained Earnings	2,080	2,536	3,133	3,264	3,737
Total Shareholders' Equity	4,266	5,992	7,495	7,592	8,210
Total Liabilities and Shareholders' Equity	12,527	16,784	20,467	20,789	26,465
Exchange Rate (U.S.$1=¥)	159.51	138.02	128.25	142.93	141.21

NA = Not available

Source: Fujitsu Limited
Annual Reports
Dataquest (December 1991)

Table 4
Consolidated Income Statement
Fiscal Year Ending March 31
(Millions of U.S. Dollars, except Per Share Data)

Consolidated Income Statement	1987	1988	1989	1990	1991
Revenue	11,218	14,830	18,616	17,839	21,043
Domestic	8,757	11,551	14,496	13,581	15,818
Overseas	2,461	3,279	4,120	4,258	5,225
Cost of Sales	7,728	9,703	11,914	11,043	12,893
R&D Expense	1,043	1,378	1,925	2,093	2,336
SG&A Expense	2,057	2,883	3,328	3,337	4,298
Capital Expense	814	1,209	1,825	2,105	2,231
Pretax Income	301	768	1,210	1,191	1,088
Pretax Margin (%)	2.68	5.18	6.50	6.68	5.17
Net Income	135	305	545	607	585
Shares Outstanding, Millions	1,593.3	1,710.0	1,760.1	1,760.1	1,760.1
Per Share Data					
Earnings	13.40	23.50	36.80	36.80	$36.80
Dividend	8.00	8.00	9.00	9.00	9.00
Book Value	2.68	3.50	4.26	4.31	4.66
Exchange Rate (U.S.$1=¥)	159.51	138.02	128.25	142.93	141.21

Source: Fujitsu Limited
Annual Reports
Dataquest (December 1991)

Table 5
Balance Sheet
Fiscal Year Ending March 31
(Millions of Yen)

Balance Sheet	1987	1988	1989	1990	1991
Cash	179,409	243,492	305,166	261,928	410,365
Receivables	463,150	503,035	591,815	729,471	850,761
Marketable Securities	21,863	89,402	24,219	32,154	22,413
Inventory	408,718	462,869	478,840	585,546	711,392
Other Current Assets	49,035	56,326	58,017	37,867	84,579
Total Current Assets	1,122,175	1,355,124	1,458,057	1,646,975	2,079,510
Net Property, Plants	546,233	591,921	702,988	825,757	980,961
Other Assets	329,779	369,549	463,882	498,633	676,699
Total Assets	1,998,187	2,316,594	2,624,927	2,971,365	3,737,170
Total Current Liabilities	796,143	974,268	1,100,577	1,283,409	1,685,950
Long-Term Debt	337,660	301,618	316,395	338,481	577,700
Other Liabilities	183,980	213,685	246,778	264,347	314,221
Total Liabilities	1,317,783	1,489,571	1,663,750	1,886,237	2,577,871
Converted Preferred Stock	NA	NA	NA	NA	NA
Common Stock	337,308	464,365	545,369	602,980	614,205
Other Equity	11,359	12,659	14,050	15,658	17,381
Retained Earnings	311,737	349,999	401,758	466,490	527,713
Total Shareholders' Equity	680,404	827,023	961,177	1,085,128	1,159,299
Total Liabilities and Shareholders' Equity	1,998,187	2,316,594	2,624,927	2,971,365	3,737,170
Exchange Rate (U.S.$1=¥)	159.51	138.02	128.25	142.93	141.21

NA = Not available

Source: Fujitsu Limited
Annual Reports
Dataquest (December 1991)

Table 6
Consolidated Income Statement
Fiscal Year Ending March 31
(Millions of Yen, except Per Share Data)

Consolidated Income Statement	1987	1988	1989	1990	1991
Revenue	1,789,417	2,046,802	2,387,442	2,549,773	2,971,462
Domestic	1,396,876	1,594,193	1,859,129	1,941,075	2,233,493
Overseas	392,541	452,609	528,313	608,698	737,969
Cost of Sales	1,232,722	1,339,183	1,527,908	1,578,343	1,820,554
R&D Expense	166,342	190,130	246,906	299,107	329,823
SG&A Expense	328,184	397,968	426,779	476,979	606,890
Capital Expense	129,822	166,924	234,113	300,822	315,109
Pretax Income	48,012	106,048	155,152	170,216	153,573
Pretax Margin (%)	2.68	5.18	6.50	6.68	5.17
Net Income	21,609	42,115	69,948	86,758	82,673
Shares Outstanding, Millions	1,593.3	1,710.0	1,760.1	1,802.4	1,812.1
Per Share Data					
Earnings	13.40	23.50	36.80	45.40	42.20
Dividend	8.00	8.00	9.00	9.00	10.00
Book Value	427.04	483.64	546.09	602.05	639.75
Exchange Rate (U.S.$1=¥)	159.51	138.02	128.25	142.93	141.21

Source: Fujitsu Limited
Annual Reports
Dataquest (December 1991)

Table 7
Key Financial Ratios
Fiscal Year Ending March 31

Key Financial Ratios	1987	1988	1989	1990	1991
Liquidity					
Current (Times)	1.41	1.39	1.32	1.28	1.23
Total Assets/Equity (%)	293.68	280.11	273.10	273.83	322.36
Current Liabilities/Equity (%)	117.01	117.80	114.50	118.27	145.43
Total Liabilities/Equity (%)	193.68	180.11	173.10	173.83	222.36
Profitability (%)					
Return on Assets	1.08	1.82	2.66	2.92	2.21
Return on Equity	3.40	6.19	8.46	9.03	7.62
Profit Margin	1.21	2.06	2.93	3.40	2.78
Other Key Ratios					
R&D Spending % of Revenue	9.30	9.29	10.34	11.73	11.10
Capital Spending % of Revenue	7.25	8.16	9.81	11.80	10.60
Employees	89,293	94,825	104,503	115,000	145,000
Revenue (¥)/Employee	20,040	21,585	22,846	22,172	20,493
Capital Spending % of Assets	6.50	7.21	8.92	10.12	8.43
Exchange Rate (U.S.$1=¥)	159.51	138.02	128.25	142.93	141.21

Source: Fujitsu Limited
Annual Reports
Dataquest (December 1991)

Fujitsu Limited

6-1, Marunouchi 2-chome
Chiyoda-du, Tokyo 100, Japan
Telephone: 03-216-3211
Fax: 03-216-9365
Dun's Number: 08-292-1644

Date Founded: 1935

CORPORATE STRATEGIC DIRECTION

Fujitsu Limited, founded in 1935 as a spin-off of the Communications Division of Fuji Electric Company, Ltd., is a multinational Japanese firm with 73 wholly owned, consolidated subsidiaries. Fujitsu designs, manufactures, and markets computer and data processing systems, telecommunications equipment, electronic devices, and other electronic products such as car stereos and digital audiotape (DAT) players. To organize and unify such a diverse product offering, Fujitsu has segmented its corporate structure into four main divisions by each of the four aforementioned product types. Approximately 60 percent of Fujitsu's revenue is derived from the Computer and Data Processing Systems Division.

Fujitsu currently is one of the largest companies in Japan with over ¥2.39 trillion (US$18.6 billion) in revenue and over ¥2.62 trillion (US$19.0 billion) in total assets. However, because it is a large, diverse, multinational company, Fujitsu is confronted with some very complex issues. Two main issues are the geographical expansion of the world's markets and the unification the European Community (EC). With the opening to trade of certain Eastern European countries and the economic development of several third-world countries, as well as the unification of the EC, new markets and subsequently new opportunities are emerging rapidly.

Fujitsu is responding to these issues by increasing its global presence at a local level. The Company is pursuing this strategy by increasing its foreign investment and by globally establishing local subsidiaries. As a consequence of this strategy, Fujitsu hopes to obtain an early foothold in the new markets and thereby position itself to take full advantage of emerging opportunities as the new markets evolve. Furthermore, Fujitsu will be in closer contact with the individual consumer so that it can respond in an appropriate and timely manner to local market demands.

In 1990, Fujitsu took a major step toward increasing its global presence by acquiring an 80 percent share in ICL, Ltd., a computer unit of STC Plc. The merger makes Fujitsu the second largest computer vendor in the world. The merger also gives Fujitsu a 43 percent share of the mainframe market in Great Britain.

Along with global expansion and unification issues, the Company is confronted with an adverse exchange rate. Since 1985, the value of the yen has risen approximately 70 percent against the US dollar, thereby decreasing profit margins on exported goods. In response, Fujitsu is streamlining its organization, reducing costs, and de-emphasizing cross-border transactions. The Company implemented a "Fresh Fujitsu '88" campaign focused toward redefining management roles for consolidating certain duties and centralizing responsibility, thereby increasing managerial efficiency. Also, the Company has begun to increase raw material sourcing and product development from within local markets in which it has manufacturing plants, thereby reducing cross-border transactions and effectively reducing the Company's exposure to adverse movement in the exchange rate.

The results of these strategies are reflected in the Company's financial performance. Net sales increased 6.8 percent to ¥2.6 trillion (US$17.9 billion) in the fiscal year ending March 31, 1990, from ¥2.4 trillion (US$18.6 billion) in fiscal 1989. (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) International sales increased 15.4 percent to ¥609.4 billion (US$4.2 billion) in fiscal 1990 from ¥528.3 billion (US$4.1 billion) in fiscal 1989. International sales accounted for 23.9 percent and 22.1 percent of the Company's total revenue in fiscal 1990 and 1989, respectively. Net income increased 24.0 percent to ¥86.6 billion (US$607.0 million) in fiscal 1990 from ¥69.9 billion (US$545.0 million) in fiscal 1989. The preceding 1990 financial figures were published prior to Fujitsu's Annual Report. Specific financial figures have not yet been made available. Consequently, 1990 figures are not included in the financial tables, which are located at the end of this profile.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channels is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Computers and Data Processing

Dataquest estimates that Fujitsu was one of the five largest information systems manufacturers in the world and the largest in Japan in the calendar year 1989. The Computer and Data Processing Division's net sales increased approximately 7 percent to ¥1.69 trillion (US$11.86 billion) in fiscal 1990, accounting for 66.1 percent of the Company's total net sales. The division's product offerings include computer systems, office automation equipment, VAN services, computer storage, electronic printers, CAD/CAM/CAE, and software. Fujitsu's main competitors, in order of their degree of competitiveness with Fujitsu, are IBM, Digital, Hewlett-Packard, Groupe Bull, NEC, Unisys, and Hitachi.

Computer Systems

Within the computer systems product line, Fujitsu offers supercomputers, retail automation systems, and general-purpose computers. The following occurred for Fujitsu during fiscal 1989:

- It introduced eight new models of the VP-2000 Series supercomputers, which offer one of the world's highest vector processing powers at 4 Gflops (floating-point operations per second).
- It made strong gains in the point-of-sale (POS) market with the FAST Series of retail automation systems.
- It released the FACT III Series, an automated teller and cash-dispensing machine.
- It enjoyed increased demand for its M Series general-purpose computers, with substantial orders from the Tokyo and Osaka stock exchanges.

Office Automation

Within the office automation product line, Fujitsu offers small business computers, workstations, word processors, and personal computers, including business, hypermedia, desktop, portable, and laptop. The following occurred for Fujitsu during fiscal 1989:

- It released the K-600 Series and K-100 Series of small business computers as office processors for strategic information systems.
- It released the Fujitsu S Family of engineering workstations in response to the growing need for UNIX.
- It introduced the OASYS Series of Japanese-language word processors with improved document production generation and graphics functions.
- It released new machines in the FM R Series of business computers, completing the lineup of desktop, portable, and laptop models.
- It introduced the FM TOWNS hypermedia personal computer, an Intel 80386-based multimedia computer system with a CD-ROM drive, featuring a bit-mapped graphical user interface (GUI) with pull-down menus and icons.

VAN Services

Within the VAN services product line, Fujitsu offers industry VANs, local VANs, corporate VANs, and personal communication services. The following occurred for Fujitsu during fiscal 1989:

- It expanded the FENICS VAN service by offering an industry VAN for application-specific services such as sending and receiving orders, a local VAN to increase the efficiency of local distribution in a common network, and a corporate VAN to expand corporate data services and telecommunications networks.
- It offered new personal computer communications services, including CompuServe, which provides an easy way to communicate with the United States through international telecommunication lines, and NIFTY-Serve, which offers various services using the FENICS network.

Computer Storage

Dataquest estimates that Fujitsu acquired a 10 percent share of the worldwide rigid disk market (by revenue) and a 6 percent share of the worldwide tape drive market in calendar year 1989. Fujitsu produces 1/2-inch reel-to-reel, start-stop, and streaming tape drives. In the rigid disk drive market, the Company produces 3.5-inch fixed drives ranging in size up to 100MB.

Electronic Printers

The Company manufactures and markets line-impacted, fully formed printers, serial impact dot matrix printers, baud printers, and laser printers.

CAD/CAM/CAE

Fujitsu strengthened its position in the CAD/CAM/CAE market in 1989, with revenue growing by 13.7 percent to a US dollar equivalent of $269 million. The Company continues to be among the major OEMs of Sun Microsystems workstations. The key strategic issue to be resolved concerns the recent IBM acquisition of Cadam, which develops Fujitsu's primary CAD/CAM product. IBM has honored all contractural commitments to date. However, a continued long-term relationship is unlikely.

Software

Within the software product line, Fujitsu offers operating system software, application software, translation support systems, and architectures. The following occurred for Fujitsu during fiscal 1989:

- It introduced the MSP-EX operating system, which is targeted toward the heavy-use demands of host computers.
- It developed application programs targeted for computer use in individual companies.
- It released the ATLAS-G Japanese-English translation support system, which runs on the M Series general-purpose computers.
- It experienced increased sales of the knowledge system architecture and applications, released in the prior year.

Telecommunication

The Telecommunications Division's product line is ISDN systems, corporate information network systems (COINS), switching systems, and transmission systems. In fiscal 1990, the division recorded net sales of $394.3 billion, an increase of approximately 5.0 percent over fiscal 1989. Net sales of the division accounted for 15.5 percent of total net sales.

Integrated Services Digital Network (ISDN) Services

Within the ISDN services, Fujitsu offers various facsimile equipment, ISDN terminals, moving image television phones, handwriting communication terminals, and key telephones. During fiscal 1989, Fujitsu introduced the F1865A Facsimile Connection Unit. This device functions as a facsimile machine, as a printer with laser printer-quality output, and as a data entry terminal with support for handwritten optical character recognition (OCR). It is designed for use on a Fujitsu Network Architecture around an M Series mainframe.

Corporate Information Network System (COINS)

COINS is a corporate informations network system that is receiving significant interest from companies as a multimedia network with excellent economy and extensibility.

Switching Systems

Within the switching systems product line, Fujitsu offers central office switching systems and digital PBX switching systems. The following occurred for Fujitsu during calendar year 1989:

- It introduced five new models of the FETEX-5000A Series, which is compatible with ISDN and supports 1.5MB per second transmission between packet-switching systems and long packets (up to 4,096 octets).
- It introduced the Starlog Business Management Package, which expands the cost management and user analysis capabilities of the Starlog PBX system, enabling telecommunications managers to better supervise use of telephone and related facilities within their companies.
- It announced expansion of its F9600 PBX product into a strategic ISDN PBX platform supporting as many as 10,000 lines or as few as 100 lines.
- It introduced the 300A Series digital PBX information switching system.

Transmission Systems

Within the transmission systems product line, Fujitsu offers digital communications equipment and earth station systems for satellite communication. During fiscal 1989, Fujitsu supplied some of the equipment for the the Transpacific Cable No. 3 (TPC-3), and supplied mobile and portable earth stations to Telecom SAT and VIDEO SAT.

Electronic Devices

Dataquest estimates that Fujitsu was the fifth largest (by revenue) semiconductor vendor in the worldwide market in calendar year 1989, with a US dollar equivalent of $2.96 billion in net sales. Net sales increased 6.7 percent over the previous year. The division accounted for 14.0 percent of total net sales with ¥356.8 billion, (US$2.8 billion). The semiconductor product line can be broken down into IC memories (MOS and bipolar technology), ASICs (MOS and bipolar technology), LSIs, and electronic components.

IC Memories

In fiscal 1989, IC memory sales grew dramatically, reflecting the growth of computers, office automation equipment, and telecommunications equipment. Domestic and international demand for the 1MB DRAM and the 4MB DRAM increased. Fujitsu also began production of BiCMOS memories.

ASICs

In fiscal 1989, the Company increased its product offering by introducing the following:

- ASIC Design Kits, which are developed specifically for the Daisy/Cadnetix Inc. (DAZIX) design environment on the Sun-4 family of workstations running UNIX (SunOS 4.0.3)
- Two new ECL gate arrays, E10040VHM and E10160VHR, which offer on-chip memory and are the newest additions to the Company's VH series of ECL arrays
- A new series of BiCMOS gate arrays, the BC-H series, which provides bipolar performance and high-current drive with low power dissipation

LSIs

During fiscal 1989, Fujitsu announced the development of 54,000-gate ultralarge-scale integration ECL gate arrays that use a substrate power supply structure, and the development of a 64MB DRAM memory cell.

Electronic Components

The Company offers a range of products from plasma display panels and membrane keyboards to connectors and relays. Hybrid ICs and other new products that use advances in thin-film technology are developed in this division.

Others

Other operations range from products such as car stereos to automatic vehicle monitors. This division accounted for only 4.3 percent of total net sales. However, sales did increase 10.1 percent to ¥109 billion (US$765 million) in fiscal 1990.

Further Information

For further information pertaining to the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Millions of US Dollars)

	1985	1986	1987	1988	1989
Five-Year Revenue	$6,415	$7,646	$11,218	$14,829	$18,616
Percent Change	-	19.19	46.70	32.19	25.54
Capital Expenditure	$1,998	$1,559	$1,964	$3,161	$4,167
Percent of Revenue	31.14	20.39	17.51	21.32	22.39
R&D Expenditure	$545	$710	$1,043	$1,377	$1,925
Percent of Revenue	8.49	9.28	9.30	9.29	10.34
Number of Employees	74,187	84,277	89,293	94,825	104,503
Revenue ($K)/Employee	$86	$91	$126	$156	$178
Net Income	$366	$176	$135	$305	$545
Percent Change	-	(51.88)	(23.00)	125.24	78.75
Exchange Rate (US$=¥)	¥243.53	¥221.26	¥159.51	¥138.02	¥128.25

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Fujitsu Limited
Annual Reports and Forms 10-K
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1985	1986	1987	1988	1989
Asia/Pacific	73.06	76.29	78.06	77.89	77.87
Japan	73.06	76.29	78.06	77.89	77.87
International	26.94	23.71	21.94	22.11	22.13

Source: Fujitsu Limited
Annual Reports and Forms 10-K
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

North America—3
Europe—4
Asia/Pacific—90
Japan—82
ROW—3

MANUFACTURING LOCATIONS

North America

Amdahl Corporation
Communications and information processing equipment
Fujitsu America
Communications and information processing equipment, development of software
Fujitsu Business Communications of America
Communications equipment
Fujitsu-GTE Business Systems
Development of large PBXs
Fujitsu Microelectronics
Semiconductor devices (256K DRAMs, 1MB DRAMs, ASICs)
Intellistor, Inc.
Development of information processing equipment

Europe

Anamartic Ltd. (United Kingdom)
Semiconductor memories
Fujitsu Espana (Spain)
Communications and information processing equipment
Fujitsu Microelectronics (Ireland)
Semiconductor devices (256K DRAMs, 1MB DRAMs)
Fujitsu Microelectronics (United Kingdom)
Development of ASICs

Asia/Pacific

Advantest Corporation (Japan)
Measuring instruments, IC testers
FKL-Dongwa (South Korea)
Magnetic floppy disk drive heads
Fanuc Ltd. (Japan)
CNC equipment, applied machines
Fuji Electrochemical (Japan)
Ferrites, electronic equipment, dry batteries
Fuji Facom (Japan)
Development of computer systems for control
Fujitsu (Singapore)
Electronic parts (digital switching systems)
Fujitsu Australia (Australia)
Digital key telephones, digital PBXs
Fujitsu Automation (Japan)
Automation equipment
Fujitsu Buhin (Japan)
Electronic parts
Fujitsu Component (Malaysia)
Electronic parts (relays, keyboards, connectors)
Fujitsu Computer Technology (Japan)
Development of LSIs, software for information processing equipment
Fujitsu Denso (Japan)
Communications/electronic equipment
Fujitsu General (Japan)
Home electric appliances, communications equipment, data processing equipment
Fujitsu Isotec (Japan)
Peripherals
Fujitsu Kasei (Japan)
Plastic products for communications equipment
Fujitsu Kiden (Japan)
Data processing equipment, indicators, molds
Fujitsu Microelectronics Asia (Singapore)
Semiconductor devices (plans 1MB DRAM production)
Fujitsu Microelectronics (Malaysia)
MOS memories, linear ICs, standard logic
Fujitsu Miyagi Electronics (Japan)
Semiconductor devices
Fujitsu Peripherals (Japan)
Peripherals
Fujitsu TEN (Japan)
Car radios, stereos
Fujitsu Thailand (Thailand)
Magnetic disk drive heads, magnetic heads for printers
Fujitsu Tohoku Electronics (Japan)
Semiconductor devices
Fujitsu VLSI (Japan)
Development of semiconductor devices
Fujitsu Yamanashi Electronics (Japan)
Semiconductor devices
Hasegawa Electric (Japan)
Communications equipment
Kyushu Fujitsu Electronics (Japan)
Semiconductor devices
Nihon Dengyon (Japan)
Radio and digital communications equipment
PFU Ltd. (Japan)
Microcomputers, peripherals
Shinano Fujitsu (Japan)
Electronic parts

Shinko Electric Industries (Japan)
Semiconductor parts
Takamisawa Electric (Japan)
Switching systems, parts
Towa Electron (Japan)
Capacitors, hybrid ICs
Yamagata Fujitsu (Japan)
Peripherals

SUBSIDIARIES

North America

Fujitsu America, Inc. (United States)
Fujitsu Business Communication Systems Inc. (United States)
Fujitsu Canada, Inc. (Canada)
Fujitsu Component of America, Inc. (United States)
Fujitsu Customer Service of America, Inc. (United States)
Fujitsu Imaging Systems of America, Inc. (United States)
Fujitsu Microelectronics, Inc. (United States)
Fujitsu Microsystems of America, Inc. (United States)
Fujitsu Network Switching of America, Inc. (United States)
Fujitsu Systems of America, Inc. (United States)
Fujitsu Systems Engineering of America, Inc. (United States)
Intelligensor, Inc. (United States)
Intellistor, Inc. (Canada)

Europe

Fujitsu Deutschland GmbH (Germany)
Fujitsu Espana S.A. (Spain)
Fujitsu Europe Ltd. (England)
Fujitsu Finance (U.K.) Plc (United Kingdom)
Fujitsu International Finance B.V. (Netherlands)
Fujitsu Italia S.p.A. (Italy)
Fujitsu Microelectronics Ireland Ltd. (Ireland)
Fujitsu Microelectronics Italia S.r.l. (Italy)
Fujitsu Microelectronics Ltd. (England)
Fujitsu Mikroelektronik GmbH (Germany)
Fujitsu Nordic AB (Sweden)

Asia/Pacific

Fuji Electrochemical Co. Ltd. (Japan)
Fujitsu (Singapore) Pte. Ltd. (Singapore)
Fujitsu (Thailand) Co. Ltd (Thailand)
Fujitsu Advanced Printing and Publishing Co. Ltd. (Japan)
Fujitsu Aichi Engineering Limited (Japan)
Fujitsu Australia Ltd. (Australia)
Fujitsu Australia Software Technology Pty. Ltd. (Australia)
Fujitsu Australia Wholesale Pty. Ltd. (Australia)
Fujitsu Automation Limited (Japan)
Fujitsu Basic Software Corporation (Japan)
Fujitsu Buhin Limited (Japan)
Fujitsu Business Systems Limited (Japan)
Fujitsu Component (Malaysia) Sdn. Bhd. (Malaysia)
Fujitsu Dai-ichi Communication Software Limited (Japan)
Fujitsu Dai-ichi System Engineering Limited (Japan)
Fujitsu Denso Ltd. (Japan)
Fujitsu Digital Technology Limited (Japan)
Fujitsu Distribution Systems Engineering Limited (Japan)
Fujitsu Documents Service Limited (Japan)
Fujitsu Electronics (Singapore) Pte. Ltd. (Singapore)
Fujitsu FACOM Information Processing Corporation (Japan)
Fujitsu Financial Information Systems Limited (Japan)
Fujitsu Financial Systems Engineering Limited (Japan)
Fujitsu Fudosan Ltd. (Japan)
Fujitsu Hong Kong Ltd. (Hong Kong)
Fujitsu Isotec Limited (Japan)
Fujitsu Kansai Communication Systems Limited (Japan)
Fujitsu Kansai System Engineering Limited (Japan)
Fujitsu Kasei Ltd. (Japan)
Fujitsu Keihin Systems Engineering Limited (Japan)
Fujitsu Kiden Ltd. (Japan)
Fujitsu Korea Ltd. (Korea)
Fujitsu Kosan Limited (Japan)
Fujitsu Kyushu Communication Systems Limited (Japan)
Fujitsu Kyushu Systems Engineering Ltd. (Japan)
Fujitsu Laboratories Ltd. (Japan)
Fujitsu Logistics Limited (Japan)
Fujitsu Microcomputer Systems Limited (Japan)
Fujitsu Microdevices Ltd. (Japan)
Fujitsu Microelectronics Asia Pte. Ltd. (Singapore)
Fujitsu Microelectronics (Malaysia) Sdn. Bhd. (Malaysia)
Fujitsu Microelectronics Pacific Asia Ltd. (Hong Kong)
Fujitsu Minami-Kyushu Systems Engineering Limited (Japan)
Fujitsu Miyagi Electronics Ltd. (Japan)
Fujitsu Nagano Systems Engineering Limited (Japan)
Fujitsu Network Engineering Limited (Japan)
Fujitsu New Zealand Holdings Ltd. (New Zealand)
Fujitsu New Zealand Ltd. (New Zealand)
Fujitsu OA Limited (Japan)

Fujitsu Office Machines Limited (Japan)
Fujitsu Oita Software Laboratories Limited (Japan)
Fujitsu Peripherals Limited (Japan)
Fujitsu Program Laboratories Limited (Japan)
Fujitsu Shikoku Infortec Limited (Japan)
Fujitsu Shizuoka Engineering Limited (Japan)
Fujitsu Sinter Limited (Japan)
Fujitsu Social Science Laboratory Limited (Japan)
Fujitsu Social Systems Engineering Limited (Japan)
Fujitsu Supplies Limited (Japan)
Fujitsu System Integration Laboratories Ltd. (Japan)
Fujitsu TEN Limited (Japan)
Fujitsu Technosystems Limited (Japan)
Fujitsu Tohoku Electronics Ltd. (Japan)
Fujitsu Tohoku Systems Engineering Limited (Japan)
Fujitsu Tokia Systems Engineering Limited (Japan)
Fujitsu Trading Ltd. (Japan)
Fujitsu VLSI Limited (Japan)
Fujitsu Yamanashi Electronics Limited (Japan)
Gunma Fujitsu Limited (Japan)
Hasegawa Electric Co. Ltd. (Japan)
Ishikawa Fujitsu Software Limited (Japan)
Iwaka Densi Ltd. (Japan)
Kyushu Fujitsu Electronics Ltd. (Japan)
Nihon Dengyo Limited (Japan)
Okinawa Fujitsu Systems Engineering Ltd. (Japan)
PFU Limited (Japan)
Shinano Fujitsu Ltd. (Japan)
Shinko Electric Industries Co. Ltd. (Japan)
Ten Onkyo Ltd. (Japan)
Totalizator Engineering Limited (Japan)
Yamagata Fujitsu Limited (Japan)

ROW

Fujitsu de Brasil Limitada (Brazil)
Fujitsu Vitonia Computadores e Servicos Ltda (Brazil)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

Novell K.K.
A joint marketing venture to sell Netware products in Japan was formed with Novell and six partners, Fujitsu being one of them.

Isuzu
The two companies have formed an automotive electronics venture and currently are attempting to get General Motors to join.

Matsushita
The companies have set up an OEM agreement whereby Fujitsu will receive the M550 and M600 series of 32-bit desktop personal computers from Matsushita and will give Matsushita its high-end laptop and desktop 32-bit PCs.

Poquet Computer
Fujitsu will produce and market Poquet Computer's pocket-sized computer under license. The companies will build a joint plant in Japan and Fujitsu will sell the computer worldwide.

Nokia Data Systems Oy
An agreement has been made whereby Nokia will OEM digital PBX systems (the F-620 and F-640) for Fujitsu.

Matsushita Electric Industrial
The two companies plan to strengthen their business relationship by mutually supplying their computers on an OEM basis.

UNIX International
Fujitsu has joined a new marketing group comprising 21 other high-tech companies. The group will promote UNIX's System V release 4 and further standard developments.

Molecular Design Ltd. and IBM
Fujitsu has formed a relationship with the two companies to ensure that Molecular Design software for managing and communicating scientific information will run on their computers.

Mitsui Bank Research Institute
The two companies have agreed to establish a system consulting service.

MEDIAGENIC
MEDIAGENIC has agreed to develop entertainment software for the Fujitsu FM TOWNS.

Daisy/Cadnetix Inc.
The companies jointly produced an ASIC design kit developed for the DAZIX design environment on the Sun-4 family of workstations running on UNIX.

Vitesse Semiconductor Corporation
The companies have entered into an alternated source agreement with regard to Vitesse's Fury gallium arsenide (GaAs) VLSI gate-array family.

1989

Japan Tobacco Inc.
Fujitsu formed a tie-up agreement with Japan Tobacco whereby Fujitsu will market two of Japan Tobacco's software modules.

The Australian National University in Canberra
The two organizations signed an R&D agreement for two three-year projects. One project is to develop a small image processing system; the other is to develop software for parallel processors.

Vitesse Semiconductor
The two agreed to jointly develop GaAs gate arrays.

Southern New England Telecommunications Systems
Southern New England Telecommunications agreed to market Fujitsu's ISDN telecommunications equipment in the United States on an exclusive basis. The list of products includes digital telephones and terminal adapters.

NTT Data Communications Systems
The two companies will jointly market their respective logic chip design software products as a total CAE design system.

Sony
The two companies jointly developed a trial common rule to develop CD-ROM XA software for their personal computers.

Bell Atlantic Optical Network (SONET)
Fujitsu agreed to sell Bell Atlantic's transmission products under a two-year, $2 million contract. Fujitsu will provide its FLM 50/150 Fiber LOOP Multiplexer for deployment in Bell Atlantic areas.

Poquet Computer Corporate
An agreement provides Poquet with funding and credit guarantees; the companies made a cooperative technology agreement allowing for mutual adaptation of technologies and joint development of new technology.

Sun Microsystems
Sun and Fujitsu will jointly develop a high-speed RISC chip.

1988

Telecom Australia
Telecom Australia agreed to sell Fujitsu's digital PBXs in Australia; the companies established a sales joint-venture, Information Switching Technology.

Daisy Systems
Fujitsu's FAME was made available on Daisy's Advansys Series of CAD/CAE systems.

Hitachi
The two companies agreed to cooperate on the development of a 32-bit MPU and peripheral LSI family based on TRON architecture.

1987

Texas Instruments
The two companies signed a semiconductor device cross-licensing agreement.

Motorola
The two companies signed a semiconductor device cross-licensing agreement.

Hyundai Electronics Industries
The two companies signed a facsimile licensing agreement.

Fujian Province, PRC
Software for digital switching systems will be developed under a joint venture.

MERGERS AND ACQUISITIONS

ICL, Ltd.
Fujitsu purchased 80 percent of ICL, a subsidiary of STC Plc. The merger increases Fujitsu's global presence and makes it the second largest computer manufacturer in the world.

KEY OFFICERS

Takuma Yamamoto
President

Matami Yasufuku
Executive vice president

Kazuo Watanabe
Executive director

Mamoru Mitsugi
Executive director

Yusaku Onaga
Executive director

Akira Ohguro
Executive director

Mikio Ohtsuki
Executive director

Tadashi Sekizawa
Executive director

Mutujiro Shiromizup
Executive director

PRINCIPAL INVESTORS

Fuji Electric—14.3 percent
Asahi Mutual Life Insurance—6.9 percent

FOUNDERS

Information is not available.

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March
(Millions of US Dollars, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$3,877	$4,555	$7,035	$9,818	$11,369
Cash	654	660	1,125	1,764	2,379
Receivables	1,515	1,888	2,903	3,644	4,615
Marketable Securities	149	65	137	648	189
Inventory	1,451	1,763	2,562	3,353	3,734
Other Current Assets	108	179	307	408	452
Net Property, Plants	$2,043	$2,504	$3,424	$4,288	$5,481
Other Assets	$1,146	$1,400	$2,067	$2,677	$3,617
Total Assets	$7,066	$8,459	$12,526	$16,783	$20,467
Total Current Liabilities	$2,922	$3,211	$4,991	$7,058	$8,581
Long-Term Debt	$1,037	$1,609	$2,117	$2,185	$2,467
Other Liabilities	$609	$763	$1,153	$1,548	$1,924
Total Liabilities	$4,567	$5,583	$8,261	$10,792	$12,973
Total Shareholders' Equity	$2,499	$2,876	$4,265	$5,992	$7,495
Common Stock	1,182	1,348	2,115	3,364	4,252
Other Equity	37	46	71	92	110
Retained Earnings	1,280	1,482	2,080	2,536	3,133
Total Liabilities and Shareholders' Equity	$7,066	$8,459	$12,526	$16,783	$20,467

Income Statement	1985	1986	1987	1988	1989
Revenue	$6,415	$7,646	$11,218	$14,829	$18,616
Japanese Revenue	4,687	5,833	8,756	11,550	14,496
Non-Japanese Revenue	1,728	1,813	2,461	3,279	4,120
Cost of Sales	$3,939	$5,156	$7,728	$9,702	$11,914
R&D Expense	$545	$710	$1,043	$1,377	$1,925
SG&A Expense	$1,133	$14,010	$2,057	$2,883	$3,328
Capital Expense	$1,998	$1,559	$1,964	$3,161	$4,167
Pretax Income	$734	$230	$301	$768	$1,210
Pretax Margin (%)	11.43	3.01	2.68	5.18	6.50
Net Income	$366	$176	$135	$305	$545
Shares Outstanding, Millions	1,299.5	1,438.6	1,593.3	1,710.0	1,760.1
Per Share Data					
Earnings	$64.70	$25.40	$13.40	$23.50	$36.80
Dividend	$9.00	$8.00	$8.00	$8.00	$9.00
Book Value	$1.92	$2.00	$2.68	$3.50	$4.26
Exchange Rate (US$1=¥)	¥243.53	¥221.26	¥159.51	¥138.02	¥128.25

Source: Fujitsu Limited
Annual Reports and Forms 10-K
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March
(Millions of Yen, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	¥944,189	¥1,007,841	¥1,122,175	¥1,355,124	¥1,458,057
Cash	159,225	146,000	179,409	243,492	305,166
Receivables	368,821	417,806	463,150	503,035	591,815
Marketable Securities	36,374	14,399	21,863	89,402	24,219
Inventory	353,394	390,103	408,718	462,869	478,840
Other Current Assets	26,375	39,533	49,035	56,326	58,017
Net Property, Plants	¥497,449	¥554,082	¥546,233	¥591,921	¥702,988
Other Assets	¥279,007	¥309,808	¥329,779	¥369,549	¥463,882
Total Assets	¥1,720,645	¥1,871,731	¥1,998,187	¥2,316,594	¥2,624,927
Total Current Liabilities	¥711,485	¥710,479	¥796,143	¥974,268	¥1,100,577
Long-Term Debt	¥252,484	¥356,051	¥337,660	¥301,618	¥316,395
Other Liabilities	¥148,209	¥168,862	¥183,980	¥213,685	¥246,778
Total Liabilities	¥1,112,178	¥1,235,392	¥1,317,783	¥1,489,571	¥1,663,750
Total Shareholders' Equity	¥608,467	¥636,339	¥680,404	¥827,023	¥961,177
Common Stock	287,824	298,187	337,308	464,365	545,369
Other Equity	8,929	10,153	11,359	12,659	14,050
Retained Earnings	311,714	327,999	331,737	349,999	401,758
Total Liabilities and Shareholders' Equity	¥1,720,645	¥1,871,731	¥1,998,187	¥2,316,594	¥2,624,927

Income Statement	1985	1986	1987	1988	1989
Revenue	¥1,562,260	¥1,691,826	¥1,789,417	¥2,046,802	¥2,387,442
Japanese Revenue	1,141,387	1,290,694	1,396,819	1,594,254	1,859,101
Non-Japanese Revenue	420,872.8	401,131.9	392,598.1	452,547.9	528,340.9
Cost of Sales	¥959,282	¥1,140,728	¥1,232,722	¥1,339,183	¥1,527,908
R&D Expense	¥132,708	¥157,028	¥166,342	¥190,130	¥246,906
SG&A Expense	¥275,791	¥3,099,940	¥328,184	¥397,968	¥426,779
Capital Expense	¥486,471	¥344,903	¥313,330	¥436,354	¥534,447
Pretax Income	¥178,635	¥50,920	¥48,012	¥106,048	¥155,152
Pretax Margin (%)	11.43	3.01	2.68	5.18	6.50
Net Income	¥89,028	¥38,926	¥21,609	¥42,115	¥69,948
Shares Outstanding, Millions	1,299.5	1,438.6	1,593.3	1,710.0	1,760.1
Per Share Data					
Earnings	¥64.70	¥25.40	¥13.40	¥23.50	¥36.80
Dividend	¥9.00	¥8.00	¥8.00	¥8.00	¥9.00
Book Value	¥468.23	¥442.33	¥427.04	¥483.64	¥546.09

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March
(Millions of Yen, except Per Share Data)

Key Financial Ratios	1985	1986	1987	1988	1989
Liquidity					
Current (Times)	1.33	1.42	1.41	1.39	1.32
Quick (Times)	0.83	0.87	0.90	0.92	0.89
Fixed Assets/Equity (%)	81.75	87.07	80.28	71.57	73.14
Current Liabilities/Equity (%)	116.93	111.65	117.01	117.80	114.50
Total Liabilities/Equity (%)	182.78	194.14	193.68	180.11	173.10
Profitability (%)					
Return on Assets	5.63	2.17	1.12	1.95	2.83
Return on Equity	16.22	6.25	3.28	5.59	7.82
Profit Margin	5.70	2.30	1.21	2.06	2.93
Other Key Ratios					
R&D Spending % of Revenue	8.49	9.28	9.30	9.29	10.34
Capital Spending % of Revenue	31.14	20.39	17.51	21.32	22.39
Employees	74,187	84,277	89,293	94,825	104,503
Revenue (¥)/Employee	¥21,058	¥20,075	¥20,040	¥21,585	¥22,846
Capital Spending % of Assets	28.27	18.43	15.68	18.84	20.36
Exchange Rate (US$1=&yen)	¥243.53	¥221.26	¥159.51	¥138.02	¥128.25

Source: Fujitsu Limited
Annual Reports and Forms 10-K
Dataquest (1990)

Hitachi Ltd.

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4-chome, Chiyuoda-ku
Tokyo 101, Japan
Telephone: (03) 258-1111
Fax: (03) 253-2186
Dun's Number: 69-054-1503

Date Founded: 1910

CORPORATE STRATEGIC DIRECTION

Hitachi Ltd. was founded to develop indigenous Japanese electrical power equipment manufacturing technology. Initially, the company emphasized the development of heavy electrical equipment and industrial machinery. After World War II, Hitachi expanded into the consumer product area and in the 1950s entered the electronics field, producing computers, semiconductors, and other electronic devices.

Over the years, most of Hitachi's business operations involved large equipment such as power plants and industrial machinery. The plant-as-profit-center concept was the basis of the management system. Today, however, a large percentage of Hitachi's business relates to electric and electronic consumer goods, office automation equipment, and other mass-market products.

Under the new system, the business divisions make the decisions regarding product development and coordinate the work of the laboratory, plant, and sales division in all phases of the development process, from R&D to marketing. This new system created the Semiconductor Design and Development Center and the Institute of Advanced Business Systems, as well as a system for promoting the development and marketing of new products in new business fields. During 1990, the office computer system design operations, which had been split between two works, were consolidated under the newly established Center for Small-Scale Processors and Workstations Development. Thus, a new profit center was created under the wing of the computer division.

Hitachi also consolidated the operations of its subsidiaries in each of the three major regions—United States, Europe, and Asia—where the company has production and marketing bases. Hitachi also made an effort to expand production at overseas sites. As part of this expansion, a company was set up in France for manufacturing computer products. Hitachi also increased the production capacity of a number of bases in other parts of the world.

During fiscal year 1991, operating income was held back by the high value of the yen, the economic slowdown in the United States and Europe, and the transition to a new generation of products in key computer and semiconductor sectors. In order to offset these factors, Hitachi increased its plant and equipment investment by 19 percent to ¥781,488 million (U.S.$55.6 million). (Percentage changes refer only to ¥ amounts; U.S.$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) Most of these funds were used to strengthen and consolidate the computer and semiconductor operations.

Hitachi's consolidated revenue of ¥7,737.0 billion (U.S.$54.8 billion) for fiscal 1991 was an increase of 10.65 percent from ¥7,077.8 billion (U.S.$49.5 billion) during fiscal 1990.

Hitachi is divided into four separate segments: Information Systems and Electronics, Power and Industrial Systems, Consumer Products, and Materials and Others. Information Systems and Electronics was the largest contributor of revenue with 34 percent or ¥2,781,351 million (U.S.$19,798 million); Power and Industrial Systems contributed 28 percent or ¥2,357,892 million (U.S.$16,783 million); Materials and Others contributed 25 percent or ¥2,100,870 million (U.S.$14,953 million); and Consumer Products contributed 13 percent or ¥1,107,388 million (U.S.$7,882 million).

Net income increased by 10.4 percent to ¥230.2 billion (U.S.$1.6 billion) for fiscal 1991, compared with ¥211.0 billion (U.S.$1.5 billion) in fiscal 1990. The improved results were attributed to the company's steady expansion on a worldwide scale. Hitachi employs more than 290,000 people worldwide.

Research and development expenditure increased to ¥490.7 billion (U.S.$3.5 billion) and represented 6.3 percent of total revenue for the period. Over 60 percent of this expenditure was channeled into the Information Systems and Electronics division. During 1990, Advanced Research Laboratory was relocated to Saitama Prefecture, Japan. This laboratory concentrates on long-term research projects with a duration of 10 to 20 years. It is currently engaged in research in the areas of quantum measurement, software science, biotechnology, and materials science.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 through 7 at the end of this backgrounder provide comprehensive financial information.

BUSINESS SEGMENT STRATEGIC DIRECTION

Semiconductors

During calendar year 1990, Hitachi was the third largest worldwide semiconductor manufacturer with U.S.$3,893 million, representing a 6.7 percent market share. Dataquest estimates the company's single largest market to be Japan, which generated approximately U.S.$2.8 million, representing 12.1 percent of the semiconductor market during 1990. Dataquest ranks Hitachi third of all Japanese companies in this market. Hitachi's next largest market is North America, where Hitachi's sales were U.S.$517 million in calendar 1990, ranking eighth, with a 3.0 percent market share.

Hitachi was the third largest worldwide supplier of MOS memory in 1990, accounting for approximately U.S.$1,366 million in revenue worldwide. This represented a 10 percent share of the worldwide market, which is an increase of about 10 percent over 1989.

In the second half of 1990, the supply of MOS memories exceeded demand, increasing the downward pressure on prices. Therefore, as a result of industry cutbacks in the production of 1Mb DRAMs implemented in fall 1990, prices stabilized. During the latter half of 1990, there was a growing demand for 4Mb DRAMs for use in new workstations and 32-bit personal computers. According to Dataquest estimates, Hitachi increased its DRAM market share from 8.5 percent in 1989 to 9.7 percent in 1990, and the company ranked fourth worldwide in DRAM production, accounting for U.S.$697 million in revenue.

Computers

During fiscal 1990, Hitachi introduced the large-scale general-purpose HITACHI M-880 Processor Group. This system will become a mainstay product in Hitachi's computer operations. In addition, the technology involved will be applied extensively in other products. During 1990, in the business computer market, Hitachi had a 12.45 percent worldwide market share and ranked third in supercomputers. In mainframes, it ranked second with a 7.40 percent worldwide market share. In the technical computer market, Hitachi had a 2.09 percent worldwide market share and ranked tenth in supercomputers. In mainframes, it ranked third with a 7.79 percent worldwide market share. In the personal computer market, Hitachi had less than one percent of the market.

Computer Storage

In addition to introducing the HITACHI M-880, the company also introduced the H-6587 series of mass-storage magnetic disk storage subsystems for large computers. Dataquest estimates that Hitachi ranks third in the worldwide total optical disk drive market with 11.5 percent of the market and U.S.$23.4 million in 1990 revenue. In the CD-ROM optical disk drive market, Hitachi ranks second worldwide with revenue of U.S.$10.4 million and a market share of 17.5 percent. Hitachi also ranks third in the worldwide 12-inch WORM optical disk drive market with a 20 percent market share and U.S.$13 million in revenue.

Other Products

Hitachi's Power and Industrial Systems witnessed a 5 percent increase in fiscal 1990 sales over 1989. The main contributing factors were a higher level of industrial demand accompanying the continuing expansion of the domestic economy. Sales in Hitachi's Consumer Products division grew 10 percent in 1990 from 1989. In Japan, sales were derived from air conditioners, washing machines, and 8mm camera/recorders. Although overseas sales were severely affected by the depressed state of the U.S. market, there was a recovery in exports of color television sets and VCRs to China and brisk exports to the USSR and Eastern Europe. The Materials and Others division posted an increase of 12 percent over 1989. Hitachi Cable Ltd. achieved an increase in sales based on a combination of strong domestic demand, mostly from the electric equipment and construction industries and brisk exports. At Hitachi Metals Ltd., sales were pushed up by demand from the automobile and electronics-related industries. Active business in the electronics equipment and industries, plus a high level of new housing starts, led to increased sales for Hitachi Chemical Co. Ltd. The major part of the service sector business was derived from Hitachi Transport System. The continuing driving pace of the Japanese economy generated strong demand for freight-hauling services and produced an increase in company sales.

Further Information

For further information pertaining to the company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Billions of U.S. Dollars)

	1987	1988	1989	1990	1991
Five-Year Revenue	30.4	36.0	49.9	49.5	54.8
Percent Change	34.19	18.61	38.48	(0.79)	10.65
Capital Expenditure	4.1	2.7	4.0	3.6	5.3
Percent of Revenue	13.56	7.49	8.04	7.27	9.61
R&D Expenditure	1.9	2.3	2.9	3.0	3.5
Percent of Revenue	6.34	6.51	5.83	6.07	6.34
Number of Employees	161,325	159,910	274,508	290,000	310,000
Revenue ($K)/Employee	0.19	0.23	0.18	0.17	0.18
Net Income	0.6	1.0	1.4	1.5	1.6
Percent Change	38.67	60.22	46.02	2.01	10.43
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Hitachi Ltd.
Annual Reports
Dataquest (November 1991)

Table 2
Revenue by Geographic Region (Percent)

Region	1987	1988	1989	1990	1991
Japan	73.82	76.00	77.05	76.58	76.02
International	26.18	24.00	22.95	23.42	23.98

Source: Hitachi, Ltd.
Annual Reports
Dataquest (November 1991)

1991 SALES OFFICE LOCATIONS

North America—2
Europe—2
Asia/Pacific—61
Japan—50
ROW—9

MANUFACTURING LOCATIONS

North America

High Voltage Breakers, Norcross, Georgia
SF6 gas breakers
Hitachi Automotive Products, Farmingtonhills, Michigan
Electronic auto parts
Hitachi Cable Manchester Inc., Manchester, New Hampshire
Cables
Hitachi Cable Manchester Inc., New Albany, Indiana
Automobile brake hose
Hitachi Computer Products (America), Norman, Oklahoma
Computer products (magnetic disk devices, magnetic tape cartridges)
Hitachi Construction Machinery Corp., Brampton, Ontario
Excavators, cranes, tunnel shield machines
Hitachi Electronic Devices USA Inc., Greenville, South Carolina
Color picture tubes
Hitachi Home Electronics of America, Anaheim, California
Color TVs, VCRs
Hitachi Denshi (Canada) Ltd., Scarborough, Ontario
Broadcast and professional video, CCTV equipment, test and instrumentation
Hitachi (HSC) Canada Inc., Pointe Claire, Quebec
TVs, VCRs, and household electric appliances
Hitachi Instruments Inc.
Medical instruments
Hitachi Semiconductor (America), Irving, Texas
Semiconductors
Hitachi Telecom, Norcross, Georgia
Digital PBXs

Europe

Hitachi Consumer Products (Europe), Germany
VCRs
Hitachi Consumer Products (U.K.), United Kingdom
Color TVs
Hitachi Semiconductor Europe, Germany
Semiconductors

Asia/Pacific

Akita Electronic Co., Akita, Japan
MOS, bipolar IC
Hanshi Electric, Japan
Ignition coils for automobiles
Haramachi Semiconductor Ltd., Ibaraga, Japan
Diodes, thyristors
Hitachi Computer Engineering, Japan
Development of automatic designing systems
Hitachi Consumer Products, Malaysia
TV parts
Hitachi Consumer Products, Singapore
Color TVs, audio equipment, vacuum cleaners
Hitachi Consumer Products, Thailand
Electric fans, refrigerators, TVs, motors, air conditioners, electric rice cookers
Hitachi Cubu Electric, Japan
Switchboards
Hitachi Denshi, Japan
Communications equipment, measuring instruments, information equipment
Hitachi Electronic Devices, Singapore
Color CRTs
Hitachi Electronics Engineering, Japan
Information equipment, semiconductor devices, energy-saving equipment
Hitachi Elevator Engineering, Singapore
Elevators, escalators
Hitachi Engineering, Japan
Electric/electronic equipment, plant engineering
Hitachi Haramachi Semiconductor, Japan
Semiconductor parts
Hitachi Kiden Kogyo, Japan
Cranes, water treatment equipment, FA-related equipment
Hitachi Kyowa Kogyo, Japan
Electric equipment
Hitachi Maxell, Japan
Dry batteries, magnetic tapes, electronic devices
Hitachi Medical, Japan
Medical equipment
Hitachi Microcomputer Engineering, Tokyo, Japan
MPUs, ASICs
Hitachi Mizusawa, Japan
Transformers for TVs
Hitachi Naka Seiki, Japan
Chromatographic equipment, scientific instruments
Hitachi Nissin Electronics, Japan
Electronic parts

Hitachi Ohira Industrial, Japan
  Parts for refrigerators, air conditioners
Hitachi Process Computer Engineering, Japan
  Process computers
Hitachi Semiconductor, Malaysia
  Semiconductors
Hitachi Setsubi Engineering, Japan
  FA equipment
Hitachi Techno Engineering, Japan
  Electronic part manufacturing equipment
Hitachi Telecom Technologies, Japan
  Switching systems
Hitachi Television, Taiwan
  Color TVs, audio equipment, displays
Hitachi Video Engineering, Japan
  Development of video equipment
Hitachi Works, Ibaraga, Japan
  Discrete devices
Hitachi Yomezawa Electronic, Japan
  Semiconductor elements
Hokkai Semiconductor, Hokkaido, Japan
  SRAMs
Horiba Ltd., Japan
  Electric measuring instruments
Japan Servo, Japan
  Precision motors
Jidosha Denki Kogyo, Japan
  Electrical auto parts
Kaohsiung Hitachi Electronics, Taiwan
  Electronic parts, transistors, LCDs
Kokusai Electric, Japan
  Electric communications equipment
Kokusan Denki, Japan
  Electrical auto parts, generators, motors
Komoro Works, Nagano, Japan
  Photo devices, hybrid ICs
Mobara Works, Chiba, Japan
  DRAMs, CMOS logic, LCDs
Musashi Works, Tokyo, Japan
  MPUs, diodes, DRAMs, SRAMs
Naka Works, Ibaraga, Japan
  Semiconductor sensors, DRAMs, SRAMs
Nakayo Telecommunications, Japan
  Telephone and switching systems
Nigata Works, Nigata, Japan
  Linear, bipolar digital ICs
Nippon Columbia, Japan
  Records, stereos, and other audio equipment
Nissin Electronics Ltd., Ibaraga, Japan
  MOS
Taga Sangyo, Japan
  Electric equipment
Taiwan Hitachi, Taiwan
  Room air conditioners
Takasaki Works, Gunma, Japan
  Bipolar and MOS ICs, EPROMs, CMOS logic
Tobu Semiconductor Ltd., Aomari, Japan
  Bipolar ICs
Tobu Semiconductor Ltd., Saitama, Japan
  Transistor, hybrid ICs
Tokico Ltd., Japan
  Electrical auto parts and equipment
Tokyo Electronics Co., Yamanashi, Japan
  Diodes, bipolar ICs
Yagi Antenna, Japan
  Antennas
Yomezawa Electronic Co., Yamagata, Japan
  MOS

ROW

Industrias Hitachi, Brazil
  Distribution equipment, air conditioners, electronic parts, transformers, switches
Hitachi Consumer Products de Mexico, Mexico
  Televisions

SUBSIDIARIES

North America

Hitachi America Ltd. (United States)
Hitachi Automotive Products (USA) Inc. (United States)
Hitachi (Canadian) Ltd. (Canada)
Hitachi Computer Products (America) Inc. (United States)
Hitachi Electronic Devices (United States)
Hitachi Farmington Technical Center (United States)
Hitachi Home Electronics of America Inc. (United States)
Hitachi Micro Systems Inc. (United States)
Hitachi Semiconductor (America) Inc. (United States)
Hitachi Telecom (USA) Inc. (United States)

Europe

Hitachi Consumer Products Europe Ltd. (United Kingdom)
Hitachi Semiconductor Europe (Germany)
Hitachi Consumer Products (Europe) (Germany)

Asia/Pacific

Asahi Kogyo Co. Ltd. (Japan)
Babcock-Hitachi K.K. (Japan)
Chuo Shoji Ltd. (Japan)

Hitachi Air Conditioning & Refrigeration Co. Ltd. (Japan)
Hitachi Australia Ltd. (Australia)
Hitachi Automobile Appliances Sales Co. Ltd. (Japan)
Hitachi Cable Ltd. (Japan)
Hitachi Chemical Co. Ltd. (Japan)
Hitachi Construction Machinery Co. Ltd. (Japan)
Hitachi Consumer Products (Malaysia) Sdn. Bhd. (Malaysia)
Hitachi Consumer Products Pte. Ltd.
Hitachi Credit Corporation (Japan)
Hitachi Electronic Components (Asia) Ltd. (Hong Kong)
Hitachi Electronic Devices (Singapore) Pte. Ltd. (Singapore)
Hitachi Denshi Ltd. (Japan)
Hitachi Electronics Engineering Co. Ltd. (Japan)
Hitachi Electronics Service Co. Ltd. (Japan)
Hitachi Elevator Engineering and Service Co. Ltd. (Japan)
Hitachi Engineering Co. Ltd. (Japan)
Hitachi Heating Appliances Co. Ltd. (Japan)
Hitachi Higashi Shohin Engineering Ltd. (Japan)
Hitachi Hokkai Semiconductor Ltd. (Japan)
Hitachi Kiden Kogyo Ltd. (Japan)
Hitachi Lighting Ltd. (Japan)
Hitachi Machinery and Engineering Ltd. (Japan)
Hitachi Maxell Ltd. (Japan)
Hitachi Medical Corporation (Japan)
Hitachi Metals Ltd. (Japan)
Hitachi Mokuzai Jisho Ltd. (Japan)
Hitachi Nishi Shohin Engineering Ltd. (Japan)
Hitachi Plant Engineering & Construction Co. Ltd. (Japan)
Hitachi Power Engineering Co. Ltd. (Japan)
Hitachi Printing Co. Ltd. (Japan)
Hitachi Sales Corporation (Japan)
Hitachi Seiko Ltd. (Japan)
Hitachi Semiconductor (Malaysia) Sdn. Bhd. (Malaysia)
Hitachi Service Engineering Co. Ltd. (Japan)
Hitachi Software Engineering Co. Ltd. (Japan)
Hitachi Techno Engineering Co. Ltd. (Japan)
Hitachi Telecom Technologie Ltd. (Japan)
Hitachi Television Ltd. (Taiwan)
Hitachi Tochigi Electronics Co. Ltd. (Japan)
Hitachi Tohbu Semiconductor Ltd. (Japan)
Hitachi Tokyo Electronics Co. Ltd. (Japan)
Hitachi Transport System Ltd. (Japan)
Hitachi Welfare Service Ltd. (Japan)
Japan Servo Co. Ltd. (Japan)
Nippon Business Consultant Co. Ltd. (Japan)
Nissei Sangyo Co. Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1991

Texas Instruments Inc., Fujitsu Ltd., and Sony Corporation

Texas Instruments, Fujitsu, and Sony, along with Hitachi Ltd., have agreed to collaborate on HDTV chip development. Texas Instruments will be doing the frame memory store, Fujitsu the signal processors, Sony the analog components, and Hitachi the audio circuits. The full Muse chip set is scheduled for completion during the first quarter of 1992.

Bull CP8 S.A.

Bull CP8 S.A., a subsidiary of Groupe Bull, located in Trappes France, has signed Hitachi Ltd. as the first Japanese licensee of its self-programmable one-chip microcomputer (SPOM) patent. Hitachi's chips for microcomputer cards will be made available in Japan through Tokyo-based SPOM Japan KK, a joint venture between Bull CP8 and Dai Nippon Printing Co. Ltd, and worldwide through Hitachi's overseas sales office.

Dongfang Power Corp.

Hitachi Ltd. is planning to supply thermal power plant construction technology to Dongfang Power Corp., a Chinese company located in Sichuan Province. Under a 10-year agreement with the Chinese company, Hitachi will provide technology relating to steam turbines and generator for use in 600,000kw class thermal power stations. The two companies will then jointly construct four power plants.

TRW Inc.

Hitachi Ltd. and TRW Inc. formed a 15-year strategic alliance to jointly pursue opportunities in space systems and related ground systems and technologies. The two companies signed an agreement to set up a management team that will meet periodically to review future space programs, market opportunities, and technology requirements.

Ultra-Network Technologies

Ultra-Network Technologies, a U.S. network system manufacturer, and Hitachi Ltd. have formed a software agreement. The agreement will allow Hitachi to port ULTRANET software, a high-speed network software package developed by Ultra-Network, to its mainframe computers. The new version of ULTRANET will run under Hitachi's VOS3 operating system.

Hewlett-Packard Company
Hewlett-Packard Company (HP) and Hitachi Ltd. have agreed to jointly develop an artificial intelligence software product based on Hitachi's ES/Kernel expert systems technology. The new software will run on HP 9000 UNIX workstation as well as on Hitachi workstations.

National Semiconductor Corporation
National Semiconductor Corporation and Hitachi Ltd. have signed a 10-year patent cross-licensing agreement that covers all semiconductor products and technologies developed by either company in the past and during the course of the agreement. The new agreement expands and replaces a previous cross-licensing agreement between the two companies concerning FACT logic products.

Goldstar Electron Company Ltd.
Hitachi Ltd. licensed Lucky Goldstar Group's Goldstar Electron Company Ltd. to fabricate 4Mb memory chips to Hitachi's design. Part of the output will be sold back to Hitachi.

1990

Comparex Information Systems GmbH
Comparex Information Systems GmbH agreed to ship Hitachi's new Integrated Vector Feature for its 8/9X series of processors.

VLSI Technology Inc.
Hitachi plans to supply SRAMs to VLSI Technology on an OEM basis. The SRAMs have been jointly developed by the two companies.

Kansai Electric Power Co., Matsushita Electric Industrial Co. Ltd., Toshiba Corporation, Mitsubishi Electronics Corporation, Sumitomo Electric Industries Ltd., Kawasaki Heavy Industries Ltd., and Kobe Steel Ltd.
Hitachi agreed to set up a new company, which will perform research and development for free electron lasers with the preceding companies.

Sears, Roebuck and Company
Hitachi agreed to let Sears market its VY15A video printer.

1989

Sun Microsystems Inc.
Hitachi licensed Sun's Open Network Computing/Network File System technology for implementation on Hitachi's mainframe computers.

Zuken Inc.
Hitachi agreed to allow Zuken to develop CAD/CAM/CAE software packages for the 2050G Series of engineering workstations made by Hitachi.

Adaptive Information Systems (AIS)
AIS has been formed by Hitachi to market document image processing systems using optical storage technology.

Hewlett-Packard
Hewlett-Packard is licensing its proprietary Precision Architecture to Hitachi. The two companies also agreed to jointly develop a new set of chips using HP's proprietary Precision Architecture RISC MPU technology.

Texas Instruments Inc.
Texas Instruments supplied SRAMs to Hitachi on an OEM basis.

GoldStar
Hitachi signed a major pact with South Korea's GoldStar Company covering 1Mb DRAMs, for which Hitachi will provide technical consultations and manufacturing technology. Hitachi will get royalty payments from GoldStar and eventually will buy chips to sell under its own label.

Cray
This agreement gives each company the right to make use of the other's patents in designing computer hardware.

National Semiconductor
Under this production agreement for FACT logic devices, both companies can mutually produce independently defined and independently developed new functions.

MERGERS AND ACQUISITIONS

1991

Hitachi has made no merger or acquisition in 1991.

1990

Dataproducts Corporation
Two Hitachi affiliates, Hitachi Koki and Nissei Sangyo, acquired Dataproducts Corporation for approximately $160 million. Dataproducts

manufactures a broad range of band, dot matrix, laser, solid ink, and thermal printers, and a wide range of printer supplies. Dataproducts is counting on solid ink jet printers to play a significant role in the printer industry and is investing heavily to finance this strategically important technology. The 1988 acquisition of Imaging Solutions Inc. gave Dataproducts 100 percent ownership of this new technology. Dataproducts had sales of $353 million in fiscal 1989.

National Advanced Systems
Hitachi purchased National Advanced Systems from National Semiconductor Corporation. The name of the company was changed to Hitachi Data Systems. The company markets and services mainframe computers and peripheral subsystems.

KEY OFFICERS

Katsushige Mita
Chairman and representative director

Tsutomu Kanai
President and representative director

Yutaka Sonoyama
Executive vice president and representative director

Sutezo Hata
Executive vice president and representative director

Takeo Miura
Executive vice president and representative director

Toshi Kitamura
Executive vice president and representative director

Tadashi Okita
Executive vice president and representative director

Iwao Matsuoka
Executive vice president and representative director

PRINCIPAL INVESTORS

Nippon Life Insurance—3.8 percent
Sumitomo Trust—2.7 percent
Mitsubishi Trust—2.7 percent
Dai-ichi Life Insurance—2.6 percent

FOUNDERS

Namihei Odaira

Table 3
Balance Sheet
Fiscal Year Ending in March
(Billions of U.S. Dollars)

Balance Sheet	1987	1988	1989	1990	1991
Cash	5.6	8.0	12.8	13.0	11.7
Receivables	6.3	7.8	10.7	11.2	13.0
Marketable Securities	2.9	3.0	3.0	2.3	2.7
Inventory	5.6	7.0	9.7	9.5	11.3
Other Current Assets	1.1	1.4	1.7	1.8	2.0
Total Current Assets	21.6	27.2	38.0	37.7	40.7
Net Property, Plants	7.4	8.2	11.5	12.0	14.1
Other Assets	4.4	5.3	4.6	4.9	5.6
Total Assets	33.4	40.7	54.1	54.6	60.4
Total Current Liabilities	14.3	17.4	24.8	23.2	26.2
Long-Term Debt	3.1	3.1	4.1	6.2	6.3
Other Liabilities	2.2	2.8	3.8	3.5	3.7
Total Liabilities	19.6	23.3	32.6	32.9	36.2
Converted Preferred Stock	0	0	0	0	0
Common Stock	0.9	1.3	1.7	1.7	1.9
Other Equity	1.3	1.8	2.5	2.5	2.9
Retained Earnings	9.3	11.5	13.6	13.7	15.1
Total Shareholders' Equity	11.4	14.6	17.8	17.9	19.9
Minority Interests	2.3	2.8	3.7	3.8	4.3
Total Liabilities and Shareholders' Equity	33.4	40.7	54.1	54.6	60.4
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Hitachi Ltd.
Annual Reports
Dataquest (November 1991)

Table 4
Consolidated Income Statement
Fiscal Year Ending in March
(Billions of U.S. Dollars, except Per Share Data)

Consolidated Income Statement	1987	1988	1989	1990	1991
Revenue	30.4	36.0	49.9	49.5	54.8
Japanese Revenue	22.4	27.3	38.4	38.1	40.8
Non-Japanese Revenue	8.0	8.7	11.5	11.6	13.1
Cost of Sales	23.0	28.7	35.5	35.1	38.4
R&D Expense	1.9	2.3	2.9	3.0	3.5
SG&A Expense	6.0	7.5	11.0	10.7	12.8
Capital Expense	4.1	2.7	4.0	3.6	5.3
Pretax Income	1.6	2.4	3.8	3.7	4.0
Pretax Margin (%)	5.33	6.66	7.67	7.49	7.27
Effective Tax Rate (%)	57.50	56.10	56.10	53.90	51.20
Net Income	0.6	1.0	1.4	1.5	1.6
Shares Outstanding, Millions	2,816.3	2,921.7	3,017.7	3,072.8	3,273.7
Per Share Data					
Earnings	0.21	0.32	0.46	0.43	0.44
Dividend	0.06	0.07	0.07	0.06	0.06
Book Value	0	0.01	0.01	0.01	0.01
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Hitachi Ltd.
Annual Reports
Dataquest (November 1991)

Table 5
Balance Sheet
Fiscal Year Ending in March
(Billions of Yen)

Balance Sheet	1987	1988	1989	1990	1991
Cash	892.9	1,103.9	1,638.3	1,853.7	1,648.5
Receivables	1,010.6	1,080.7	1,372.2	1,594.3	1,833.9
Marketable Securities	470.6	412.3	385.1	324.8	384.9
Inventory	898.5	960.6	1,250.0	1,355.0	1,597.1
Other Current Assets	172.2	199.9	224.4	263.1	286.6
Total Current Assets	3,444.8	3,757.4	4,870.0	5,390.9	5,751.0
Net Property, Plants	1,179.1	1,133.0	1,473.1	1,708.9	1,985.7
Other Assets	704.1	730.7	594.4	705.3	789.3
Total Assets	5,327.9	5,621.1	6,937.5	7,805.1	8,526.0
Total Current Liabilities	2,288.5	2,399.0	3,183.5	3,314.9	3,694.3
Long-Term Debt	488.9	432.8	520.9	886.8	891.0
Other Liabilities	352.3	381.9	481.0	494.0	520.1
Total Liabilities	3,129.7	3,213.7	4,185.4	4,695.7	5,105.4
Converted Preferred Stock	0	0	0	0	0
Common Stock	141.2	180.3	219.4	246.9	269.7
Other Equity	199.6	244.4	322.0	357.8	410.4
Retained Earnings	1,485.0	1,593.9	1,740.3	1,956.1	2,131.0
Total Shareholders' Equity	1,825.8	2,018.6	2,281.7	2,560.8	2,811.1
Minority Interests	372.4	388.8	470.4	548.6	609.5
Total Liabilities and Shareholders' Equity	5,327.9	5,621.1	6,937.5	7,805.1	8,526.0
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Hitachi Ltd.
Annual Reports and
Dataquest (November 1991)

Table 6
Consolidated Income Statement
Fiscal Year Ending in March
(Billions of Yen, except Per Share Data)

Consolidated Income Statement	1987	1988	1989	1990	1991
Revenue	4,848.7	4,975.0	6,401.4	7,077.8	7,737.0
Japanese Revenue	3,579.3	3,781.0	4,932.3	5,420.1	5,881.6
Non-Japanese Revenue	1,269.4	1,194.0	1,469.1	1,657.7	1,855.4
Cost of Sales	3,675.0	3,961.9	4,552.1	5,023.5	5,417.2
R&D Expense	307.6	324.0	373.5	429.4	490.7
SG&A Expense	958.8	1,032.4	1,416.1	1,533.2	1,813.4
Capital Expense	657.4	320.4	532.4	514.9	743.4
Pretax Income	258.3	331.1	491.1	530.0	562.1
Pretax Margin (%)	5.33	6.66	7.67	7.49	7.27
Effective Tax Rate (%)	57.50	56.10	55.50	53.10	51.70
Net Income	98.7	136.8	185.6	211.0	230.2
Shares Outstanding, Millions	2,816.3	2,921.7	3,017.7	3,072.8	3,273.7
Per Share Data					
Earnings	33.45	44.14	58.94	61.71	65.96
Dividend	9.00	9.00	9.00	9.00	9.00
Book Value	0.65	0.69	0.76	0.83	0.86
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Hitachi Ltd.
Annual Reports
Dataquest (November 1991)

Table 7
Key Financial Ratios
Fiscal Year Ending in March

Key Financial Ratios	1987	1988	1989	1990	1991
Liquidity					
Current (Times)	1.51	1.57	1.53	1.63	1.56
Total Assets/Equity (%)	291.81	278.47	304.05	304.79	303.30
Current Liabilities/Equity (%)	125.34	118.84	139.52	129.45	131.42
Total Liabilities/Equity (%)	171.42	159.20	183.43	183.37	181.62
Profitability (%)					
Return on Assets	1.85	2.43	2.68	2.70	2.70
Return on Equity	5.41	6.78	8.13	8.24	8.19
Profit Margin	2.04	2.75	2.90	2.98	2.98
Other Key Ratios					
R&D Spending % of Revenue	6.34	6.51	5.83	6.07	6.34
Capital Spending % of Revenue	13.56	6.44	8.32	7.27	9.61
Employees	161,325	159,910	274,508	290,000	290,000
Revenue (¥K)/Employee	30.06	31.11	23.32	24.41	26.68
Capital Spending % of Assets	12.34	5.70	7.67	6.60	8.72
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Hitachi Ltd.
Annual Reports
Dataquest (November 1991)

Hitachi, Ltd.

6, Kanda-Surugadai
4-chome, Chiyuoda-ku
Tokyo 101, Japan
Telephone: (03) 258-1111
Fax: (03) 253-2186
Dun's Number: 69-054-1503

Date Founded: 1910

CORPORATE STRATEGIC DIRECTION

Hitachi, Ltd., was founded to develop indigenous Japanese electrical power equipment manufacturing technology. Initially, the Company emphasized the development of heavy electrical equipment and industrial machinery. After World War II, Hitachi expanded into the consumer product area and in the 1950s entered the electronics field, producing computers, semiconductors, and other electronic devices.

Over the years, Hitachi continued to expand and diversify the scope of its business activities, which led to the development of the Hitachi Group. The Hitachi Group is made up of Hitachi, Ltd., domestic and overseas, and its subsidiaries and affiliates, including the three major subsidiaries, Hitachi Chemical, Hitachi Metals, and Hitachi Cable. The Hitachi Group companies conduct business in electrical and electronic equipment, metals, metallic products, machinery, chemicals, trading, and transportation.

Hitachi's consolidated revenue of ¥7,077.8 billion (US$49.7 billion) in the period ending March 31, 1990, increased 10.5 percent from ¥6,401.4 billion (US$49.9 billion) in 1989. (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) Information, Communication Systems, and Electronic Devices were the largest contributors, responsible for 33 percent of revenue with ¥2,318 billion ($16.3 billion). Overseas computer sales had substantial increases, primarily for large general-purpose machines.

The Japanese domestic sales contribution to Hitachi's total revenue increased to ¥5,420.1 billion (US$38.0 billion) for the period ending March 31, 1990, up from ¥4,932.3 billion (US$38.5 billion) in fiscal 1988. In fiscal 1989, domestic sales accounted for about 77 percent of total revenue.

Net income increased by 13.69 percent to ¥211.0 billion (US$1.5 billion) for the period ending March 31, 1990, compared with ¥185.6 billion (US$1.4 billion) in fiscal 1988. The improved results were attributed to the Company's steady expansion on a worldwide scale. Hitachi employs more than 290,000 people worldwide.

Research and development expenditure increased to ¥429.4 billion (US$3.0 billion) and represented 6.0 percent of total revenue for the period. This figure is an increase of 15 percent over the 1988 figure of ¥373.5 billion (US$2.9 billion). Areas of focus were the development of technologies that will enable Hitachi to respond to future increased processing power, the development of higher speed and packing density technologies for semiconductors, and development of nonsilicon devices.

Capital expenditure for the year ending March 31, 1990, were not available.

More detailed information is available in Tables 1 through 3, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region and distribution channel. Tables 4 and 5, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Semiconductors

Hitachi is the third largest worldwide semiconductor manufacturer with ¥5.09 trillion (US$3.974 billion, Dataquest exchange rate) in if-sold revenue for calendar 1989, representing a 6.9 percent market share.

Dataquest estimates the Company's single largest market to be Japan, which generates approximately ¥3.48 trillion (US$2.7 billion), representing 11.8 percent of the market. Dataquest ranks Hitachi third in this market. Hitachi's next largest market is in North America, where Hitachi earned ¥752 billion (US$587 million) in calendar 1989, ranking eighth and posting a 28 percent increase in revenue generated. Dataquest estimates that Hitachi ranks tenth in Europe with 3 percent of the market and fourth in Rest of World with a 5.8 percent market share in calendar 1989.

Dataquest estimates that the highest growth rate experienced by Hitachi in semiconductors was in BiCMOS semiconductors, which grew by 2,086 percent worldwide. Hitachi's best-selling semiconductor was the MOS memory chip, which accounted for approximately ¥1.96 trillion (US$13.75 billion) worldwide in calendar 1989. Hitachi's CMOS semiconductors accounted for ¥1.86 trillion (US$13.05 billion) worldwide in calendar 1989.

Dataquest estimates that the Company ranked second in the Japanese bipolar digital market with a 19.7 percent share. This ranking is based on ¥4.4 billion (US$345 million) in revenue for calendar 1989. The revenue figures were down 7 percent when compared with the 1988 figures of ¥4.73 billion (US$369 million), while the total market experienced an 8 percent decrease in sales.

Hitachi has focused on high-value-added products such as 1MB, 4MB, and 16MB DRAMs. However, future revenue may be gained by the Company's increasing efforts on 32-bit MPUs and ASICs. These efforts are part of a corporate goal to expand the Company's product mix and reduce dependence on any one product line.

Hitachi generates significant revenue from its bipolar (ECL) products. In calendar 1989, Hitachi earned ¥1.56 billion (US$122 million) in revenue from the ECL products.

Computers

In 1989, Hitachi and General Motors Electronic Data Systems bought National Advanced Systems, the mainframe arm of National Semiconductor. The two companies have changed the name of the company to Hitachi Data Systems (HDS).

In 1989, Hitachi had less than 1 percent of the worldwide market share in the personal, business, and technical computer industry segments. Dataquest estimates that Hitachi had 4.9 percent of the worldwide mainframe market while Hitachi Data Systems controlled 1.8 percent of the market. HDS's Andromeda system, which competes directly with IBM in the United States and elsewhere, is pushing the eventual release of IBM's Summit system.

HDS announced in 1989 extensions to its family of 370 plug-compatible machines (PCMs). The three new machines—the EX 85, EX 310, and EX 420—are upgrades of the existing EX Series. A fourth model was announced in Japan, the M880/220. The announcement precedes the release of HDS's new mainframe, "ZEUS," expected out in 1990.

Other Hitachi computers include the B16 LX XX, the B32 Series, the HL 500 Series, the PROSET 30, the PWS 2020, and the PWS 2050.

Computer Storage

Hitachi is active in two computer storage markets. Dataquest estimates that Hitachi ranks second in the 12-inch WORM optical disk drive market, with a 28 percent share based on 3,400 units shipped. Hitachi is the leader in the CD-ROM optical disk drive market. Hitachi captured 26 percent of this market in 1989 by selling 40,000 units, which generated $11.8 million in if-sold revenue. Hitachi sold CD-ROMs under its own brand name, as well as through Amdek and Denon via its subsidiary Nippon Columbia.

Printers

Dataquest estimates that in the printer peripheral market, Hitachi is in the lower 25 percent of both line printer and page printer companies. Hitachi had less than 1 percent in these markets in 1989.

Telecommunications

Hitachi is not a very significant competitor in the PBX business communications market. Dataquest estimates that Hitachi ranked tenth in the US PBX market, with a 2.3 percent market share. Hitachi is not considered a major player in the European PBX market.

CAD/CAM

Hitachi holds a 1.4 percent market share by revenue, on a worldwide basis, of the CAD/CAM market. Hitachi has concentrated on the Asian market, which is responsible for all of its market-generated revenue in 1989. The revenue generated was in turnkey systems and services.

Other Products

Hitachi's Power and Equipment Division witnessed a 10 percent increase in calendar 1989 sales because of expanded sales of thermal plants to power companies. Sales in Hitachi's Consumer Product Division, on the other hand, grew only slightly as a result of a mature VCR market, reduced export levels, and increasing competition. Revenue in the Industrial Machinery and Plants Division increased 16 percent, primarily because of expanded activities in the construction equipment field. The Wire and Cable, Metals, Chemicals, and Other Products Division witnessed a 10 percent growth in sales over the preceding year.

Further Information

For further information pertaining to the Company's business segments, please contact the appropriate industry service.

Table 1
Five-Year Corporate Highlights (Billions of US Dollars)

	1986	1987	1988	1989	1990
Five-Year Revenue	$22.6	$30.4	$36.0	$49.9	$49.7
Percent Change	-	34.19	18.61	38.48	(0.47)
Capital Expenditure	$2.0	$4.1	$2.3	$4.2	NA
Percent of Revenue	8.92	13.56	6.44	8.32	0
R&D Expenditure	$1.3	$1.9	$2.3	$2.9	$3.0
Percent of Revenue	5.90	6.34	6.51	5.83	6.07
Number of Employees	164,117	161,325	159,910	274,508	290,000
Revenue ($K)/Employee	$0.14	$0.19	$0.23	$0.18	$0.17
Net Income	$0.4	$0.6	$1.0	$1.4	$1.5
Percent Change	-	38.67	60.22	46.02	2.34
Exchange Rate (US$1=¥)	¥221.26	¥159.56	¥138.03	¥128.25	¥142.47

NA = Not available

Source: Hitachi, Ltd.
Annual Reports and Forms 20-F
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1986	1987	1988	1989	1990
Japan	99.86	99.84	76.00	77.05	76.58
International	30.16	26.18	24.00	22.95	23.42

Source: Hitachi, Ltd.
Annual Reports
Dataquest (1990)

Table 3
Revenue by Distribution Channel (Percent)

Channel	1988	1989	1990
Direct Sales	30	30	30
Indirect Sales	70	70	70
Distributor	70	70	70

Source: Hitachi, Ltd.
Annual Reports
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

North America—2
Europe—2
Asia/Pacific—11
Japan—50
ROW—9

MANUFACTURING LOCATIONS

North America

High Voltage Breakers, Norcross, Georgia
SF6 gas breakers
Hitachi Automotive Products, Farminghills, Michigan
Electronic auto parts
Hitachi Cable Manchester, Inc., Manchester, New Hampshire
Cables
Hitachi Cable Manchester, Inc., New Albany, Indiana
Automobile brake hose
Hitachi (Canadian), Ltd., Calgary, Alta.
Turbine generator and heavy industrial equipment
Hitachi Computer Products (America), Norman, Oklahoma
Computer products (magnetic disk devices, magnetic tape cartridges)
Hitachi Construction Machinery Corp., Brampton, Ontario
Excavators, cranes, tunnel shield machines
Hitachi Consumer Products of America, Anaheim, California
Color TVs, VCRs
Hitachi Denshi (Canada), Ltd., Scarborough, Ontario
Broadcast and professional video, CCTV equipment, test and instrumentation
Hitachi (HSC) Canada, Inc., Pointe Claire, Quebec
TVs, VCRs, and household electric appliances
Hitachi Semiconductor (America), Irving, Texas
Semiconductors
Hitachi Telecom, Norcross, Georgia
Digital PBXs

Europe

Hitachi Consumer Products (Europe), Germany
VCRs
Hitachi Consumer Products (U.K.), United Kingdom
Color TVs
Hitachi Semiconductor Europe, Germany
Semiconductors

Asia/Pacific

Akita Electronic Co., Akita, Japan
MOS, bipolar IC
Hanshi Electric, Japan
Ignition coils for automobiles
Haramachi Semiconductor Ltd., Ibaraga, Japan
Diodes, thyristors
Hitachi Computer Engineering, Japan
Development of automatic designing systems
Hitachi Consumer Products, Malaysia
TV parts
Hitachi Consumer Products, Singapore
Color TVs, audio equipment, vacuum cleaners
Hitachi Consumer Products, Thailand
Electric fans, refrigerators, TVs, motors, air-conditioners, electric rice cookers
Hitachi Cubu Electric, Japan
Switchboards
Hitachi Denshi, Japan
Communications equipment, measuring instruments, information equipment
Hitachi Electronic Devices, Singapore
Color CRTs
Hitachi Electronics Engineering, Japan
Information equipment, semiconductor devices, energy-saving equipment
Hitachi Elevator Engineering, Singapore
Elevators, escalators
Hitachi Engineering, Japan
Electric/electronic equipment, plant engineering
Hitachi Haramachi Semiconductor, Japan
Semiconductor parts
Hitachi Kiden Kogyo, Japan
Cranes, water treatment equipment, FA-related equipment
Hitachi Kyowa Kogyo, Japan
Electric equipment
Hitachi Maxell, Japan
Dry batteries, magnetic tapes, electronic devices
Hitachi Medical, Japan
Medical equipment
Hitachi Microcomputer Engineering, Tokyo, Japan
MPUs, ASICs
Hitachi Mizusawa, Japan
Transformers for TVs
Hitachi Naka Seiki, Japan
Chromatographic equipment, scientific instruments
Hitachi Nissin Electronics, Japan
Electronic parts
Hitachi Ohira Industrial, Japan
Parts for refrigerators, air conditioners
Hitachi Process Computer Engineering, Japan
Process computers
Hitachi Semiconductor, Malaysia
Semiconductors

Hitachi Setsubi Engineering, Japan
FA equipment
Hitachi Techno Engineering, Japan
Electronic part manufacturing equipment
Hitachi Telecom Technologies, Japan
Switching systems
Hitachi Television, Taiwan
Color TVs, audio equipment, displays
Hitachi Video Engineering, Japan
Development of video equipment
Hitachi Works, Ibaraga, Japan
Discrete devices
Hitachi Yomezawa Electronic, Japan
Semiconductor elements
Hokkai Semiconductor, Hokkaido, Japan
SRAMs
Horiba Ltd., Japan
Electric measuring instruments
Japan Servo, Japan
Precision motors
Jidosha Denki Kogyo, Japan
Electrical auto parts
Kaohsiung Hitachi Electronics, Taiwan
Electronic parts, transistors, LCDs
Kokusai Electric, Japan
Electric communications equipment
Kokusan Denki, Japan
Electrical auto parts, generators, motors
Komoro Works, Nagano, Japan
Photo devices, hybrid ICs
Mobara Works, Chiba, Japan
DRAMs, CMOS logic, LCDs
Musashi Works, Tokyo, Japan
MPUs, diodes, DRAMs, SRAMs
Naka Works, Ibaraga, Japan
Semiconductor sensors, DRAMs, SRAMs
Nakayo Telecommunications, Japan
Telephone and switching systems
Nigata Works, Nigata, Japan
Linear, bipolar digital ICs
Nippon Columbia, Japan
Records, stereos, and other audio equipment
Nissin Electronics Ltd., Ibaraga, Japan
MOS
Taga Sangyo, Japan
Electric equipment
Taiwan Hitachi, Taiwan
Room air-conditioners
Takasaki Works, Gunma, Japan
Bipolar and MOS ICs, EPROMs, CMOS logic
Tobu Semiconductor Ltd., Aomari, Japan
Bipolar ICs
Tobu Semiconductor Ltd., Saitama, Japan
Transistor, hybrid ICs
Tokico Ltd., Japan
Electrical auto parts and equipment
Tokyo Electronics Co., Yamanashi, Japan
Diodes, bipolar ICs
Yagi Antenna, Japan
Antennas
Yomezawa Electronic Co., Yamagata, Japan
MOS

ROW

Industrias Hitachi, Brazil
Distribution equipment, air-conditioners, electronic parts, transformers, switches

SUBSIDIARIES

North America

Hitachi America, Ltd. (United States)
Hitachi Automotive Products (USA), Inc. (United States)
Hitachi Computer Products (America), Inc. (United States)
Hitachi Consumer Products of America Inc. (United States)
Hitachi Semiconductor (America) Inc. (United States)
Hitachi Telecom (USA), Inc. (United States)

Europe

Hitachi Consumer Products Europe Ltd. (United Kingdom)
Hitachi Semiconductor Europe (Germany)
Hitachi Consumer Products (Europe) (Germany)

Asia/Pacific

Asahi Kogyo Co., Ltd. (Japan)
Babcock-Hitachi K.K. (Japan)
Chuo Shoji, Ltd. (Japan)
Hitachi Air Conditioning & Refrigeration Co., Ltd. (Japan)
Hitachi Australia Ltd. (Australia)
Hitachi Automobile Appliances Sales Co., Ltd. (Japan)
Hitachi Cable Ltd. (Japan)
Hitachi Chemical Co., Ltd. (Japan)
Hitachi Construction Machinery Co., Ltd. (Japan)
Hitachi Consumer Products (Malaysia) Sdn. Bhd. (Malaysia)
Hitachi Consumer Products Pte. Ltd.
Hitachi Credit Corporation (Japan)

Hitachi Electronic Components (Asia) Ltd. (Hong Kong)
Hitachi Electronic Devices (Singapore) Pte. Ltd. (Singapore)
Hitachi Denshi, Ltd. (Japan)
Hitachi Electronics Engineering Co., Ltd. (Japan)
Hitachi Electronics Service Co., Ltd. (Japan)
Hitachi Elevator Engineering and Service Co., Ltd. (Japan)
Hitachi Engineering Co., Ltd. (Japan)
Hitachi Heating Appliances Co., Ltd. (Japan)
Hitachi Higashi Shohin Engineering, Ltd. (Japan)
Hitachi Hokkai Semiconductor, Ltd. (Japan)
Hitachi Kiden Kogyo, Ltd. (Japan)
Hitachi Lighting, Ltd. (Japan)
Hitachi Machinery and Engineering, Ltd. (Japan)
Hitachi Maxell, Ltd. (Japan)
Hitachi Medical Corporation (Japan)
Hitachi Metals, Ltd. (Japan)
Hitachi Mokuzai Jisho, Ltd. (Japan)
Hitachi Nishi Shohin Engineering, Ltd. (Japan)
Hitachi Plant Engineering & Construction Co., Ltd. (Japan)
Hitachi Power Engineering Co., Ltd. (Japan)
Hitachi Printing Co., Ltd. (Japan)
Hitachi Sales Corporation (Japan)
Hitachi Seiko, Ltd. (Japan)
Hitachi Semiconductor (Malaysia) Sdn. Bhd. (Malaysia)
Hitachi Service Engineering Co., Ltd. (Japan)
Hitachi Software Engineering Co., Ltd. (Japan)
Hitachi Techno Engineering Co., Ltd. (Japan)
Hitachi Telecom Technologies, Ltd. (Japan)
Hitachi Television, Ltd. (Taiwan)
Hitachi Tochigi Electronics, Co., Ltd. (Japan)
Hitachi Tohbu Semiconductor, Ltd. (Japan)
Hitachi Tokyo Electronics Co., Ltd. (Japan)
Hitachi Transport System, Ltd. (Japan)
Hitachi Welfare Service, Ltd. (Japan)
Japan Servo Co., Ltd. (Japan)
Nippon Business Consultant Co., Ltd. (Japan)
Nissei Sangyo Co., Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

Comparex Information Systems GmbH
Comparex Information Systems GmbH will ship Hitachi's new Integrated Vector Feature for its 8/9X series of processors.

VLSI Technology Inc.
Hitachi plans to supply SRAMs to VLSI Technology Inc. on an OEM basis. The SRAMs have been jointly developed by the two companies.

Kansai Electric Power Co., Matsushita Electric Industrial Co., Toshiba Corp., Mitsubishi Electric Corp., Sumitomo Electric Industries, Ltd., Kawasaki Heavy Industries, Ltd., and Kobe Steel, Ltd.
Hitachi has agreed to set up a new company by year end, which will perform research and development for free electron lasers with the preceding companies.

Sears and Roebuck
Hitachi agreed to let Sears and Roebuck market its VY15A video printer.

1989

Sun Microsystems
Hitachi will license Sun's Open Network Computing/Network File System technology for implementation on Hitachi's mainframe computers.

Zuken Inc.
Hitachi agreed to allow Zuken to develop CAD/CAM/CAE software packages for the 2050G Series of engineering workstations made by Hitachi.

Adaptive Information Systems (AIS)
AIS has been formed by Hitachi to market document image processing systems using optical storage technology.

Hewlett-Packard
Hewlett-Packard is licensing its proprietary Precision Architecture to Hitachi.

Texas Instruments
Texas Instruments will supply SRAMs to Hitachi on an OEM basis.

GoldStar
Hitachi signed a major pact with South Korea's GoldStar Company covering 1Mb DRAMs, for which Hitachi will provide technical consultations and manufacturing technology. Hitachi will get royalty payments from GoldStar and eventually will buy chips to sell under its own label.

Cray
This agreement gives each company the right to make use of the other's patents in designing computer hardware.

Hewlett-Packard
The two companies will jointly develop a new set of chips using HP's proprietary Precision Architecture RISC MPU technology.

National Semiconductor
Under this production agreement for FACT logic devices, both companies can mutually produce independently defined and independently developed new functions.

MERGERS AND ACQUISITIONS

1990

Dataproducts Corporation
Two Hitachi affiliates, Hitachi Koki and Nissei Sangyo, acquired Dataproducts Corporation for approximately $160 million. Dataproducts manufactures a broad range of band, dot matrix, laser, solid ink, and thermal printers, and a wide range of printer supplies. Dataproducts is counting on solid ink jet printers to play a significant role in the printer industry and is investing heavily to finance this strategically important technology. The 1988 acquisition of Imaging Solutions, Inc., gave Dataproducts 100 percent ownership of this new technology. Dataproducts had sales of $353 million in fiscal 1989, an increase of 2 percent over 1988.

1989

National Advanced Systems
Mainframe computers and peripheral subsystems

KEY OFFICERS

Katsushige Mita
President and representative director

Masataka Nishi
Executive vice president and representative director

Shiro Kawada
Executive vice president and director

Yutaka Sonoyama
Executive vice president and director

Sutezo Hata
Executive vice president and director

Takeo Miura
Executive vice president and director

Tsutomu Kanai
Executive vice president and director

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March
(Billions of US Dollars, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$14.8	$21.6	$27.2	$38.0	$37.8
Cash	3.0	5.6	8.0	12.8	12.0
Receivables	4.4	6.3	7.8	10.7	11.2
Marketable Securities	2.2	2.9	3.0	3.0	3.3
Inventory	4.4	5.6	7.0	9.7	9.5
Other Current Assets	0.8	1.1	1.4	1.7	1.8
Net Property, Plants	$5.4	$7.4	$8.2	$11.5	$12.0
Other Assets	$3.1	$4.4	$5.3	$4.6	$5.0
Total Assets	$23.3	$33.4	$40.7	$54.1	$54.8
Total Current Liabilities	$10.8	$14.3	$17.4	$24.8	$23.3
Long-Term Debt	$1.7	$3.1	$3.1	$4.1	$9.7
Other Liabilities	$1.4	$2.2	$2.8	$3.8	NA
Total Liabilities	$13.9	$19.6	$23.3	$32.6	$33.0
Minority Interests	$1.5	$2.3	$2.8	$3.7	$3.9
Total Shareholders' Equity	$7.9	$11.4	$14.6	$17.8	$18.0
Common Stock	0.6	0.9	1.3	1.7	1.7
Other Equity	0.8	1.3	1.8	2.5	2.5
Retained Earnings	6.4	9.3	11.5	13.6	13.7
Total Liabilities and Shareholders' Equity	$23.3	$33.4	$40.7	$54.1	$54.8

Income Statement	1986	1987	1988	1989	1990
Revenue	$22.6	$30.4	$36.0	$49.9	$49.7
Japanese Revenue	22.6	30.3	27.4	38.5	38.0
Non-Japanese Revenue	6.8	8.0	8.7	11.5	11.6
Cost of Sales	$16.9	$23.0	$28.7	$35.5	$35.3
R&D Expense	$1.3	$1.9	$2.3	$2.9	$3.0
SG&A Expense	$4.4	$6.0	$7.5	$11.0	$10.8
Capital Expense	$2.0	$4.1	$2.3	$4.2	N/A
Pretax Income	$1.7	$1.6	$2.4	$3.8	$3.7
Pretax Margin (%)	7.41	5.33	6.66	7.67	7.49
Effective Tax Rate (%)	57.50	57.50	56.10	56.10	56.10
Net Income	$0.4	$0.6	$1.0	$1.4	$1.5
Shares Outstanding, Millions	2,803.4	2,816.3	2,921.7	3,017.7	3,418.6
Per Share Data					
Earnings	$0.23	$0.21	$0.32	$0.46	$0.43
Dividend	$0.04	$0.06	$0.07	$0.07	$0.06
Book Value	0	0	$0.01	$0.01	$0.01
Exchange Rate (US$1=¥)	¥221.26	¥159.56	¥138.03	¥128.25	¥142.47

Source: Hitachi Ltd.
Annual Reports
Dataquest (1990)

Table 5
Comprehensive Financial Statement
Fiscal Year Ending March
(Billions of Yen, except Per Share Data)

Balance Sheet	1986	1987	1988	1989	1990
Total Current Assets	¥3,276.2	¥3,444.8	¥3,757.4	¥4,870.0	¥5,390.9
Cash	661.7	892.9	1,103.9	1,638.3	1,705.5
Receivables	971.0	1,010.6	1,080.7	1,372.2	1,594.3
Marketable Securities	492.4	470.6	412.3	385.1	473.0
Inventory	980.0	898.5	960.6	1,250.0	1,355.0
Other Current Assets	171.1	172.2	199.9	224.4	263.1
Net Property, Plants	¥1,200.0	¥1,179.1	¥1,133.0	¥1,473.1	¥1,708.9
Other Assets	¥688.0	¥704.1	¥730.7	¥594.4	¥705.3
Total Assets	¥5,164.2	¥5,328.0	¥5,621.1	¥6,937.5	¥7,805.1
Total Current Liabilities	¥2,393.3	¥2,288.5	¥2,399.0	¥3,183.5	¥3,314.9
Long-Term Debt	¥369.7	¥488.9	¥432.8	¥520.9	¥1,380.8
Other Liabilities	¥319.6	¥352.3	¥381.9	¥481.0	NA
Total Liabilities	¥3,082.6	¥3,129.7	¥3,213.7	¥4,185.4	¥4,695.7
Minority Interests	¥338.9	¥372.4	¥388.8	¥470.4	¥548.7
Total Shareholders' Equity	¥1,742.7	¥1,825.8	¥2,018.6	¥2,281.7	¥2,560.7
Common Stock	140.3	141.2	180.3	219.4	246.8
Other Equity	186.5	199.6	244.4	322.0	357.8
Retained Earnings	1,415.9	1,485.0	1,593.9	1,740.3	1,956.1
Total Liabilities and Shareholders' Equity	¥5,164.2	¥5,327.9	¥5,621.1	¥6,937.5	¥7,805.1

Income Statement	1986	1987	1988	1989	1990
Revenue	¥5,010.5	¥4,848.7	¥4,975.0	¥6,401.4	¥7,077.8
Japanese Revenue	3,499.5	3,579.3	3,781.0	4,932.3	5,420.1
Non-Japanese Revenue	1,511.0	1,269.4	1,194.0	1,469.1	1,657.7
Cost of Sales	¥3,741.2	¥3,675.0	¥3,961.9	¥4,552.1	¥5,023.5
R&D Expense	¥295.7	¥307.6	¥324.0	¥373.5	¥429.4
SG&A Expense	¥962.7	¥958.8	¥1,032.4	¥1,416.1	¥1,533.2
Capital Expense	¥447.0	¥657.4	¥320.4	¥532.4	NA
Pretax Income	¥371.1	¥258.3	¥331.1	¥491.1	¥530.0
Pretax Margin (%)	7.41	5.33	6.66	7.67	7.49
Effective Tax Rate (%)	57.50	57.50	56.10	56.10	56.10
Net Income	¥98.7	¥98.7	¥136.8	¥185.6	¥211.0
Shares Outstanding, Millions	2,803.4	2,816.3	2,921.7	3,017.7	3,418.6
Per Share Data					
Earnings	¥50.65	¥33.45	¥44.14	¥58.94	¥61.71
Dividend	¥9.00	¥9.00	¥9.00	¥9.00	¥9.00
Book Value	¥0.62	¥0.65	¥0.69	¥0.76	¥0.75

Table 5 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March
(Billions of Yen, except Per Share Data)

Key Financial Ratios	1986	1987	1988	1989	1990
Liquidity					
Current (Times)	1.37	1.51	1.57	1.53	1.63
Quick (Times)	0.96	1.11	1.17	1.14	1.22
Fixed Assets/Equity (%)	68.86	64.58	56.13	64.56	66.74
Current Liabilities/Equity (%)	137.33	125.34	118.84	139.52	129.45
Total Liabilities/Equity (%)	176.89	171.42	159.20	183.43	183.37
Profitability (%)					
Return on Assets	-	1.88	2.50	2.96	2.86
Return on Equity	-	5.53	7.12	8.63	8.71
Profit Margin	1.97	2.04	2.75	2.90	2.98
Other Key Ratios					
R&D Spending % of Revenue	5.90	6.34	6.51	5.83	6.07
Capital Spending % of Revenue	8.92	13.56	6.44	8.32	0
Employees	164,117	161,325	159,910	274,508	290,000
Revenue (¥K)/Employee	¥30.53	¥30.06	¥31.11	¥23.32	¥24.41
Capital Spending % of Assets	8.66	12.34	5.70	7.67	0
Exchange Rate (US$1=¥)	¥221.26	¥159.56	¥138.03	¥128.25	¥142.47

NA = Not available

Source: Hitachi, Ltd.
Annual Reports
Dataquest (1990)

Matsushita Electric Industrial Co. Ltd.

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Osaka 571, Japan
Telephone: (06) 908-1121
Fax: (06) 906-1762
Dun's Number: 69-053-6552

Date Founded: 1918

CORPORATE STRATEGIC DIRECTION

Matsushita Electric Industrial Co. Ltd. was founded as a family business in 1918 by Konosuke Matsushita to produce and market an electric adapter plug for consumer products. Today, Matsushita is a worldwide electric and electronics manufacturer with products that range from consumer electronics equipment, home appliances, and housing-related products through sophisticated industrial and communications equipment, including electronic components.

Matsushita is currently divided into four major business segments. These segments are discussed below:

Audiovisual (AV) Products and Home Appliances

The audiovisual products and home appliances segment is Matsushita's core business. Matsushita strengthened its position as a digital video industry leader by introducing its composite digital 1/2-inch tape VCR system (D3) for broadcast use. This system will be used as the official system for the 1992 Barcelona Olympic Games.

Further advances in intelligent products are expected in home appliances. With Matsushita's success of appliances employing fuzzy logic and neuro-fuzzy logic, the company is working to develop next-generation technologies. It is pursuing basic R&D into artificial intelligence and home-use robots.

Information and Communications Equipment

In systems and networks, Matsushita has made advances in urban cable TV (CATV) systems, as well as in airport traffic control systems and subway information management systems that use optical fiber LANs. The company is also increasing installations of AV information networks employing satellite signals. To meet emerging markets, such as integrated services digital network (ISDN)-related products and systems and intraorganizational information systems, the company is currently constructing the Tokyo Information and Communications Development Center.

Construction Electronics

Matsushita is a major manufacturer of virtually all of the key equipment needed in homes, offices, and other buildings, including air-conditioning equipment, gas water-heating equipment, kitchen-related products, lighting fixtures and elevators, as well as appliances and communications equipment used in the home. Drawing on its capabilities as a manufacturer of a comprehensive range of products, Matsushita is using this approach to develop a totally integrated package concept and proposing it to the construction industry. To foster this concept, the company established the Construction Electronics Business Group.

Components and Industrial Goods

Matsushita supplies a vast array of electronic components including semiconductors. The company is also one of Japan's leading suppliers of factory automation equipment. It plans to continue developing a well-balanced semiconductor business, stressing not only memory devices but also bipolar ICs, microprocessors, logic ICs and charge-coupled devices.

Within the four major segments, Matsushita has six major product categories: video equipment, communications and industrial equipment, electronic components, home appliances, audio equipment, and batteries and kitchen-related products.

Matsushita's products are sold in more than 160 countries under the brand names National, Panasonic, Technics, and Quasar and under other trade names including JVC.

The company reported consolidated sales of $46.7 billion* for the fiscal year ended March 31, 1991. Net income for the year increased over 13 percent, to $1.8 billion, versus $1.6 billion in fiscal 1990. International sales accounted for 45 percent of revenue in fiscal 1991. Within the major product categories, video equipment sales increased 9 percent; audio equipment sales rose 8 percent; home appliances sales increased 13 percent; communications and industrial equipment had a sales growth of 14 percent; electronic components' sales grew 9 percent; and batteries and kitchen-related products had sales gains of 13 percent. (Note: Percentage growth figures apply to U.S. dollar-based growth.)

In December 1990, Matsushita acquired MCA Inc. for approximately $6.1 billion. MCA Inc. is a leading U.S. entertainment company, which includes Universal Pictures Production. It engages primarily in the film, music, and publishing business. MCA's strength in the production of film and music software will widen Matsushita's business scope in the audiovisual field.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 through 7 at the end of this backgrounder provide comprehensive financial information.

BUSINESS SEGMENT STRATEGIC DIRECTION

Video Equipment

The video equipment category remains Matsushita's largest revenue producer, accounting for 26 percent of fiscal 1991 revenue. Sales totaled $12,144 million for this period. This category includes VCRs, camcorders and related equipment; color, projection, and liquid crystal display televisions; videodisc players; and satellite broadcast receivers.

*All dollar amounts are in U.S. dollars.

Communications and Industrial Equipment

The second-largest revenue-producing category for the company is communications and industrial equipment. This category accounted for 24 percent of fiscal 1991 revenue. Total sales increased 14 percent over the previous period to $11.0 billion and include Matsushita's targeted growth areas of information/communication and factory automation. Products include facsimile and copier equipment, PCs and workstations, printers, telephones and private branch exchange systems, industrial robots, electronic parts mounting equipment, welding machines, air conditioners, and compressors.

Computers

Matsushita has expanded its desktop and laptop PC lines, resuming exports to Europe and North America, which were curtailed in 1987. The company is manufacturing 8-, 16-, and 32-bit IBM-compatible laptops in Japan, under the Panasonic label, for sale in Europe. In the U.S. market, the company is selling 16- and 32-bit models made by Tandy Corporation on an OEM basis. According to Dataquest, Matsushita had less than 1 percent of the worldwide market share for desktop and laptop PCs during 1990.

Facsimiles

During 1989, Matsushita merged its Panafax Corporation into the larger Office Automation Group of Panasonic Communications & Systems Company. The company intends to expand its presence across the entire spectrum of facsimile product markets through the merger of the two groups. According to Dataquest, Panasonic facsimile sales in the North American market during 1990 were more than 95,000 units, placing Panasonic/Matsushita among the top five vendors in the market with a 6.8 percent market share.

In addition to sales by its Panasonic subsidiary, Matsushita manufactures facsimile equipment sold by Pitney Bowes Inc. and several models sold by Fujitsu, Tandy, and Telautograph.

In April 1990, Matsushita's Quasar subsidiary announced a facsimile model for sale in the U.S. market, manufactured by Matsushita in Japan.

Copiers

Selling copiers under the Panasonic label, Matsushita continued to gain market share during 1990. Panasonic copiers compete in segments 1 through 4 of the six Dataquest copier segments. Based on plain paper copier placements, Dataquest ranked Panasonic thirteenth in 1990, with 30.7 thousand units. In the Western European copier market, Panasonic's 1990 sales rose to a total of 24.9 thousand units, up from 23.1 for 1989.

In addition to copier sales under the Panasonic label, Matsushita manufactures several models sold under the Lanier label in the United States and under the Adler-Royal label in Europe.

Printers

Matsushita also manufactures and markets its printers under the Panasonic label. Its product line focus is primarily on the serial printer market. According to Dataquest, Panasonic ranked fourth among page printer vendors in North America during 1990, with 75.5 thousand units and a market share of 3.6 percent. In the serial printer market, the company had unit shipments of 1.2 million with a market share of 20.8 percent.

Electronic Components

The electronic components category accounted for 13 percent of Matsushita's fiscal 1991 revenue, with sales of $5,961 million. In the general components field, sales gains domestically as well as overseas were led by surface-mounted components and microwave parts used in audiovisual and mobile communications equipment, as well as parts for office automation equipment.

Semiconductors

Matsushita's 1990 worldwide semiconductor ranking went from ninth in worldwide semiconductor sales to tenth, based on revenue of $1,942 million. Its semiconductor sales include MOS digital ICs, analog devices, discrete devices, optoelectronics, and bipolar digital ICs. The total revenue and worldwide market share breakdown is as follows: MOS digital, $819 million with a 2.5 percent market share; MOS memory, $284 million with a 2.2 percent market share; MOS microcomponents, $250 million with a 2.5 percent market share; MOS logic, $285 million with a 3.1 percent market share; analog devices, $410 million with a 3.9 percent market share; discrete devices, $374 million with a 4.5 percent market share; and optoelectronics, $325 million with a 12.1 percent market share.

Home Appliances

The home appliances category accounted for 14 percent of total revenue during the 1991 fiscal year. Sales for the period were $6,370 million, up 13 percent from $5,614 million for the previous period.

Products in the home appliances category include refrigerators, room air conditioners, laundry equipment, vacuum cleaners, electric irons, microwave ovens, electric fans, electric blankets, and cooking appliances. Appliances using fuzzy or neuro-fuzzy logic and air conditioners with heating and cooling capabilities sold especially well.

Audio Equipment

Matsushita's audio equipment category accounted for 9 percent of the company's revenue, with sales of $4,234 million for the period ended March 31, 1991. Although audio equipment in Japan was generally slow during this fiscal year, compact discs (CDs), radio/cassette recorders, and portable headphone cassette players continued as sales leaders in this segment.

Other products under the audio equipment category are radios, tape recorders, stereo hi-fi and related equipment, car audio products, and electronic musical instruments.

Batteries and Kitchen-Related Products

The batteries and kitchen-related products category accounted for 5 percent of Matsushita's revenue, $2,474 million for the fiscal year 1991. Batteries include compact batteries such as nickel-cadmium batteries. These batteries are used in video camcorders, portable phones, notebook-size personal computers, and other portable electronic products. Lithium batteries are also produced and used in cameras and for office automation equipment memory backups.

Others

The balance of Matsushita's business includes sales of bicycles, cameras and flash units, prerecorded tapes and discs, water purifiers, and imported materials and products such as nonferrous metals, lumber, paper, medical equipment, and cabin cruisers. This category accounted for 10 percent of the company's total revenue for fiscal 1991, with total sales of $4,551 million.

Further Information

For further information on the company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Four-Year Corporate Highlights (Millions of U.S. Dollars)

	1988*	1989	1990	1991
Four-Year Revenue	36,710.8	42,918.1	41,998.1	46,733.9
Percent Change	NA	16.91	-2.14	11.28
Capital Expenditure	1,679.8	2,537.5	2,482.0	3,377.9
Percent of Revenue	4.58	5.91	5.91	7.23
R&D Expenditure	2,022.7	2,488.1	2,418.5	2,718.6
Percent of Revenue	5.51	5.80	5.76	5.82
Number of Employees	134,186	193,088	198,299	210,848
Revenue ($K)/Employee	273.58	222.27	211.79	221.65
Net Income	1,192.7	1,664.4	1,648.1	1,833.4
Percent Change	NA	39.56	-0.98	11.25
Exchange Rate (U.S.$1=¥)	138.03	128.25	142.93	141.21

1991 Fiscal Year	Q1	Q2	Q3	Q4
Quarterly Revenue	11,162.8	11,831.9	12,635.8	11,103.5
Quarterly Profit	413.02	486.13	596.03	338.36

NA = Not applicable
*In 1987, Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1987.

Source: Matsushita Electric Industrial Co. Ltd. Annual Reports
Dataquest (January 1992)

Table 2
Revenue by Geographic Region (Percent)

Region	1988*	1989	1990	1991
Japan	59	58	56	55
International	41	42	44	45

*In 1987, Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1987.

Source: Matsushita Electric Industrial Co. Ltd. Annual Reports
Dataquest (January 1992)

1991 SALES OFFICE LOCATIONS

North America—9
Europe—15
Asia/Pacific—142
Japan—132
ROW—12

MANUFACTURING LOCATIONS

North America

America Kotobuki Electronics Industries (United States)
VCRs
American Matsushita Electronics Corporation (United States)
Color TV picture tubes
Kyushu Matsushita Electric Corporation of America (United States)
Deflection yokes
Matsushita Communication Industrial Corporation of America (United States)
Car telephones, pagers, point-of-sale electronic cash register systems
Matsushita Compressor Corporation of America (United States)
Air conditioning compressors
Matsushita Computer Company (United States)
Personal computers, workstations
Matsushita Electronic Components Corporation of America (United States)
Electrolytic capacitors, car audio speakers, filters, switchers
Matsushita Industrial Canada (Canada)
Color TVs, speaker boxes, TV cabinets, AV racks
Matsushita Industrial de Baja California S.A. de C.V. (United States)
TV chassis, color TVs
Matsushita Refrigeration Co. of America (United States)
Refrigerators
Matsushita Semiconductor Corporation of America (United States)
Semiconductors
Matsushita-Ultra Tech. Battery Corp. (United States)
Batteries
Panasonic Technologies (United States)
R&D

Europe

Kyushu Matsushita Electric (United Kingdom)
Electronic typewriters, printers
Matsushita Business Machine (Germany)
Plain paper copiers
Matsushita Communication Deutschland (Germany)
Car radios/stereos
Matsushita Communication Industrial (United Kingdom)
Car telephones
Matsushita Electric (United Kingdom)
Color TVs, microwave ovens
Matsushita Electric Motor (Germany)
Motors
Matsushita Electronic Components (Germany)
Electronic parts, materials
Matsushita Electronic Components (United Kingdom)
Transformers, LC filters
Matsushita Electronic Magnetron Corp. (United Kingdom)
Magnetrons for microwave ovens
Matsushita Graphic Communication Systems Ltd. (United Kingdom)
Fax machines
Matsushita Video Manufacturing (Germany)
VCR mechanisms
MB Video (Germany)
VCRs, CD players
Panasonic Espana (Spain)
Electric equipment
Panasonic France S.A. (France)
Consumer electronics

Asia/Pacific

A.P. National (Thailand)
Home electrical appliances
Asahi Kogyo (Japan)
Tape recorders
Beijing-Matsushita Color CRT (China)
Color CRTs
International Fan Manufacturing (Hong Kong)
Electric fans
Katano Matsushita (Japan)
Audio equipment
Kibi Matsushita (Japan)
Video equipment
Kyushu Matsushita Electric (Japan)
Data processing, business machines, magnetic heads
Matsue Matsushita Denki (Japan)
Capacitors
Matsusaka Seimitsu (Japan)
Assembly of motors
Matsushita Air-Conditioning Corporation (Malaysia)
Air conditioners

Matsushita Communication Industrial (Japan)
Data processing, communication, control, video equipment
Matsushita Communication Industrial Corp. of the Philippines (Philippines)
FDDs, ECM
Matsushita Compressor & Motor (Malaysia)
Compressors, fan motors
Matsushita Denshi (Singapore)
IC production, large-scale integration (LSI) design
Matsushita Electric (Australia)
TVs, audio equipment
Matsushita Electric (Malaysia)
Home electrical appliances
Matsushita Electric (Taiwan)
Electrical appliances
Matsushita Electric Institute of Technology (Taiwan)
R&D
Matsushita Electric Works (Japan)
Electrical housing equipment
Matsushita Electronic Components (Japan)
Electronic equipment parts
Matsushita Electronic Components (Malaysia)
Electronic parts
Matsushita Electronic Components (Singapore)
Electronic parts
Matsushita Electronic Motor (Malaysia)
Electronic motors
Matsushita Electronic Motor (Singapore)
Precision motors, applied equipment
Matsushita Electronics (Japan)
Semiconductors, electron tubes, lighting equipment
Matsushita Electronics (Singapore)
Audio equipment
Matsushita Graphic Communication Systems (Japan)
Facsimiles, graphics equipment
Matsushita Graphic Communications Systems (Singapore)
Fax machines
Matsushita Industrial (Malaysia)
Air conditioners, compressors
Matsushita Industrial Equipment (Japan)
Industrial equipment
Matsushita-Kotobuki Electronics (Japan)
Video equipment, TVs, tape recorders
Matsushita Precision Industrial (Malaysia)
Flyback transformers, coils
Matsushita Refrigeration (Japan)
Refrigerators, air conditioners
Matsushita Refrigeration Industries (Malaysia)
Refrigerator/freezers
Matsushita Refrigeration Industries (Singapore)
Compressors
Matsushita Refrigeration Industries (Thailand)
Refrigerator/freezers
Matsushita Research Institute (Japan)
Electronics research
Matsushita Seiko (Japan)
Electric fans, ventilators, air conditioners
Matsushita Seiko Hong Kong International Manufacturing Co. Ltd. (Hong Kong)
Air conditioners
Matsushita Technical Center (Singapore)
Production equipment
Matsushita Television (Malaysia)
Color TVs
Miyazaki Matsushita Denki (Japan)
Ceramics, magnetic materials, resistant materials
National Micromotor (Japan)
Microprecision motors
National Thai (Thailand)
Home electrical appliances
PFU Ltd. (Japan)
Minicomputers
Precision Electronics (Philippines)
Home electrical appliances
P.T. Matsushita Gobel Battery Industry (Indonesia)
Batteries
P.T. National Gobel (Indonesia)
Home electrical appliances
Takefu Matsushita Electric (Japan)
Micromotors
Victor Company of Japan (Japan)
Video/audio equipment, TVs
Wakayama Precision (Japan)
Refrigerators, air conditioners

ROW

Matsushita Electric (East Africa)
Radios, radio cassette recorders, dry batteries
Matsushita Electrica de Guatemala (Guatemala)
Audio equipment
Matsushita Electric de El Salvador (El Salvador)
Audio equipment
Matsushita Industrial de Baja California (Mexico)
Color TV chassis
National Centroamericana
Dry batteries, audio equipment
National Componentes Electronicos do Brazil (Brazil)
Electronic parts
National do Brazil (Brazil)
Matsushita group products
National Electric Cote d'Ivoire (Ivory Coast)
TVs, radio cassette recorders
National Panasonic Fueguina
Color TVs, radio cassette recorders
National Peruana (Peru)
Home electrical appliances
Panasonic de Mexico (Mexico)
Audio equipment, electronic parts
Panasonic Industrial de Venezuela C.A. (Venezuela)
Consumer electronic products

Springer National Componentes (Brazil)
Assembly of micromotors, CRT sockets, PC boards
Springer National da Amazonia (Brazil)
Color TVs, audio equipment

SUBSIDIARIES

North America

Matsushita Electric Corporation of America (United States)
Solbourne Computer (United States)

Europe

Matsushita Electric (U.K.) Ltd. (United Kingdom)
Matsushita Electronic Magnetron Corp. (United Kingdom)
Matsushita Graphic Communication Systems U.K. Ltd. (United Kingdom)
Panasonic Espana S.A. (Spain)
Panasonic France S.A. (France)

Asia/Pacific

Kyushu Matsushita Electric Co. Ltd. (Japan)
Matsushita Battery Industrial Co. Ltd. (Japan)
Matsushita Communications Industrial Co. Ltd. (Japan)
Matsushita Electric (Taiwan) Co. Ltd. (Taiwan)
Matsushita Electronic Components Co. Ltd. (Japan)
Matsushita Electronics Corporation (Japan)
Matsushita Electronics (S) Pte. Ltd. (Singapore)
Matsushita Graphic Communications Systems Inc. (Japan)
Matsushita Housing Products Co. Ltd. (Japan)
Matsushita Industrial Equipment Co. Ltd. (Japan)
Matsushita Industrial Corporation Sdn. Bhd. (Malaysia)
Matsushita Kotobuki Electronics Industries Ltd. (Japan)
Matsushita Refrigeration Company (Japan)
Matsushita Refrigeration Industries (S) Pte. Ltd. (Singapore)
Matsushita Seiko Co. Ltd. (Japan)
Victor Company of Japan Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1991

Digital Tape Licensing
Matsushita will share its digital compact cassette tape technology, which was jointly developed with Philips, with third parties. The aim is to make the digital tape format, which competes against digital audio tape, a standard in the industry.

Tandy Corporation
Tandy Corporation and Matsushita have signed a joint venture to manufacture laptop and notebook computers. Both companies will be equal partners and share in the technology of the new company called PTCC Inc.

Texas Instruments Inc. (TI)
TI and Matsushita signed a cross-licensing agreement. This five-year agreement replaced the previous agreement that expired in 1990. TI will continue to receive royalty payments from Matsushita based on worldwide sales of chips by the two Japanese firms.

Energy Conversion Devices Co. (ECD)
ECD and Matsushita have signed a patent licensing agreement for ECD's patented phase transformation optical disk system. With this agreement Matsushita will be able to sell optical disks worldwide.

Siemens Nixdorf Information Systems (SNI)
SNI and Matsushita have signed an agreement to develop PC peripherals. The development will include an expansion unit for 16-bit and 32-bit notebook-size PCs. The unit will contain extra memory and space for an additional battery unit. Matsushita will produce the expansion unit. The company will market it in Europe and will also supply the device to SNI on an OEM basis.

Sun Microsystems Inc.
Sun Microsystems Inc. has signed an agreement with Matsushita, Fujitsu, and Toshiba whereby Sun will exchange information with the other firms on image-processing techniques for multimedia workstations.

1990

The Santa Cruz Operation
The Santa Cruz Operation and Matsushita have signed an agreement to codevelop a Japanese version of a UNIX operating system. Matsushita will manufacture the new product on an OEM basis, while The Santa Cruz Operation will be responsible for marketing efforts through a new branch office to be established in Japan.

SNI
SNI and Matsushita signed an agreement to have SNI supply desktop PCs to Matsushita. In return, Matsushita will supply laptop PCs to SNI on an OEM basis.

1989

Signetics Company
Signetics and Matsushita entered a sales agency agreement for memory products.

Weitek Corporation
Weitek and Matsushita are jointly developing a microprocessor product.

Siemens
Matsushita and Siemens formed a joint venture for producing passive electronic components.

Office Workstations Ltd.
Matsushita and Office Workstations of Scotland formed a joint venture for development of office automation software products.

1988

Hewlett-Packard Company, IBM Corporation, Intel
Matsushita agreed to supply these companies with a total of more than 1 million 1Mb DRAMs per month.

Intel Corporation
Matsushita agreed to subcontract production of Intel's 8-bit microcontrollers for the Japanese market. The companies also agreed to jointly develop a sub-0.5-micron 16Mb DRAM process.

Sun Microsystems
The SPARC RISC chip was licensed for use in workstations being developed by Solbourne Computer, a Matsushita subsidiary.

Tosoh
The companies agreed to jointly develop conductive electron-beam resist that completely solves the electrification problem occurring with direct-write e-beams.

Motorola
Matsushita agreed to purchase Motorola semiconductors for use in videocassette recorders.

1987

NEC Corporation
NEC and Matsushita agreed to develop the next generation of steppers for very large scale integration (VLSI) manufacturing.

SAE Inc.
SAE and Matsushita agreed to jointly develop a 64-bit microprocessor with plans for a 64-bit engineering workstation in 1989.

Philips
Philips and Matsushita renewed a business cooperation agreement for the next ten years in which Matsushita Electric will continue to own 65 percent of Matsushita Electronics and Philips will own 35 percent. Matsushita agreed to supply LSIs for compact discs to Philips, and the companies made a second-source agreement for 8-bit CMOS microcontrollers.

Intel
Matsushita obtained a license from Intel for the 8051 and three other 8-bit microcontrollers.

TRW
The companies agreed to jointly develop a 0.8-micron-wavelength GaAlAs semiconductor laser for space communications.

Nikon Corporation
The companies jointly developed advanced i-line steppers and excimer lasers for next-generation VLSIs.

MERGERS AND ACQUISITIONS

1991

Matsushita made no mergers or acquisitions in 1991.

1990

MCA Inc.
MCA Inc. was acquired by Matsushita for approximately $6.1 billion. MCA is primarily engaged in the production and distribution of motion pictures and musical recordings, theme parks, book publishing, retailing, and real estate development.

1989

Matsushita made no mergers or acquisitions in 1989.

1988

Matsushita Electric Trading Co. Ltd. (MET)
MET, a 51.24 percent owned consolidated subsidiary, was merged into the company in exchange for 73.4 million shares of Matsushita common stock having a fair market value of $1.1 billion.

KEY OFFICERS

Masaharu Matsushita
Chairman of the board

Akio Tanii
President

Shoji Sakuma
Executive vice president

Masahiko Hirata
Executive vice president

Keiya Toyonaga
Senior managing director

Hiroyuki Mizuno
Senior managing director

Tsuzo Murase
Senior managing director

PRINCIPAL INVESTORS

Sumitomo Bank—4.4 percent
Sumitomo Life Insurance—4.4 percent
Nippon Life Insurance—4.0 percent
Matsushita Investment and Development—3.2 percent
Mitsubishi Trust—3.0 percent
Sumitomo Trust—2.9 percent
Konosuke Matsushita—2.6 percent
Toyo Trust—2.0 percent
Kyowa Bank—2.0 percent

FOUNDERS

Konosuke Matsushita

Table 3
Balance Sheet
Fiscal Year Ending March 31
(Millions of U.S. Dollars)

Balance Sheet	1988*	1989	1990	1991
Cash	10,016.4	11,229.2	14,068.8	11,737.8
Receivables	4,915.5	6,137.8	7,782.4	9,062.4
Marketable Securities	2,562.6	1,652.8	2,346.6	1,294.5
Inventory	4,857.9	6,210.6	5,919.0	6,593.7
Other Current Assets	1,967.2	2,303.0	2,157.4	2,491.3
Total Current Assets	24,319.6	27,533.4	32,274.3	31,179.8
Net Property, Plants	5,056.0	6,426.6	6,700.1	8,202.7
Investments	8,971.7	11,828.3	11,527.1	17,420.9
Other Assets	3,149.8	4,128.9	4,429.0	5,239.7
Total Assets	41,497.2	49,917.3	54,930.5	62,043.1
Total Current Liabilities	13,359.1	16,717.6	18,208.2	22,500.5
Long-Term Debt	4,093.6	4,849.1	8,375.3	8,665.8
Other Liabilities	6,005.4	5,999.5	5,952.1	6,553.4
Total Liabilities	23,458.1	27,566.3	32,535.6	37,719.7
Common Stock	1,048.2	1,280.7	1,293.9	1,383.0
Other Equity	1,815.8	3,266.7	3,700.2	3,688.8
Retained Earnings	15,175.1	17,803.6	17,400.8	19,251.5
Total Shareholders' Equity	18,039.1	22,351.0	22,394.9	24,323.3
Total Liabilities and Shareholders' Equity	41,497.2	49,917.3	54,930.5	62,043.1
Exchange Rate (U.S.$1=¥)	138.03	128.25	142.93	141.21

*In 1987, Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1987.

Source: Matsushita Electric Industrial Co. Inc.
Annual Reports
Dataquest (January 1992)

Table 4
Consolidated Income Statement
Fiscal Year Ending March 31
(Millions of U.S. Dollars, except Per Share Data)

Consolidated Income Statement	1988*	1989	1990	1991
Revenue	36,710.8	42,918.1	41,998.1	46,733.9
Cost of Sales	24,223.1	28,622.9	28,052.8	31,113.2
R&D Expense	2,022.7	2,488.1	2,418.5	2,718.6
SG&A Expense	9,880.5	11,042.3	10,777.8	12,273.9
Capital Expense	1,679.8	2,537.5	2,482.0	3,377.9
Pretax Income	3,283.6	4,128.2	4,000.1	4,230.6
Pretax Margin (%)	8.94	9.62	9.52	9.05
Effective Tax Rate (%)	55.50	54.20	52.60	51.10
Net Income	1,192.7	1,664.4	1,648.1	1,833.4
Shares Outstanding, Millions	1,861.8	1,955.6	2,080.2	2,093.4
Per Share Data				
Earnings	0.67	0.76	0.68	0.83
Dividend	0.80	0.90	0.63	0.89
Book Value	9.69	11.43	10.77	11.62
Exchange Rate (U.S.$1=¥)	138.03	128.25	142.93	141.21

*In 1987, Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1987.

Source: Matsushita Electric Industrial Co. Ltd. Annual Reports
Dataquest (January 1992)

Table 5
Balance Sheet
Fiscal Year Ending March 31
(Billions of Yen)

Balance Sheet	1988*	1989	1990	1991
Cash	1,382.6	1,440.1	2,010.8	1,657.5
Receivables	678.5	787.2	1,112.3	1,279.7
Marketable Securities	353.7	212.0	335.4	182.8
Inventory	670.5	796.5	846.0	931.1
Other Current Assets	271.5	295.4	308.4	351.8
Total Current Assets	3,356.8	3,531.2	4,612.9	4,402.9
Net Property, Plants	697.9	824.2	957.6	1,158.3
Investments	1,238.4	1,516.9	1,647.6	2,460.0
Other Assets	434.8	529.6	633.0	739.9
Total Assets	5,727.9	6,401.9	7,851.1	8,761.1
Total Current Liabilities	1,843.9	2,144.0	2,602.5	3,177.3
Long-Term Debt	565.0	621.9	1,197.1	1,223.7
Other Liabilities	828.9	769.4	850.7	925.4
Total Liabilities	3,237.8	3,535.3	4,650.3	5,326.4
Common Stock	144.7	164.3	184.9	195.3
Other Equity	250.7	419.0	528.9	520.9
Retained Earnings	2,094.7	2,283.3	2,487.1	2,718.5
Total Shareholders' Equity	2,490.1	2,866.6	3,200.9	3,434.7
Total Liabilities and Shareholders' Equity	5,727.9	6,401.9	7,851.2	8,761.1
Exchange Rate (U.S.$1=¥)	138.03	128.25	142.93	141.21

*In 1987, Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1987.

Source: Matsushita Electric Industrial Co. Ltd. Annual Reports
Dataquest (January 1992)

Table 6
Consolidated Income Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Income Statement	1988*	1989	1990	1991
Revenue	5,067.2	5,504.3	6,002.8	6,599.3
Cost of Sales	3,343.5	3,670.9	4,009.6	4,393.5
R&D Expense	279.2	319.1	345.7	383.9
SG&A Expense	1,363.8	1,416.2	1,540.5	1,733.2
Capital Expense	231.9	325.4	354.8	477.0
Pretax Income	453.2	529.4	571.7	597.4
Pretax Margin (%)	8.94	9.62	9.52	9.05
Effective Tax Rate (%)	55.50	54.20	52.60	51.10
Net Income	164.6	213.5	235.6	258.9
Shares Outstanding, Millions	1,861.8	1,955.6	2,080.2	2,093.4
Per Share Data				
Earnings	80.34	99.94	108.34	117.12
Dividend	9.52	11.90	10.00	12.50
Book Value	1.34	1.47	1.54	1.64
Exchange Rate (U.S.$1=¥)	138.03	128.25	142.93	141.21

*In 1987, Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1987.

Source: Matsushita Electric Industrial Co. Ltd. Annual Reports
Dataquest (January 1992)

Table 7
Key Financial Ratios
Fiscal Year Ending March 31

Key Financial Ratios	1988*	1989	1990	1991
Liquidity				
Current (Times)	1.82	1.65	1.77	1.39
Fixed Assets/Equity (%)	230.03	223.33	245.28	255.08
Current Liabilities/Equity (%)	74.05	74.79	81.31	92.51
Total Liabilities/Equity (%)	130.03	123.33	145.28	155.08
Profitability (%)				
Return on Assets	2.87	3.33	3.00	2.96
Return on Equity	6.61	7.45	7.36	7.54
Profit Margin	3.25	3.88	3.92	3.92
Other Key Ratios				
R&D Spending % of Revenue	5.51	5.80	5.76	5.82
Capital Spending % of Revenue	4.58	5.91	5.91	7.23
Employees	134,186	193,088	198,299	210,848
Revenue (¥M)/Employee	37.76	28.51	30.27	31.30
Capital Spending % of Assets	4.05	5.08	4.52	5.44
Exchange Rate (U.S.$1=¥)	138.03	128.25	142.93	141.21

*In 1987, Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1987.

Source: Matsushita Electric Industrial Co. Ltd. Annual Reports
Dataquest (January 1992)

Matsushita Electric Industrial Co., Ltd.

1006 Kadoma, Kadoma City
Osaka 571, Japan
Telephone: (06) 908-1121
Fax: (06) 906-1762
Dun's Number: 69-053-6552

Date Founded: 1918

CORPORATE STRATEGIC DIRECTION

Matsushita Electric Industrial Co., Ltd., was founded as a family business in 1918 by Konosuke Matsushita to produce and market an electric adapter plug for consumer products. Today, Matsushita is a worldwide electric and electronic manufacturer with thousands of products that range from consumer electronic equipment, home appliances, and housing-related products through sophisticated industrial and communications equipment, as well as electronic components.

Matsushita is divided into seven product groups. The groups and examples of products within each are listed below:

- Video equipment—VCRs, camcorders, televisions
- Audio equipment—CDs, radios, digital tapes, recorders, electronic musical instruments, speaker systems
- Home appliances—Air-conditioners, refrigerators, microwave ovens, vacuum cleaners, bread-baking machines, dishwashers, laundry equipment
- Communications and industrial equipment—Office automation, communications, and information equipment; traffic control and post office sorting systems; industrial robots; electric motors; welding equipment
- Batteries and kitchen-related products—Batteries, kitchen fixtures, gas equipment, solar energy equipment
- Electronic components—Semiconductors, electronic tubes and lamps, general components
- Others—Musical tapes, records, bicycles, photographic equipment, electronic pencil sharpeners, water purifiers

Matsushita's products are sold in more than 130 countries under the brand names National, Panasonic, Technics, and Quasar, and under other trade names including JVC.

Matsushita has targeted six growth areas for the 1990s: information/communication, factory automation (FA), semiconductors, new audiovisual (AV) equipment, automotive electronics, and housing-related products, which include integrated air-conditioning systems. These areas accounted for approximately 28 percent of total sales in 1985 and 35 percent in 1989. The Company's target by 1992 is more than 40 percent.

The Company reported consolidated sales of ¥6,002.8 billion (US$42.1 billion) for the fiscal year ended March 31, 1990. Net income for the year increased over 10 percent, to ¥235.6 billion (US$1.7 billion), versus ¥213.5 billion (US$1.7 billion) in fiscal 1989. (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) International sales accounted for 44 percent of revenues in fiscal 1990.

During the past year, Matsushita launched its "Action Plan for International Cooperation" to promote globalization of Matsushita activities, and to help correct trade imbalances. By fiscal 1994, the Company plans to increase the ratio of internationally produced goods to total international business to 50 percent. Total production by international subsidiaries and affiliates in fiscal 1990 accounted for 36 percent of total international business.

A third step in Matsushita's globalization plan is to establish and expand R&D facilities in North America, Europe, and Asia to serve the needs of each region. The Company is also localizing planning, manufacturing, marketing, and management functions internationally. Total R&D expenditure for fiscal 1990 amounted to 5.8 percent of revenue, or ¥345.7 billion (US$2.43 billion). Capital expenditure totaled ¥354.8 billion (US$2.49 billion), or 5.9 percent of revenue.

Matsushita's international operations include 117 companies in 38 countries. The Company has 79 manufacturing plants and 39 sales offices overseas (11 combined sales and manufacturing locations). Matsushita has established regional headquarters in Europe, Singapore, and the United States. Total employees at the end of fiscal year 1990 were 198,299, of which 30 percent (59,216) were in international operations.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Video Equipment

The video equipment segment remains Matsushita's largest revenue producer, accounting for 27 percent of fiscal 1990 revenue. This segment includes VCRs, camcorders and related equipment; color, projection, and LCD televisions; video disc players, and satellite broadcast receivers. Total sales for this segment during the period were ¥1,598 billion (US$11.2 billion).

Communications and Industrial Equipment

The second largest revenue producer for the Company is communications and industrial equipment. This segment accounted for 23 percent of fiscal 1990 revenue. Total sales increased 24 percent over the previous period, to ¥1,374.9 billion (US$9.6 billion). This segment includes Matsushita's targeted growth areas of information/communication and factory automation. Products in this segment include facsimile and copier equipment, PCs and workstations, printers, telephones and PBX systems, industrial robots, electronic parts mounting equipment, welding machines, air conditioners, and compressors.

Computers

Matsushita has made considerable progress in the PC and workstation markets during the past year. The Company has expanded its desktop and laptop PC lines, resuming exports to Europe and North America, which were curtailed in 1987. The Company is manufacturing 8-, 16-, and 32-bit IBM-compatible laptops in Japan, under the Panasonic label, for sale in Europe. In the US market, the Company is selling 16- and 32-bit models made by Tandy Corporation on an OEM basis. Dataquest estimates that Matsushita sold more than 86,000 units worldwide during calendar year 1989.

In October 1989, Matsushita began selling 32-bit engineering workstations developed by its majority owned company, Solbourne Computer of Colorado. Dataquest estimated sales of the Solbourne systems at over 300 for the period that ended December 31, 1989. Matsushita also introduced a 32-bit UNIX-based business workstation in Japan during 1989, targeted at the growing office automation market.

Matsushita has established the Matsushita Computer Co. (MAC) in Tokyo to improve its penetration into the high-end PC and workstation markets. MAC will specialize in workstation sales, support, and systems integration.

Facsimiles

During 1989, Matsushita merged its Panafax Corporation into the larger Office Automation Group of Panasonic Communications & Systems Company. The Company intends to expand its presence across the entire spectrum of facsimile product markets through the merger of the two groups. Dataquest estimates Panasonic facsimile sales in the North American market to be more than 120,000 units for the year that ended December 31, 1989, placing Panasonic/Matsushita among the top five vendors in the market with an 8.5 percent market share.

In addition to sales by its Panasonic subsidiary, Matsushita manufactures facsimile equipment sold by Pitney Bowes, and several models sold by Fujitsu, Tandy, and Telautograph. In April 1990, Matsushita's Quasar subsidiary announced a facsimile model for sale in the US market, manufactured by Matsushita in Japan.

Copiers

Selling copiers under the Panasonic label, Matsushita continued to gain market share during 1989. Panasonic copiers compete in Segments 1 through 4 of the six Dataquest copier segments. Based on plain paper copier placements, Dataquest ranked Panasonic eleventh in market share in 1989, up from twelfth place in 1988. In the Western European copier market, Panasonic's 1989 sales rose to 47,500 units, up from 36,000 units for 1988, Dataquest estimates.

In addition to copier sales under the Panasonic label, Matsushita manufactures several models sold under the Lanier label in the United States and under the Adler-Royal label in Europe.

Printers

Matsushita also manufactures and markets its printers under the Panasonic label. Its product line focus is primarily on the serial printer market. Dataquest ranks Panasonic third among page printer vendors in the 11- to 15-ppm category, and within the top five vendors for all types of serial printers in the North American market in 1989.

Panasonic also ranks among the top ten serial printer vendors in Western Europe, based on 1989 shipments. The Company's most popular products in Europe were the 9-pin serial impact dot matrix (SIDM) printers, followed closely by its 24-pin SIDM products.

Electronic Components

The electronic components group accounted for 13 percent of Matsushita's fiscal 1990 revenue, with sales of ¥781.2 billion (US$5.5 billion). This represents an increase of over 7 percent from sales of ¥726.5 billion (US$5.7 billion) for the previous period. Sales of components for industrial uses accounted for nearly 50 percent of the Company's general components market. Domestic sales of components for automotive use and office automation equipment were particularly active, whereas sales to consumer products markets remained stable.

Semiconductors

Matsushita's 1989 worldwide semiconductor ranking remained unchanged from 1988. Dataquest ranked Matsushita ninth in worldwide semiconductor sales, based on revenue of $1.9 billion. The Company's strongest semiconductor product area is MOS, which accounts for 45 percent of its semiconductor revenue. Analog devices account for 20 percent, followed by discrete devices at 18 percent, optoelectronics at 16 percent, and bipolar digital at 1 percent.

The Company's strongest gains were in the MOS memory device markets, including the DRAM, mask ROM, and optoelectronic device markets. In worldwide markets, Matsushita's 1989 DRAM market share was 3.0 percent, up from 1988's 2.4 percent, Dataquest estimates, yet Matsushita slipped from tenth to eleventh place among the top DRAM vendors. The Company also moved from eighth to tenth place in sales of analog devices, based on estimated revenue of $376 million in 1989.

Home Appliances

The home appliances segment posted slight gains in revenue during fiscal 1990. Sales for the period were ¥802.4 billion (US$5.6 billion), up from ¥776.8 billion (US$6 billion) for the previous period. Home appliance sales were 13 percent of total revenue in fiscal 1990, a decrease from 14 percent in the previous year.

Products in the home appliance category include refrigerators, room air conditioners, laundry equipment, vacuum cleaners, electric irons, microwave ovens, electric fans, electric blankets, and cooking appliances.

Audio Equipment

Matsushita's audio equipment group accounted for 9 percent of the Company's revenue, with sales of ¥561 billion (US$3.9 billion) for the period ended March 31, 1990. CDs, radio/cassette recorders, and portable headphone cassette players continued as sales leaders in this segment.

Other products included under the audio equipment segment are radios, tape recorders, stereo hi-fi and related equipment, car audio products, and electronic musical instruments.

Batteries and Kitchen-Related Products

The batteries and kitchen-related products segment accounted for 5 percent of Matsushita's revenue, ¥312 billion (US$2.2 billion) for the fiscal year 1990. Sales leaders in this group include nickel-cadmium and lithium batteries, and alkaline-manganese cells used for portable audio equipment. A strong housing construction and renovation market also boosted sales of the Company's integrated kitchen systems.

As part of its human amenity life systems (HALS) campaign, Matsushita introduced new AV-equipped bathroom units and other enhanced lifestyle products to expand housing-related business.

Other

The balance of Matsushita's business includes sales of bicycles, cameras and flash units, prerecorded tapes and discs, water purifiers, and imported materials and products such as nonferrous metals, lumber, paper, medical equipment, and cabin cruisers. This segment accounted for 10 percent of the Company's total revenue, with total sales of ¥572.9 billion (US$4 billion).

Further Information

For further information on the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Corporate Highlights (Millions of US Dollars)

		1988*	1989	1990
Three-Year Revenue		$36,718.8	$43,002.0	$42,124.8
Percent Change		-	17.11	(2.04)
Capital Expenditure		$1,680.2	$2,542.5	$2,489.5
Percent of Revenue		4.58	5.91	5.91
R&D Expenditure		$2,023.2	$2,493.0	$2,425.8
Percent of Revenue		5.51	5.80	5.76
Number of Employees		134,186	193,088	198,299
Revenue ($K)/Employee		$273.64	$222.71	$212.43
Net Income		$1,192.9	$1,667.7	$1,653.1
Percent Change		-	39.80	(0.88)
Exchange Rate (US$1=¥)		¥138.0	¥128.0	¥142.5
1989 Calendar Year	**Q1**	**Q2**	**Q3**	**Q4**
Quarterly Revenue	$9.38	$10.15	$10.43	$11.43
Quarterly Profit	$0.25	$0.38	$0.40	$0.53

*Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1986 and 1987.

Source: Matsushita Electric Industrial Co., Ltd. Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1988*	1989	1990
Asia/Pacific	58.00	58.00	56.00
Japan	58.00	58.00	56.00
International	42.00	42.00	44.00

*Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1986 and 1987.

Source: Matsushita Electric Industrial Co., Ltd.

1989 SALES OFFICE LOCATIONS

North America—9 (includes sales companies)
Europe—15 (includes sales companies)
Asia/Pacific—142 (includes sales companies)
Japan—132
ROW—12 (includes sales companies)

MANUFACTURING LOCATIONS

North America

America Kotobuki Electronics Industries (United States)
VCRs
American Matsushita Electric Corp. of America (United States)
Electric products
Kyushu Matsushita Electric Corporation of America (United States)
TVs, microwave ovens, PCs
Matsushita Communication Industrial Corp. of America (United States)
Car telephones, pagers, car audio systems
Matsushita Compressor Corp. of America (United States)
Compressors
Matsushita Electronic Components Corp. of America (United States)
Electronic parts
Matsushita Industrial Canada (Canada)
Color TVs
Matsushita Refrigeration Co. of America (United States)
Refrigerators
Matsushita-Ultra Tech. Battery Corp. (United States)
Batteries
Panasonic Technologies (United States)
R&D

Europe

Kyushu Matsushita Electric (United Kingdom)
Electronic typewriters, printers
Matsushita Business Machine (Germany)
PPC copiers
Matsushita Communication Deutschland (Germany)
Car radios/stereos
Matsushita Communication Industrial (United Kingdom)
Car telephones
Matsushita Electric (United Kingdom)
Color TVs, microwave ovens
Matsushita Electric Motor (Germany)
Motors
Matsushita Electronic Components (Germany)
Electronic parts, materials
Matsushita Electronic Components (United Kingdom)
Transformers, LC filters
Matsushita Electronic Magnetron Corp. (United Kingdom)
Magnetrons for microwave ovens
Matsushita Graphic Communication Systems Ltd. (United Kingdom)
Fax machines
Matsushita Video Manufacturing (Germany)
VCR mechanisms
MB Video (Germany)
VCRs, CD players
Panasonic Espana (Spain)
Electric equipment
Panasonic France S.A. (France)
Consumer electronics

Asia/Pacific

A.P. National (Thailand)
Home electrical appliances
Asahi Kogyo (Japan)
Tape recorders
Beijing-Matsushita Color CRT (China)
Color CRTs
International Fan Manufacturing (Hong Kong)
Electric fans
Katano Matsushita (Japan)
Audio equipment
Kibi Matsushita (Japan)
Video equipment
Kyushu Matsushita Electric (Japan)
Data processing, business machines, magnetic heads
Matsue Matsushita Denki (Japan)
Capacitors
Matsusaka Seimitsu (Japan)
Assembly of motors
Matsushita Air-Conditioning Corporation (Malaysia)
Air conditioners
Matsushita Communication Industrial (Japan)
Data processing, communication, control, video equipment
Matsushita Communication Industrial Corp. of the Philippines (Philippines)
FDDs, ECM
Matsushita Compressor & Motor (Malaysia)
Compressors, fan motors
Matsushita Denshi (Singapore)
IC production, LSI design

Matsushita Electric Works (Japan)
Electrical housing equipment
Matsushita Electric (Australia)
TVs, audio equipment
Matsushita Electric (Malaysia)
Home electrical appliances
Matsushita Electric (Taiwan)
Electrical appliances
Matsushita Electric Institute of Technology (Taiwan)
R&D
Matsushita Electronic Motor (Singapore)
Precision motors, applied equipment
Matsushita Electronic Components (Japan)
Electronic equipment parts
Matsushita Electronic Components (Malaysia)
Electronic parts
Matsushita Electronic Components (Singapore)
Electronic parts
Matsushita Electronics (Singapore)
Audio equipment
Matsushita Electronic Motor (Malaysia)
Electronic motors
Matsushita Electronics (Japan)
Semiconductors, electron tubes, lighting equipment
Matsushita Graphic Communications Systems (Singapore)
Fax machines
Matsushita Graphic Communication Systems (Japan)
Facsimiles, graphics equipment
Matsushita Industrial Equipment (Japan)
Industrial equipment
Matsushita Industrial (Malaysia)
Air conditioners, compressors
Matsushita Precision Industrial (Malaysia)
Flyback transformers, coils
Matsushita Refrigeration Industries (Malaysia)
Refrigerator/freezers
Matsushita Refrigeration Industries (Thailand)
Refrigerator/freezers
Matsushita Refrigeration (Japan)
Refrigerators, air conditioners
Matsushita Refrigeration Industries (Singapore)
Compressors
Matsushita Research Institute (Japan)
Electronics research
Matsushita Seiko (Japan)
Electric fans, ventilators, air conditioners
Matsushita Seiko Hong Kong International Manufacturing Co., Ltd. (Hong Kong)
Air conditioners
Matsushita Technical Center (Singapore)
Production equipment
Matsushita Television (Malaysia)
Color TVs
Matsushita-Kotobuki Electronics (Japan)
Video equipment, TVs, tape recorders
Miyazaki Matsushita Denki (Japan)
Ceramics, magnetic materials, resistant materials
P.T. National Gobel (Indonesia)
Home electrical appliances
National Micromotor (Japan)
Microprecision motors
National Thai (Thailand)
Home electrical appliances
P.T. Matsushita Gobel Battery Industry (Indonesia)
Batteries
PFU Ltd. (Japan)
Minicomputers
Precision Electronics (Philippines)
Home electrical appliances
Takefu Matsushita Electric (Japan)
Micromotors
Victor Company of Japan (Japan)
Video/audio equipment, TVs
Wakayama Precision (Japan)
Refrigerators, air conditioners

ROW

Matsushita Electric (East Africa)
Radios, radio cassette recorders, dry batteries
Matsushita Electrica de Guatemala (Guatemala)
Audio equipment
Matsushita Electric de El Salvador (El Salvador)
Audio equipment
Matsushita Industrial de Baja California (Mexico)
Color TV chassis
National Centroamericana
Dry batteries, audio equipment
National Componentes Electronicos do Brazil (Brazil)
Electronic parts
National do Brazil (Brazil)
Matsushita group products
National Electric Cote d'Ivoire (Ivory Coast)
TVs, radio cassette recorders
National Panasonic Fueguina
Color TVs, radio cassette recorders
National Peruana (Peru)
Home electrical appliances
Panasonic de Mexico (Mexico)
Audio equipment, electronic parts
Panasonic Industrial de Venezuela, C.A. (Venezuela)
Consumer electronic products
Springer National Componentes (Brazil)
Assembly of micromotors, CRT sockets, PC boards
Springer National da Amazonia (Brazil)
Color TVs, audio equipment

SUBSIDIARIES

North America

Matsushita Electric Corporation of America (United States)
Solbourne Computer (United States)

Europe

Matsushita Electric (U.K.) Ltd. (United Kingdom)
Matsushita Electronic Magnetron Corp. (United Kingdom)
Matsushita Graphic Communication Systems U.K. Ltd. (United Kingdom)
Panasonic Espana S.A. (Spain)
Panasonic France S.A. (France)

Asia/Pacific

Kyushu Matsushita Electric Co., Ltd. (Japan)
Matsushita Battery Industrial Co., Ltd. (Japan)
Matsushita Communications Industrial Co., Ltd. (Japan)
Matsushita Electric (Taiwan) Co., Ltd. (Taiwan)
Matsushita Electronic Components Co., Ltd. (Japan)
Matsushita Electronics Corporation (Japan)
Matsushita Electronics (S) Pte. Ltd. (Singapore)
Matsushita Graphic Communications Systems, Inc. (Japan)
Matsushita Housing Products Co., Ltd. (Japan)
Matsushita Industrial Equipment Co., Ltd. (Japan)
Matsushita Industrial Corporation Sdn. Bhd. (Malaysia)
Matsushita Kotobuki Electronics Industries, Ltd. (Japan)
Matsushita Refrigeration Company (Japan)
Matsushita Refrigeration Industries (S) Pte. Ltd. (Singapore)
Matsushita Seiko Co., Ltd. (Japan)
Victor Company of Japan, Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1989

Signetics
The companies entered a sales agency agreement for memory products.

Weitek
The companies are jointly developing a microprocessor product.

Siemens
Matsushita and Siemens formed a joint venture for producing passive electronic components.

Office Workstations Ltd.
Matsushita and Office Workstations of Scotland formed a joint venture for development of office automation software products.

1988

Hewlett-Packard, IBM Corp., Intel
Matsushita agreed to supply these companies with a total of more than 1 million 1M DRAMs per month.

Intel
Matsushita agreed to subcontract production of Intel's 8-bit microcontrollers for the Japanese market. The companies agreed to jointly develop sub-0.5-micron 16M DRAM process.

Sun Microsystems
The SPARC RISC chip was licensed for use in workstations being developed by Solbourne Computer, a Matsushita subsidiary.

Tosoh
The companies agreed to jointly develop conductive electron-beam resist that completely solves the electrification problem occurring with direct-write e-beams.

Motorola
Matsushita agreed to purchase Motorola semiconductors for use in video cassette recorders.

1987

NEC
The companies agreed to develop the next generation of steppers for VLSI manufacturing.

SAE Inc.
The companies agreed to jointly develop a 64-bit microprocessor with plans for a 64-bit engineering workstation in 1989.

Philips
The companies renewed a business cooperation agreement for the next ten years in which Matsushita Electric will continue to own 65 percent of

Matsushita Electronics and Philips will own 35 percent. Matsushita agreed to supply LSIs for compact disks to Philips, and the companies made a second-source agreement for 8-bit CMOS microcontrollers.

Intel
Matsushita obtained a license from Intel for the 8051 and three other 8-bit microcontrollers.

TRW
The companies agreed to jointly develop an 0.8-micron-wavelength GaAlAs semiconductor laser for space communications.

Nikon
The companies jointly developed advanced i-line steppers and excimer lasers for next-generation VLSIs.

Technology Imports--Licensor, Patents, and Contract Term

Allen Organ
Electronic organs (7/82 until expires)

AT&T and Sun Microsystems
Computer architecture license (9/88-undetermined)

AT&T Technologies
Electronic equipment (2/71 until expires)

Blaupunkt Werke
Car radios (5/82 until expires)

BSR North America
Noise reduction devices for tape recorders (8/80 until expires)

Design & Manufacturing
Electronic digital control systems (8/85 until expires)

Energy Conversion
Devices, Optical information recorders (12/83 until expires)

Hewlett-Packard
Data/word processors (4/85 until expires)

IBM Corp.
Data processing equipment (5/71 until expires)

RCA Licensing
Video cameras (7/87 through 6/92)

RCA Licensing
Color TV sets (1/88 through 12/92)

Saunier Duval
Gas water boilers of electronic control (1/79 until expires)

Telefunken Fernseh and Rundfunk GmbH
PAL color TV receivers (7/72 until expires)

Texas Instruments
Semiconductors (5/87 through 12/90)

Thorn EMI Patents
PAL color TV receivers (6/73 until expires)

Xerox Corp.
Plain paper copiers (9/81 until expires)

Technology Exports--Licensor, Patents, and Contract Term

Digital Equipment
Reel motors (5/86 until expires)

Grundig
VCR heads (3/88-undetermined)

SECI S.p.A.
Piezoelectric elements (8/80 through 8/90)

OEM Contracts--Licensing Partner

IBM Corp.
OEM supply of optical disk drives by Matsushita

Westinghouse Electric
Matsushita to sell Westinghouse's robot control equipment under Matsushita/Panasonic brand in North America

MERGERS AND ACQUISITIONS

1988

Matsushita Electric Trading Co., Ltd. (MET)
MET, a 51.24 percent owned consolidated subsidiary, was merged into the Company in exchange for 73.4 million shares of Matsushita common stock having a fair value of ¥1.5 billion (US$1.1 billion).

KEY OFFICERS

Masaharu Matsushita
Chairman of the board

Akio Tanii
President

Shoji Sakuma
Executive vice president

Masahiko Hirata
Executive vice president

Keiya Toyonaga
Senior managing director

Hiroyuki Mizuno
Senior managing director

Tsuzo Murase
Senior managing director

PRINCIPAL INVESTORS

Sumitomo Bank—4.4 percent
Sumitomo Life Insurance—4.4 percent
Nippon Life Insurance—4.0 percent
Matsushita Investment and Development—3.2 percent
Mitsubishi Trust—3.0 percent
Sumitomo Trust—2.9 percent
Konosuke Matsushita—2.6 percent
Toyo Trust—2.0 percent
Kyowa Bank—2.0 percent

FOUNDERS

Konosuke Matsushita

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of US Dollars, except Per Share Data)

Balance Sheet	1988*	1989	1990
Total Current Assets	$24,324.9	$27,587.1	$32,371.7
Cash	10,018.6	11,251.1	14,111.2
Receivables	4,916.6	6,149.8	7,805.9
Marketable Securities	2,563.1	1,656.0	2,353.7
Inventory	4,859.0	6,222.7	5,936.9
Other Current Assets	1,967.6	2,307.5	2,164.0
Net Property, Plants	$5,057.1	$6,439.2	$6,720.3
Investments	$8,973.7	$11,851.4	$11,561.9
Other Assets	$3,150.5	$4,137.0	$4,442.3
Total Assets	$41,506.2	$50,014.8	$55,096.2
Total Current Liabilities	$13,362.0	$16,750.2	$18,263.1
Long-Term Debt	$4,094.5	$4,858.6	$8,400.6
Other Liabilities	$6,006.7	$6,011.3	$5,970.0
Total Liabilities	$23,463.2	$27,620.1	$32,633.7
Total Shareholders' Equity	$18,043.0	$22,394.7	$22,462.5
Common Stock	1,048.4	1,283.2	1,297.8
Other Equity	1,816.2	3,273.1	3,711.4
Retained Earnings	15,178.4	17,838.4	17,453.3
Total Liabilities and Shareholders' Equity	$41,506.2	$50,014.8	$55,096.2
Income Statement	**1988***	**1989**	**1990**
Revenue	$36,718.8	$43,002.0	$42,124.8
Cost of Sales	$24,228.4	$28,678.8	$28,137.5
R&D Expense	$2,023.2	$2,493.0	$2,425.8
SG&A Expense	$9,882.6	$11,063.9	$10,810.4
Capital Expense	$1,680.2	$2,542.5	$2,489.5
Pretax Income	$3,284.3	$4,136.3	$4,012.1
Pretax Margin (%)	8.94	9.62	9.52
Effective Tax Rate (%)	55.50	54.20	54.20
Net Income	$1,192.9	$1,667.7	$1,653.1
Shares Outstanding, Millions	1,861.8	1,955.6	2,080.2
Per Share Data			
Earnings	0.67	0.76	0.68
Dividend	0.80	0.90	0.63
Book Value	9.69	11.45	10.80
Exchange Rate (US$1=¥)	¥138.0	¥128.0	¥142.5

*Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from 11/86 to 3/31/87. Because of these changes, information is not included for 1986 and 1987.

Source: Matsushita Electric Industrial Co., Ltd. Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Balance Sheet	1988*	1989	1990
Total Current Assets	¥3,356.8	¥3,531.2	¥4,612.9
Cash	1,382.6	1,440.1	2,010.8
Receivables	678.5	787.2	1,112.3
Marketable Securities	353.7	212.0	335.4
Inventory	670.5	796.5	846.0
Other Current Assets	271.5	295.4	308.4
Net Property, Plants	¥697.9	¥824.2	¥957.6
Investments	¥1238.4	¥1516.9	¥1647.6
Other Assets	¥434.8	¥529.6	¥633.0
Total Assets	¥5,727.9	¥6,401.9	¥7,851.1
Total Current Liabilities	¥1,843.9	¥2,144.0	¥2,602.5
Long-Term Debt	¥565.0	¥621.9	¥1,197.1
Other Liabilities	¥828.9	¥769.4	¥850.7
Total Liabilities	¥3,237.8	¥3,535.3	¥4,650.3
Total Shareholders' Equity	¥2,490.0	¥2,866.6	¥3,200.9
Common Stock	144.7	164.3	184.9
Other Equity	250.7	419.0	528.9
Retained Earnings	2,094.6	2,283.3	2,487.1
Total Liabilities and Shareholders' Equity	¥5,727.8	¥6,401.9	¥7,851.2

Income Statement	1988*	1989	1990
Revenue	¥5,067.2	¥5,504.3	¥6,002.8
Cost of Sales	¥3,343.5	¥3,670.9	¥4,009.6
R&D Expense	¥279.2	¥319.1	¥345.7
SG&A Expense	¥1,363.8	¥1,416.2	¥1,540.5
Capital Expense	¥231.9	¥325.4	¥354.8
Pretax Income	¥453.2	¥529.4	¥571.7
Pretax Margin (%)	8.94	9.62	9.52
Effective Tax Rate (%)	55.50	54.20	52.60
Net Income	¥164.6	¥213.5	¥235.6
Shares Outstanding, Millions	1,861.8	1,955.6	2,080.2
Per Share Data			
Earnings	¥80.34	¥99.94	¥108.34
Dividend	¥9.52	¥11.90	¥10.00
Book Value	¥1.34	¥1.47	¥1.54

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Key Financial Ratios	1988	1989	1990
Liquidity			
Current (Times)	1.82	1.65	1.77
Quick (Times)	1.46	1.28	1.45
Fixed Assets/Equity (%)	28.03	28.75	29.92
Current Liabilities/Equity (%)	74.05	74.79	81.31
Total Liabilities/Equity (%)	130.03	123.33	145.28
Profitability (%)			
Return on Assets	5.75	3.52	3.31
Return on Equity	13.22	7.97	7.77
Profit Margin	3.25	3.88	3.92
Other Key Ratios			
R&D Spending % of Revenue	5.51	5.80	5.76
Capital Spending % of Revenue	4.58	5.91	5.91
Employees	134,186	193,088	198,299
Revenue (¥M)/Employee	¥37.76	¥28.51	¥30.27
Capital Spending % of Assets	4.05	5.08	-
Exchange Rate (US$1=¥)	¥138.0	¥128.0	¥142.5

*Matsushita changed its fiscal year-end from November to March 31. Fiscal 1987 represents only four months from November 1986 to March 31, 1987. Because of these changes, no information is included for 1986 and 1987.

Source: Matsushita Electric Industrial Co., Ltd.
Annual Reports
Dataquest (1990)

Mitsubishi Electric Corporation

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2-3, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100 Japan
Telephone: (03) 218-2111
Fax: (03) 218-3686
Dun's Number: 09-141-8897

Date Founded: 1921

CORPORATE STRATEGIC DIRECTION

Established in 1921, Mitsubishi Electric Corporation is one of the world's foremost electronics and electrical appliance manufacturers. The Corporation is a pioneer in information processing equipment and new communications systems, incorporating teleconferencing technology, satellite relay, and optical fiber communications. Applying advances in electronics to industrial equipment, power generation, transportation, and consumer products, Mitsubishi Electric has been instrumental in improved efficiency, automation, and safety.

The Company achieved record net sales and profit during fiscal year 1990. Total revenue increased 7.3 percent to ¥2.9 billion (US$20.9 billion) in fiscal year ending March 1990, up from ¥2.8 billion (US$21.6 billion) in year ending March 1989. (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) Net income totaled ¥76.8 billion (US$539 million) for fiscal 1990, representing an increase of 44.3 percent over fiscal 1989.

Mitsubishi Electric divides its products into four separate segments: information and communications systems and electronic products, systems, and devices; consumer products; heavy machinery; and industrial products and automotive equipment. The Company's information and communications systems and electronic products, systems, and devices segment generated the greatest amount of sales. This segment made up 30.4 percent of the Company's total sales. Consumer products sales represented the second most profitable segment, with 25.5 percent of the total, followed closely by the heavy machinery segment, which contributed 23.0 percent. Industrial products and automotive equipment accounted for 21.1 percent of total sales.

For 1990, Mitsubishi Electric's growth strategies are targeted at the restructuring of its operations and the promotion of globalization. The Company plans to focus on three main objectives: establishing a high value-added business organization centered on information and communications systems and electronic products, systems, and devices; improving its international manufacturing and sales network; and utilizing its management resources in an effective manner.

The Company believes its greatest global marketing challenge lies in the completion of construction of an efficient international manufacturing and sales network. During 1990, the Company took many actions geared at achieving this goal. In May 1990, the Company purchased the computer hardware division of Apricot Computers Plc of the United Kingdom. The company has been renamed Apricot Computers Ltd. and will be a subsidiary of Mitsubishi Electric UK Ltd. Mitsubishi Electric Europe GmbH is investing approximately ¥42.0 billion (US$294 million) in the construction of a new production facility in Germany. Mass production of 4MB DRAMs is expected to begin in 1991 and will be followed by the manufacture of application-specific integrated circuits (ASICs) and ICs using advanced production technology. In September 1989, Mitsubishi Electric Corporation was listed on the London Stock Exchange and in November became listed on the Paris Stock Exchange.

During fiscal years 1990 and 1989, R&D expenditure totaled ¥145.1 billion (US$1.0 billion) and ¥118.5 billion (US$924 million), respectively. These figures represented 4.9 percent and 4.3 percent of total revenue, respectively. The Company's R&D efforts developed a digital image signal processor (DISP) during 1990, which is suitable for use in a wide range of high-precision, high-speed digital-image and video-signal processing such as that used in video teleconferencing systems. Also developed during the year was a superconductive ceramic fiber with a diameter of 30 to 50 microns.

Capital expenditure totaled ¥223.5 billion (US$1.6 billion), representing 7.5 percent of total revenue for year ending March 1990. This is an increase of nearly 7 percent of the 1989 figure of ¥209.5 billion (US$1.6 billion). The Company's efforts went to construct a synchrotron radiation facility for use in the R&D of ultrafine processing semiconductors and the analysis of new materials.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Information and Communications Systems, Electronic Products, Systems, and Devices

Products in the information and communications systems, electronic products, systems, and devices area include semiconductors, mobile telephones, computers, radar systems, satellites, CRTs, printers, disk drives, POS terminals, facsimile transceivers, and information network systems and equipment. This segment produced the greatest amount of sales in 1990, totaling ¥903.5 billion (US$6.0 billion), an 11.7 percent increase over 1989. The growth was attributed to increased sales of microcomputers, power devices, and communications equipment. A rise in export sales of semiconductors, cellular telephones, and computer peripherals also contributed significantly to this segment's growth.

Semiconductors

According to Dataquest, Mitsubishi ranks seventh in worldwide semiconductor market with an estimated ¥333.5 billion (US$2.6 billion) in semiconductor sales for 1989. Mitsubishi ranked fifth in the MOS memory segment with ¥153.9 billion (US$1.2 million), or a 7.1 percent share of the worldwide market, and fifth in the MOS microcomponents segment with ¥55.8 billion (US$435 million), or a 5.3 percent market share, according to Dataquest estimates.

Throughout fiscal 1990, Mitsubishi Electric had many product developments, as well as expansion of its production facilities. The Company produced a memory card that it claims can accommodate one thousand 8.25 x 11.75-inch pages of information in Japanese. The Company also developed a 1MB EPROM with full capabilities, an access time of 120 nanoseconds, and a large-scale integrated (LSI) circuit that processes images and pictures ten times faster than existing models. Building began on Mitsubishi Electric's 32-bit MPU to The Real-Time Operating System Nucleus (TRON) specifications. The Company also developed a 64-bit RISC MPU using the UNIX operating system. Early in 1988, 4MB DRAMs were developed and tested and, in early 1989, the Company started production of 4MB DRAMs at the Saijo plant.

During fiscal 1989, Mitsubishi Electric expanded its 1MB DRAM manufacturing capabilities by installing a 1MB DRAM mass-production line in its Saijo and Kochi plants. This allowed production of 1MB DRAMs to reach 1 million units per month. The Kochi plant also expanded its facilities for microcomponents, enabling plant production capacity to reach 4 million units per month. The Company is enlarging its Durham, North Carolina, facility to accommodate the manufacturing of 1MB DRAMs and application-specific integrated circuits (ASICs). The full process of wafer fabrication to assembly to testing will be completed in-house.

Communications

Mitsubishi Electric's communications products include digital private branch exchanges (PBXs), facsimile machines, satellites, and video teleconferencing systems. During April 1989, the Company introduced small-capacity digital PBXs and upgraded its facsimile machines to G4 Integrated Services Digital Network (ISDN) specifications. The Company developed multichannel access mobile facsimile transmission and receiving equipment in 1988. Another innovation in digital communication being produced by Mitsubishi Electric is a packet multiplexer that connects computers and terminal units to a switching packet network.

Mitsubishi Electric is a leading manufacturer of satellite technology. In spring 1989, Mitsubishi Electric established a partnership with an American Company and a French company, receiving orders for commercial communications satellites meeting the INTELSAT-VII series standards. The Company also manufactures Japan's ETS-VI Engineering Test Satellite, which uses an ion engine for correcting the satellite's attitude and for extending the satellite's life by lightening the lead. Both the INTELSAT-VII and the ETS-VI are planned for departure in 1992. Over the past three years, the Company has been involved in the development of the CS-3b domestic communications satellite, the IR-5120A thermal imager, a variety of active-phased array radars for the Japan Defense Agency, and mission computers and electronic equipment for use in fighter planes.

Information Processing Systems

Information processing systems include general-purpose, small business, and personal computers in addition to other systems. Mitsubishi Electric introduced the mp286L laptop computers and the mp386s desktop computer to the US and European markets in 1988 and 1989, respectively. The mp386s utilizes a 32-bit central processing unit. The Company began domestic marketing of its AX computers as well in 1988. In April 1989, the Company opened a subsidiary that provides systems development and information-processing services using MIND, a digital value-added network. MIND was first used to connect the Company's domestic facilities. However, it is now being extended to the Company's overseas facilities as well as being offered to other companies and clients.

Consumer Products

Sales of Mitsubishi Electric consumer products increased 8.4 percent over 1989, equaling ¥757.5 billion (US$5.1 billion). The Company credits the growth to increased domestic consumer spending on value-added items such as color televisions, refrigerators, washing machines, and air conditioners.

Heavy Machinery

Mitsubishi Electric's sales of heavy machinery totaled ¥685.6 billion (US$4.6 billion), representing a 7.2 percent increase over the previous year. Despite lower expected sales resulting from a drop in large-scale orders, strong domestic demand for elevators and transportation equipment, supported by major contracts for power systems and other items, allowed for a slight growth in sales.

Industrial Products and Automotive Equipment

In Mitsubishi Electric's industrial products and automotive equipment segment, the 10.5 percent increase in sales to ¥629.7 billion (US$4.2 billion) was due primarily to extensive investment in plant and equipment and expansion of factory automation that occurred throughout the industry. This was complemented by strong domestic automobile production and increased use of mechatronics equipment.

Further Information

For more information about the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Millions of US Dollars)

	1986	1987	1988	1989	1990
Five-Year Revenue	$9,752	$13,208	$17,571	$21,637	$20,892
Percent Change	-	35.44	33.03	23.14	(3.44)
Capital Expenditure	$697	$791	$1,038	$1,633	$1,569
Percent of Revenue	7.15	5.99	5.91	7.55	7.51
R&D Expenditure	$403	NA	$739	$924	$1,018
Percent of Revenue	4.13	NA	4.20	4.27	4.87
Number of Employees	71,479	73,536	75,795	85,723	85,723
Revenue ($K)/Employee	$136	$180	$232	$252	$244
Net Income	$136	$66	$161	$415	$539
Percent Change	-	(51.09)	142.29	157.94	29.86
Exchange Rate (US$1=¥)	¥221.26	¥159.56	¥138.03	¥128.25	¥142.47

1990 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Mitsubishi Electric Corporation
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1986	1987	1988	1989	1990
Asia/Pacific	NA	NA	NA	NA	77.40
Japan	NA	NA	NA	NA	77.40
International	NA	NA	NA	NA	22.60

NA = Not available

Source: Mitsubishi Electric Corporation
Annual Reports
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

North America—22
Europe—9
Asia/Pacific—36
Japan—34
ROW—7

MANUFACTURING LOCATIONS

North America

Mitsubishi Consumer Electronics America, Inc. (United States)
Color TVs, projection TVs, car telephones
Mitsubishi Electric Manufacturing Cincinnati, Inc. (United States)
Electrical auto parts, car audio equipment powerex, diodes, thyristors, and transistors
Mitsubishi Electric Sales Canada (Canada)
Color TVs
Mitsubishi Electronics Industries Canada, Inc. (Canada)
Color CRTs
Mitsubishi Semiconductor America, Inc. (United States)
Semiconductors

Europe

Mitsubishi Electric (United Kingdom)
Color TVs, VCRs

Asia/Pacific

D. B. Seiko (Japan)
Electrical auto parts
Dahsen Electronic Industries (Malaysia)
Audio equipment
K. K. Sowa (Japan)
Electrical equipment
Kanebo Denshi (Japan)
IC assembly
Kang Yong Electric Manufacturing (Malaysia)
TVs, air conditioners, fans
Koryo Denki (Japan)
Electrical/electronic materials
Koshin Denki (Japan)
Measuring instruments, electrical equipment
MELCO Manufacturing Thailand (Thailand)
FDDs for personal computers
Mitsubishi Australia Pte. Ltd. (Australia)
Color TVs, car telephones
Mitsubishi Electric Home Appliance (Japan)
Home electrical appliances
Mitsubishi Electronics Manufacturing (Singapore)
Color TVs, car audio equipment
Mitsubishi Kochi (Japan)
1Mb DRAMs
Mitsubishi Precision (Japan)
Electronic instruments
Mitsubishi Sajo (Japan)
1Mb DRAMs
Oi Electric (Japan)
Communications equipment
Omori Denki Kogyo (Japan)
Electrical equipment
Osram Melco (Japan)
Lamps
Ryoden Denshi Kiko (Japan)
Antennas
Ryoden Kasei (Japan)
Electrical/electronic materials
Ryoden Tokki (Japan)
Electronic applied equipment
SPC Electronics (Japan)
Microwave/ultrasonic applied equipment
Sanryo Sangyo (Japan)
Electronic equipment
Sanwa Denki (Japan)
Electrical equipment
Seiryo Buhin (Japan)
Electrical equipment parts
Shihlin Electric and Engineering (Malaysia)
Capacitors, electrical auto parts, transformers
Shizuki Electric (Japan)
Capacitors
Shoryo Denshi (Japan)
Electrical equipment
Thai CRT (Thailand)
Color CRTs
Toyo Kiko Seisakusho (Japan)
Air conditioning equipment
VXL India (India)
Wattmeters, relays, time buses

ROW

Comercio e Industria Induco (South America)
Power systems for communications equipment
Friem S. A. de C. V. (South America)
Refrigerators, washing machines
Grupo Industrial Comasa (South America)
Compressors for refrigerators

SUBSIDIARIES

North America

Horizon Research, Inc. (United States)
Mitsubishi Consumer Electronics America, Inc. (United States)
Mitsubishi Electric America, Inc. (United States)
Mitsubishi Electric Manufacturing Cincinnati, Inc. (United States)
Mitsubishi Electric Sales America, Inc. (United States)
Mitsubishi Electric Sales Canada, Inc. (Canada)
Mitsubishi Electronics America, Inc. (United States)
Mitsubishi Electronics Industries Canada, Inc. (United States)
Mitsubishi Semiconductor America, Inc. (United States)

Europe

Melco Iberia S.A. (Spain)
Mitsubishi Electric Europe GmbH (Germany)
Mitsubishi Electric France S.A. (France)
Mitsubishi Electric Netherlands B.V. (Netherlands)
Mitsubishi Electric (UK) Ltd. (United Kingdom)

Asia/Pacific

Ad. Melco Co., Ltd. (Japan)
Koryo Denki (Japan)
Koshin Denki (Japan)
Melcom Business Machines Co., Ltd. (Japan)
Mitsubishi Electric Credit Co., Ltd. (Japan)
Mitsubishi Electric Home Appliance Co., Ltd. (Japan)
Mitsubishi Electric Service Engineering Co., Ltd. (Japan)
Mitsubishi Electronics Manufacturing Singapore (Pte.) Ltd. (Singapore)
Mitsubishi Space Software Co., Ltd. (Japan)
Nakayama Kikai Co., Ltd. (Japan)
Ryoden Denshi Kiko (Japan)
Ryoden Elevator Construction Co., Ltd. (Japan)
Ryoden Engineering Co., Ltd. (Japan)
Ryoden Estate Co., Ltd. (Japan)
Ryoden Kasei (Japan)
Ryoden Service Co., Ltd. (Japan)
Ryoden Tokki Co.,Ltd. (Japan)
Ryoden Unyu Co., Ltd. (Japan)
Ryoreisha Co., Ltd. (Japan)
Ryowa Shoko Co., Ltd. (Japan)
SPC Electronics Corporation (Japan)
Sanryo Sangyo (Japan)
Seiryo Buhin (Japan)
Shiga Bolt Co., Ltd. (Japan)
Tada Electric Co., Ltd. (Japan)
The Kodensha Co., Ltd. (Japan)
Toyo Electric Co., Ltd. (Japan)
Toyo Kiko Seisakusho (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

Interactive Systems Corporation
Mitsubishi Electric Corporation signed an agreement to distribute Interactive Systems Corporation's UNIX products in Europe.

Yokogawa Hewlett-Packard Company
Yokogawa Hewlett-Packard Company has agreed to work with Mitsubishi Electric Corporation to develop in-circuit emulators and software development equipment for Mitsubishi's 16-bit microcontrollers.

AT&T Microelectronics
Mitsubishi Electric Corporation signed a technology-sharing and marketing agreement with AT&T Microelectronics. Under this five-year agreement, AT&T will receive access to Mitsubishi's SRAM design and process technology. AT&T also will get global manufacturing and marketing rights to all of Mitsubishi's SRAM products.

Raytheon
Mitsubishi Electric Corporation will produce US-developed Aim-7M Sparrow missiles under license from Raytheon. The Aim-7M Sparrow is an all-weather, air-to-air, medium-range missile that will be used with a fleet of F-15 fighters.

1989

Siam Cement
Under a joint venture, Mitsubishi established capital participation in Siam Compressor Industry Co., Ltd.

1988

Fujitsu and Hitachi
Fujitsu, Hitachi, and Mitsubishi Electric Corporation developed the first silicon on the TRON-based H32/200 32-bit MPU. First silicon was also achieved on several peripheral devices.

National Semiconductor
Mitsubishi Electric Corporation began importing National Semiconductor's 32-bit MPUs and assembling National's high-speed TTLs in Japan.

RCA Corporation
The companies made a licensing agreement for TV sets and color CRTs.

Goldstar Electric Equipment
The companies made a licensing agreement for CD players.

1987

Texas Instruments
The companies made a licensing agreement for semiconductors and ICs.

Motorola Inc.
The companies made a licensing agreement for semiconductors and ICs.

Samtel Color
The companies made a licensing agreement for color CRTs.

Melco Manufacturing
The companies made a licensing agreement for floppy disk devices.

KEFICO Corporation
The companies made a licensing agreement for automotive engine control equipment.

Thai CRT
The companies made a licensing agreement for color CRTs.

National Semiconductor
The companies made an agreement for the OEM import of 32-bit microprocessors by Mitsubishi.

Intel Corp.
Mitsubishi subcontracts production of Intel 8-bit microcontrollers for the Japanese market.

Osram GmbH
The companies undertook a joint venture in Japan to produce lamps.

MERGERS AND ACQUISITIONS

1990

Apricot Computers
Mitsubishi Electric Corporation acquired Apricot Computers' computer hardware division for $64.0 million. The PC unit will trade under the name Apricot Computers Ltd. as a subsidiary of Mitsubishi Electric (UK) Ltd., while Apricot will change its name to ACT. The hardware unit makes IBM-compatible Micro Channel Architecture (MCA) machines.

KEY OFFICERS

Nihachiro Katayama
Chairman

Moriya Shiki
President

Shinichi Yufu
General manager, International Operations Group

Kokichi Sonda
General manager, Headquarters—Marketing

Yasuo Endo
General manager, Information and Communication Systems Group

Hideo Morii
General manager, Corporate Strategic Planning Office

Hisao Oka
General manager, Headquarters—Research and Development; Headquarters—Engineering and Manufacturing

PRINCIPAL INVESTORS

Mitsubishi Trust & Banking—5.6 percent
Meiji Mutual Life Insurance—4.1 percent
Mitsui Trust & Banking—4.1 percent
Nippon Life Insurance—3.7 percent
Mitsubishi Bank—3.2 percent
Japan Securities Clearing—2.7 percent
Sumitomo Trust & Banking—2.3 percent
Yasuda Trust & Banking—2.1 percent
Employees' Association—2.0 percent
Norinchukin Bank—1.9 percent

FOUNDERS

Information is not available.

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March
(Millions of US Dollars, except Per Share Data)

Balance Sheet	1986	1987	1988	1989	1990
Total Current Assets	$5,446	$8,051	$10,668	$14,490	$17,532
Cash	462	NA	2,482	3,738	4,557
Receivables	2,077	NA	3,994	5,133	5,024
Marketable Securities	494	NA	833	985	3,059
Inventory	1,810	NA	2,478	3,336	3,602
Other Current Assets	604	NA	881	1,299	1,290
Net Property, Plants	1,756	NA	3,501	4,050	3,901
Other Assets	1,083	NA	1,979	2,559	841
Total Assets	$8,284	$12,182	$16,149	$21,099	$22,274
Total Current Liabilities	$4,810	NA	$9,817	$12,698	$11,612
Long-Term Debt	$974	NA	$1,489	$2,112	$4,082
Other Liabilities	$389	NA	$808	$1,206	$1,337
Total Liabilities	$6,173	NA	$12,114	$16,016	$17,032
Minority Interest	$17	NA	$38	$100	$118
Total Shareholders' Equity	$2,095	NA	$3,996	$4,982	$5,125
Common Stock	532	NA	1,096	1,328	1,214
Other Equity	506	NA	1,168	1,504	1,577
Retained Earnings	1,057	NA	1,732	2,150	2,334
Total Liabilities and Shareholders' Equity	$8,284	$12,182	$16,149	$21,099	$22,274
Income Statement	**1986**	**1987**	**1988**	**1989**	**1990**
Revenue	$9,752	$13,208	$17,571	$21,637	$20,892
Japanese Revenue	NA	NA	NA	NA	16,162
Non-Japanese Revenue	NA	NA	NA	NA	4,730
Cost of Sales	$7,285	$10,187	$13,162	$15,612	$14,828
R&D Expense	$403	NA	$739	$924	$1,018
SG&A Expense	$1,547	$2,594	$2,679	$3,424	$3,449
Capital Expense	$697	$791	$1,038	$1,633	$1,569
Pretax Income	$327	$239	$455	$1,005	$1,267
Pretax Margin (%)	3.36	1.81	2.59	4.65	6.06
Effective Tax Rate (%)	58.0	58.0	56.0	56.0	54.0
Net Income	$136	$66	$161	$415	$539
Shares Outstanding, Millions	1,799	1,864	2,023	2,124	2,135
Per Share Data					
Earnings	$6.18	$3.44	$7.80	$19.24	$24.36
Dividend	NA	NA	NA	NA	NA
Book Value	$1.16	0	$1.98	$2.35	$2.40
Exchange Rate (US$1=¥)	¥221.26	¥159.56	¥138.03	¥128.25	¥142.47

NA = Not available

Source: Mitsubishi Electric Corporation
Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March
(Millions of Yen, except Per Share Data)

Balance Sheet	1986	1987	1988	1989	1990
Total Current Assets	¥1,204,998	¥1,284,614	¥1,472,490	¥1,858,299	¥2,497,749
Cash	102,119	NA	342,638	479,376	649,249
Receivables	459,647	NA	551,235	658,279	715,763
Marketable Securities	109,215	NA	115,044	126,281	435,817
Inventory	400,423	NA	341,987	427,791	513,199
Other Current Assets	133,594	NA	121,586	166,572	183,721
Net Property, Plants	¥388,487	NA	¥483,311	¥519,387	¥555,846
Other Assets	¥239,533	NA	¥273,194	¥328,241	¥119,823
Total Assets	¥1,833,018	¥1,943,779	¥2,228,995	¥2,705,927	¥3,173,418
Total Current Liabilities	¥1,064,193	NA	¥1,355,048	¥1,628,557	¥1,654,413
Long-Term Debt	¥215,532	NA	¥205,548	¥270,815	¥581,555
Other Liabilities	¥86,129	NA	¥111,537	¥154,669	¥190,538
Total Liabilities	¥1,365,854	NA	¥1,672,133	¥2,054,041	¥2,426,506
Minority Interest	¥3,715	NA	¥5,263	¥12,887	¥16,781
Total Shareholders' Equity	¥463,449	NA	¥551,599	¥638,999	¥730,131
Common Stock	117,658	NA	151,310	170,285	172,984
Other Equity	111,981	NA	161,273	192,935	224,646
Retained Earnings	233,810	NA	239,016	275,779	332,501
Total Liabilities and Shareholders' Equity	¥1,833,018	¥1,943,779	¥2,228,995	¥2,705,927	¥3,173,418

Income Statement	1986	1987	1988	1989	1990
Revenue	¥2,157,708	¥2,107,505	¥2,425,319	¥2,774,931	¥2,976,420
Japanese Revenue	NA	NA	NA	NA	2,302,603
Non-Japanese Revenue	NA	NA	NA	NA	673,817
Cost of Sales	¥1,611,843	¥1,625,497	¥1,816,806	¥2,002,269	¥2,112,504
R&D Expense	¥89,118	NA	¥101,948	¥118,507	¥145,076
SG&A Expense	¥342,333	¥413,835	¥369,750	¥439,127	¥491,343
Capital Expense	¥154,192	¥126,236	¥143,291	¥209,454	¥223,500
Pretax Income	¥72,461	¥38,175	¥62,784	¥128,950	¥180,472
Pretax Margin (%)	3.36	1.81	2.59	4.65	6.50
Effective Tax Rate (%)	58.0	58.0	56.0	56.0	54.0
Net Income	¥30,047	¥10,598	¥22,213	¥53,236	¥76,796
Shares Outstanding, Millions	1,799	1,864	2,023	2,124	2,135
Per Share Data					
Earnings	¥1,367	¥549	¥1,077	¥2,468	¥3,471
Dividend	NA	NA	NA	NA	NA
Book Value	¥258	0	¥273	¥301	¥342

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March
(Millions of Yen, except Per Share Data)

Key Financial Ratios	1986	1987	1988	1989	1990
Liquidity					
Current (Times)	1.13	NA	1.09	1.14	1.51
Quick (Times)	0.76	NA	0.83	0.88	1.20
Fixed Assets/Equity (%)	83.83	NA	87.62	81.28	76.13
Current Liabilities/Equity (%)	229.62	NA	245.66	254.86	226.59
Total Liabilities/Equity (%)	294.72	-	303.14	321.45	332.34
Profitability (%)					
Return on Assets	-	0.56	1.06	2.16	2.61
Return on Equity	-	4.57	8.05	8.94	11.22
Profit Margin	1.39	0.50	0.92	1.92	2.58
Other Key Ratios					
R&D Spending % of Revenue	4.13	NA	4.20	4.27	4.87
Capital Spending % of Revenue	7.15	5.99	5.91	7.55	7.51
Employees	71,479	73,536	75,795	85,723	89,113
Revenue (¥K)/Employee	¥30,187	¥28,660	¥31,998	¥32,371	¥33,401
Capital Spending % of Assets	8.41	6.49	6.43	7.74	7.04
Exchange Rate (US$1=¥)	¥221.26	¥159.56	¥138.03	¥128.25	¥142.47

NA = Not available

Source: Mitsubishi Electric Corporation
Annual Reports
Dataquest (1990)

NEC Corporation

33-1 Shiba 5-chome
Minato-ku, Tokyo 108, Japan
Telephone: (03) 454-1111
Fax: (03) 452-6351
Dun's Number: 00-183-6014

Date Founded: July 1899

CORPORATE STRATEGIC DIRECTION

NEC Corporation (known as Nippon Electric Company Ltd. prior to April 1, 1983) was founded in 1899 to manufacture telephone sets and switchboards. NEC is a leading global supplier of a broad range of communications systems and equipment, computers and industrial electronic systems, electron devices, consumer electronics, and information services. The company bases its activities on the synergistic integration of computers and communications systems.

NEC divides its operations into five main product groups: Communications Systems and Equipment, Computers and Industrial Electronic Systems, Electron Devices, Home Electronic Products, and Other Operations. In 1990, the Computers and Industrial Electronic Systems group remained the largest in terms of percentage of total revenue, with sales totaling ¥1.5 trillion (U.S.$9.5 billion), which accounted for 43.7 percent of total revenue. (Percentage changes refer only to ¥ amounts; U.S.$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) This figure was up 13 percent from the group's 1989 revenue of ¥1.3 trillion (U.S.$8.4 billion). The biggest rate of increase in 1990 came from the Other Operations group, whose 1990 revenue of ¥192.9 billion represented a 23.7 percent increase over the 1989 total of ¥155.9 billion.

NEC reported consolidated revenue for fiscal year ending March 31, 1990, of ¥3.44 trillion, or approximately U.S.$22.2 billion, up 11.7 percent from fiscal 1989's total of ¥3.08 trillion (U.S.$19.5 billion). Net income rose 32.1 percent from ¥64.48 billion (U.S.$408.1 million) in fiscal 1989 to ¥85.22 billion (U.S.$539.4 million) in fiscal 1990.

NEC points to the strength of the domestic Japanese economy as a major contributor to its strong operating results. NEC operates 56 consolidated subsidiaries, 62 manufacturing plants, and more than 300 sales offices in Japan. Domestic sales in 1990 totaled ¥2.55 trillion, accounting for 74.0 percent of total sales. Overseas, NEC markets its products through a network of 68 subsidiaries and affiliates in 28 countries. Overseas sales increased 15.0 percent in 1990, climbing to ¥892.1 billion, or 25.9 percent of total revenue.

Capital expenditure increased 20.3 percent during fiscal 1990 to ¥343.8 billion, representing 10 percent of total revenue. Research and development expenditure totaled ¥552.9 billion for fiscal 1990, representing 16.1 percent of revenue.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region and distribution channel. Information on revenue by distribution channel is not available. Tables 3 through 5, at the end of this backgrounder, present comprehensive financial information.

BUSINESS SEGMENT STRATEGIC DIRECTION

Computers and Industrial Electronic Systems

NEC's Computers and Industrial Electronic Systems group manufactures, designs, and markets a diverse product line of mainframe computers, personal computers, small business computers, peripherals, software, and industrial electronics systems. In 1990, sales of computers and industrial electronic systems rose 13.1 percent to ¥1.51 trillion, accounting for 43.8 percent of total sales.

NEC introduced a number of new products designed to strengthen and expand its product line in 1990. In

February, NEC released the NEC System 3600 series of large-scale mainframe computers, a series featuring bipolar complementary metal oxide semiconductors (BiCMOS) to increase processing speed and reduce power consumption. NEC also added 12 new models to its popular PC-9800 series. Designed for scientific and engineering calculations, image processing, and communication that requires high-speed processing, the PC-H98 features new extended standard architecture, a 32-bit bus architecture offering a faster data transfer rate. Other PC-9800 series additions include the PC-9801N NOTE laptop and a new addition to the PC PowerMate series that adopts the extended industry standard architecture. In the software market, NEC released SPECDESSIN, a development support system for business-application software that improves efficiency in system design for mainframes.

NEC's PC product line centers around the PC-9800 and PowerMate series. According to Dataquest estimates, the PC-9801 XXXX was the sixth-rated model in the 1990 worldwide desktop computer market, with a market share of 2.09 percent based on 312,000 units shipped. NEC ranked third in the 1990 worldwide desktop market, trailing only IBM Corporation and Apple Computer Inc. NEC garnered 7.85 percent of the market with sales totaling $2.5 billion. The PC-9801 N/NV laptop computer was the leading model in the 1990 worldwide laptop D/C market, bringing in $319.9 million in factory revenue and an 8.11 percent market share. NEC ranked second overall in the 1990 worldwide laptop D/C market with an 18.17 percent market share and $715.6 million in factory revenue. NEC is also active in the computer storage market; Dataquest estimates that NEC ranked sixth in the total rigid disk drive market, with 2.1 million units shipped in 1990 and a 7.1 percent market share. The company's strongest entry in the storage market is 8- to 14-inch disk drives; NEC ranked third in the worldwide market in 1990 with a 13.8 percent market share.

Electron Devices

NEC is active in the production of various memories, microcontrollers, microcomponents, integrated circuits (ICs), gate arrays, and logic devices through its Electron Devices product group. The group's sales increased 7.1 percent to ¥605.9 billion in 1990, comprising 17.6 percent of total revenue. Dataquest estimates that NEC was the world leader in semiconductor sales in 1990, possessing an 8.4 percent market share based on $4.9 billion in factory revenue. NEC was also the worldwide market leader in 1990 in the total IC, the MOS Digital, and the MOS Logic markets with respective market shares of 8.9, 10.8, and 11.3 percent.

During fiscal 1990, NEC began production of 4Mb DRAMs at its manufacturing facilities in Yamaguchi and Kyushu. Production of 4Mb DRAMs also began in 1990 at NEC's new Hiroshima manufacturing plant. Other major accomplishments for the group in 1990 included a joint venture with AT&T Microelectronics of the United States, involving cooperation on semiconductor technologies such as gate arrays; the development of the world's fastest 4Mb SRAM; the introduction of the company's first 32-bit RISC products, the VR3000 and the VR3010; the release of a 75mW helium-neon (He-Ne) laser designed for spectral analysis and holography; and the release of a new gallium arsenide prescaler IC for VSATs that responds at frequencies up to 14 GHz.

Communications Systems and Equipment

Communications systems are an integral part of NEC's vision of "C&C," the company's corporate strategy of integrating computers and communication. NEC's product line in the communications industry includes digital switching systems, fiber-optic and radio transmission systems, space electronics, mobile communications systems, customer premises equipment, and broadcast equipment. The Communications Systems and Equipment group's revenue increased 9.1 percent in 1990 to ¥875 billion, representing 25.4 percent of total revenue.

Dataquest estimates that NEC ranked fifth in the 1990 North American PBX systems market with 309,400 lines installed and a 6.9 percent market share. NEC also ranked third in 1990 in Segment 5 of the North American facsimile equipment market with a 7.8 percent market share.

Major contracts in 1990 included an order for an optical submarine cable system, which will link Japan, Hong Kong, and the Republic of Korea. Two NEC satellites were released in 1990 by Japan's National AeroSpace Development Agency: the Momo-1b marine observation satellite and the Fuji 2 amateur radio satellite. NEC also strengthened its Integrated Services Digital Network (ISDN) product line in fiscal 1990 with the introduction of two new products: the G4 facsimile NEFAX D800, designed to meet the needs of ISDN services primarily in domestic financial institutions and local government, and the Advanced DK Series digital key telephone system.

Home Electronics Products

Home electronics products in NEC's portfolio include color TV receivers and projectors, VCRs, videodisk players, and other small home electronics devices such as electronic diaries. The group's sales increased 16.8 percent to ¥264 billion in 1990, and accounted for 7.7 percent of total revenue. NEC has been active in the introduction of the state-of-the-art broadcast satellite visual audio home entertainment system. In 1990, the PARABOLA series of home-use direct broadcast satellite receiver systems was released, consisting of antennas, tuners, televisions, VCRs, and projection televisions using the new tuning systems.

Other Operations

Other services offered by NEC include value-added network (VAN) information services, electrical connectors, and measuring and testing systems. The Other Operations group was NEC's fastest-rising group in terms of revenue in fiscal 1990. The group's revenue increased 23.7 percent to ¥193 billion, representing 5.6 percent of total revenue.

The VAN information system has continued to gain widespread acceptance both in Japan and internationally. The number of subscribers to the company's PC-based VAN service doubled during 1990; the current total is more than 100,000 subscribers. In 1990, NEC released the C&C Marine VAN Service, which provides ships at sea with the same communications services offered to onshore subscribers. NEC also released the AF-8410P memory testing system in 1990, which boasts the world's highest test rate of 500 MHz.

Further Information

For further information about the company's business segments, please contact the appropriate industry service.

Table 1
Five-Year Corporate Highlights (Millions of U.S. Dollars)

	1986	1987	1988	1989	1990
Five-Year Revenue	13,501	17,159	22,220	23,510	22,179
Percent Change	46.24	27.09	29.49	5.81	(5.66)
Capital Expenditure	1,648	1,326	2,016	2,148	2,176
Percent of Revenue	12.20	7.73	9.07	9.14	9.81
R&D Expenditure	1,836	2,629	3,496	3,657	3,499
Percent of Revenue	13.60	15.32	15.73	15.56	15.78
Number of Employees	95,796	101,227	102,452	104,022	104,022
Revenue ($K)/Employee	140.94	169.51	216.88	226.01	213.22
Net Income	153	103	205	485	539
Percent Change	(42.92)	(32.55)	98.54	137.07	11.26

1990 Fiscal Year	Q1	Q2	Q3	Q4
Quarterly Revenue	N/A	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: NEC Corporation
Annual Reports
Dataquest (October 1991)

Table 2
Revenue by Geographic Region (Percent)

Region	1986	1987	1988	1989	1990
Japan	67.00	72.00	73.00	75.00	74.00
All Others	33.00	28.00	27.00	25.00	26.00

Source: NEC Corporation
Annual Reports
Dataquest (October 1991)

1990 SALES OFFICE LOCATIONS

Japan—More than 300
Overseas—170

MANUFACTURING LOCATIONS

Japan

Ando Electric
Measuring and testing systems
Anelva Corp.
Semiconductor manufacturing equipment, vacuum equipment
Anritsu Corp.
Communications and electronic equipment, measuring instruments
Anten Kogyo
Antennas, related equipment
Japan Aviation Electronics
Electrical connectors, electronic equipment
Kaijo Denki
Industrial marine equipment
NEC Akita
ICs, discrete semiconductor devices
NEC Data Terminals
Computer terminals
NEC Fukui
ICs, discrete semiconductor devices
NEC Fukuoka
ICs
NEC Fukushima
Communications equipment, related components
NEC Gunma
Computers, related systems
NEC Hiroshima
4Mb DRAMs
NEC Home Electronics
TVs, home electronic appliances, electronic parts
NEC Hyogo
Communications equipment parts
NEC Ibaraki
Computers, related systems
NEC Kagoshima
Electronic devices
NEC Kansai
ICs, discrete semiconductor devices, electronic devices
NEC Kofu
Development of computers
NEC Kumamoto
ICs
NEC Kyushu
ICs
NEC Miyagi
Communications equipment, related components
NEC Nagano
Home electrical appliances
NEC Niigata
Computers, related systems
NEC Oita
ICs
NEC Radio & Electronics
Communications equipment, related components
NEC Saitama
Communications equipment, related components
NEC San-ei Instruments
Medical electronic equipment, industrial measuring systems
NEC Shizuoka
Communications equipment, computer terminals
NEC Tohoku
Communications equipment, computer terminals
NEC Toyama
Electronic devices
NEC Yamagata
ICs, discrete semiconductor devices
NEC Yamaguchi
ICs
NEC Yonezawa
Communications equipment, computer terminals
Nico Electronics
Special communications equipment, vending machines
Nippon Avionics
Electronic equipment for aircraft
Nippon Electric Glass
CRTs, other glass products
Nippon Electric Industry
Electrical machinery, precision instruments
Nitsuko Ltd.
Communications equipment and parts
Showa Koki Seizo
Optical precision instruments
Takasago Ltd.
Telephones, communications equipment
Tama Electric
Resistors
Tohoku Metal Industries
Magnetic materials
Tokin Corp.
Magnetic materials, electric parts
Toyo Communication Equipment
Communications equipment and parts

North America

NEC America
Faxes, printers, magnetic disk drives
NEC Electronics
256K DRAMs
NEC Home Electronics
Home electronic products, laptop PCs
NEC Information Systems
Office computers, printers, etc.
NEC Research Institute
R&D center

Europe

NEC Ireland
ICs
NEC Semiconductor, United Kingdom
256K DRAMs
NEC Technologies, United Kingdom
VCRs, printers, car telephones, faxes

Asia/Pacific

NEC Electronics Singapore
Linear ICs, 256K DRAMs
NEC Home Electronics, Malaysia
Home electronic products
NEC Semiconductor, Malaysia
ICs, discrete semiconductor devices
NEC Technologies, Thailand
Telephones
PERNAS NEC Telecommunications, Malaysia
Communications equipment
Siam NEC Company (Thailand)
Color TVs
Taiwan Telecommunications Ind.
Communications equipment

ROW

NEC Australia
ICs
NEC de Mexico
Communications equipment
NEC do Brazil
Telephone switching systems, radio equipment electronics
NEC Home Electronics, Australia
Color TVs
PECOM-NEC, Argentina
Digital electronic switching
Philco Argentina
TVs, radios, etc.

SUBSIDIARIES

Japan

ANELVA Corporation
Ando Electric Company Ltd.
Japan Aviation Electronics Industry Ltd.
NEC Akita Ltd.
NEC Data Terminals Ltd.
NEC Engineering Ltd.
NEC Factory Engineering Ltd.
NEC Field Service Ltd.
NEC Fukui Ltd.
NEC Fukuoka Ltd.
NEC Fukushima Ltd.
NEC Gunma Ltd.
NEC Home Electronics Ltd.
NEC Hyogo Ltd.
NEC Ibaraki Ltd.
NEC Information Service Ltd.
NEC Kagoshima Ltd.
NEC Kansai Ltd.
NEC Kumamoto Ltd.
NEC Kyushu Ltd.
NEC Miyagi Ltd.
NEC Nagano Ltd.
NEC Niigata Ltd.
NEC Oita Ltd.
NEC Radio & Electronics Ltd.
NEC Saitama Ltd.
NEC San-ei Instruments Ltd.
NEC Shizuoka Ltd.
NEC Software Ltd.
NEC System Integration & Construction Ltd.
NEC Tohoku Ltd.
NEC-Toshiba Information Systems Inc.
NEC Toyama Ltd.
NEC Warehouse and Distribution Ltd.
NEC Yamagata Ltd.
NEC Yamaguchi Ltd.
NEC Yonezawa Ltd.
Nippon Avionics Co. Ltd.

North America

HNSX Supercomputers Inc. (United States)
NEC America Inc. (United States)
NEC Business Communication Systems (United States)
NEC Canada Inc. (Canada)
NEC Electronics Inc. (United States)
NEC Industries Inc. (United States)
NEC Logistics America Inc. (United States)
NEC Research Institute Inc. (United States)

NEC USA Inc. (United States)
NMI Corporation (United States)

Europe

NEC Business Systems (Italiana) s.r.l. (Italy)
NEC Deutschland GmbH (Germany)
NEC Electronics (Europe) GmbH (Germany)
NEC Electronics (France) S.A. (France)
NEC Electronics (Germany) GmbH (Germany)
NEC Electronics Italiana s.r.l. (Italy)
NEC Electronics (UK) Limited (United Kingdom)
NEC Finland OY (Finland)
NEC France S.A. (France)
NEC Electronics GmbH (West Germany)
NEC Iberia S.A. (Spain)
NEC Industries Netherlands B.V. (Netherlands)
NEC Scandinavia AB (Sweden)
NEC Semiconductors Ireland Limited (Ireland)
NEC Semiconductors (UK) Limited (United Kingdom)
NEC Technologies (UK) Ltd. (United Kingdom)
NEC (UK) Ltd. (United Kingdom)

ROW

Home Electronics Co. Ltd. (Thailand)
NEC Argentina S.A. (Argentina)
NEC Australia Pty. Ltd. (Australia)
NEC do Brasil S.A. (Brazil)
NEC Chile S.A. (Chile)
NEC Colombia S.A. (Colombia)
NEC Communication Systems (Thailand) Co. Ltd. (Thailand)
NEC Customer Services (Australia) Pty. Ltd. (Australia)
NEC Electronics Hong Kong Limited (Hong Kong)
NEC Electronics Singapore Pte. Ltd. (Singapore)
NEC Electronics Taiwan Limited (Taiwan)
NEC Engineering (Thailand) Co. Ltd. (Thailand)
NEC Home Electronics Australia Pty. Ltd. (Australia)
NEC Home Electronics (Malaysia) Sdn. Bhd. (Malaysia)
NEC Hong Kong Limited (Hong Kong)
NEC Information Systems Australia Pty. Ltd. (Australia)
NEC de Mexico, S.A. de C.V. (Mexico)
NEC Nigeria Limited (Nigeria)
NEC Sales (Malaysia) Sdn. Bhd. (Malaysia)
NEC Saudi Arabia Limited (Saudi Arabia)
NEC Semiconductors Sdn. Bhd. (Malaysia)
NEC Singapore Pte. Ltd. (Singapore)
NEC Taiwan Ltd. (Taiwan)
NEC Technologies Hong Kong Limited (Hong Kong)
NEC Technologies Philippines Inc. (Philippines)
NEC Technologies (Thailand) Co. Ltd. (Thailand)
NEC (Thailand) Ltd. (Thailand)
NEC de Venezuela (Venezuela)
New Zealand Telecommunications Systems Support Centre Limited (New Zealand)
PERNAS NEC Telecommunications Sdn. Bhd. (Malaysia)
Siam NEC Co. Ltd. (Thailand)
Taiwan Telecommunication Industry Co. Ltd. (Taiwan)
Tianjin NEC Telecommunications Engineering Co. Ltd. (China)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1991

AT&T Corporation

The two companies agreed to jointly produce digital car telephone systems targeted at Japanese communications companies. In a separate agreement, the two companies also agreed to jointly develop 0.35-micron CMOS technologies.

Robert Bosch GmbH

The two companies signed an agreement giving NEC worldwide rights to design, develop, and market large-scale integrated circuits that conform with Bosch's Controller Area Network specification.

DEC Corporation

NEC joined DEC's PowerFrame Synergy Programme, a union of 23 companies designed to promote industry standards in ASIC design.

IBM Japan Ltd.

NEC and IBM Japan signed an agreement whereby IBM Japan will market NEC's SX-3 supercomputer.

NTT Corporation

NEC and NTT signed a joint technology agreement dealing with the joint development of a digital portable telephone with a volume of only 195cc.

Otsuka Shokai and Matra Datavision K.K.

NEC and Otsuka Shokai made an agreement with Matra Datavision K.K., under which NEC and Otsuka Shokai will market a version of Matra Datavision's EUCLID-IS 3-D mechanical CAD/CAM/CAE software.

Sanyo Corporation
Sanyo entered the UNIX engineering market by signing a technology agreement with NEC that allows Sanyo to sell NEC's EWS4800 Series engineering workstations.

Valid Logic Systems Inc.
Valid Logic Systems signed a $1 million technology development agreement with NEC for the development of analog IC tools.

1990

Hughes Aircraft Company
Hughes Aircraft licensed NEC to build C-Nite night-attack fire control equipment for Japanese Ground Self Defense Force AH-1S antitank helicopters.

Philips NV
NEC and Philips signed a licensing agreement to manufacture and market chips using Philips I(2)C-bus system technology.

Texas Instruments Inc. (TI)
NEC and TI renewed their five-year semiconductor patent cross-licensing agreement.

1989

MIPS Computer Systems Inc.
MIPS entered into a royalty-bearing technology exchange with Siemens and NEC for its RISC MPUs. NEC plans to manufacture the R2000A and R3000 devices and peripherals in Japan and Europe. Siemens will manufacture in Europe.

1988

Optoelectronics Research Labs
Photodiodes

Summit Microcircuits
64K/256K fast SRAMS

Enabling Technologies Inc.
Enabling Technologies entered into a strategic alliance with NEC Home Electronics (United States) to develop products and explore new technologies in graphics manipulation, animation, and optical media.

British Telecom U.K.
NEC's U.K. subsidiary, NEC Technologies, manufactures jointly developed car telephones for British Telecom.

Honeywell Bull
NEC Computer Systems and Honeywell Bull will cooperate in R&D of artificial intelligence.

Corvus Systems
NEC and Corvus Systems are involved in joint development of a CMOS single-chip controller.

Digital Research Incorporated
NEC has a joint-marketing agreement with Digital Research regarding a CP/M operating system for the V Series.

Oki
NEC has developed a CMOS signal processor (uPD77C20) with Oki.

Sharp Electronics Corporation
NEC and Sharp agreed to jointly develop and produce V Series microperipherals. Under the agreement, NEC will provide its original microperipherals to Sharp on an OEM basis, and Sharp will develop new microprocessors for NEC.

Sharp and Sony
Sharp and Sony have been announced as second sources for the NEC V Series.

MERGERS AND ACQUISITIONS

Information is not available.

KEY OFFICERS

Kenzo Nakamura
Chairman of the board

Tadahiro Sekimoto
President

Yoshiteru Ishii
Senior executive vice president

Koji Maeda
Senior executive vice president

Toshiro Kunihiro
Senior executive vice president

PRINCIPAL INVESTORS

Sumitomo Life Insurance
Sumitomo Trust & Banking
Sumitomo Bank
Mitsubishi Trust & Banking
Nippon Life Insurance
Dai-ichi Mutual Life Insurance
Sumitomo Marine & Fire Insurance
Toyo Trust & Banking
Sumitomo Electric Industries
Sumitomo Corporation

Table 3
Balance Sheet
Fiscal Year Ending March 31
(Millions of U.S. Dollars)

Balance Sheet	1986	1987	1988	1989	1990
Cash	822.6	1,229.0	1,685.9	2,930.5	2,230.8
Receivables	3,635.7	4,670.8	5,987.3	6,568.7	6,329.5
Marketable Securities	437.0	558.8	404.9	442.9	424.3
Inventory	3,087.9	4,100.2	5,243.0	5,140.1	4,657.6
Other Current Assets	748.1	1,493.4	1,436.5	889.2	516.6
Total Current Assets	8,731.3	12,052.2	14,757.6	15,971.4	14,158.8
Long-Term Receivables and Investments	1,563.9	1,662.1	2,101.1	2,247.4	1,970.4
Net Property, Plants	3,621.0	4,395.2	5,490.5	5,787.7	6,061.6
Other Assets	612.8	834.9	1,077.5	1,154.6	1,125.6
Total Assets	14,529.0	18,944.4	23,426.7	25,161.1	23,316.4
Total Current Liabilities	7,987.6	10,162.9	12,878.5	13,234.8	12,408.9
Long-Term Debt	3,579.7	5,052.8	5,480.4	6,431.1	5,478.8
Other Liabilities	163.7	206.4	283.9	311.9	332.6
Total Liabilities	11,731.0	15,422.1	18,642.8	19,977.8	18,220.3
Common Stock	600.0	784.3	1,184.9	1,202.8	1,109.8
Additional Paid-In Capital	953.6	1220.0	1716.7	1842.9	1,700.9
Other Equity	44.9	49.1	64.0	75.1	289.8
Retained Earnings	1,199.7	1,470.0	1,818.8	2,068.9	1,995.7
Treasury Stock	(0.1)	(0.8)	(0.2)	(6.5)	(0.1)
Total Shareholders' Equity	2,798.2	3,523.4	4,784.4	5,189.7	5,096.2
Total Liabilities and Shareholders' Equity	14,529.1	18,944.7	23,427.0	25,161.0	23,316.4

Source: NEC Corporation
Annual Reports
Dataquest (October 1991)

Table 4
Consolidated Income Statement
Fiscal Year Ending March 31
(Millions of U.S. Dollars, except Per Share Data)

Consolidated Income Statement	1986	1987	1988	1989	1990
Revenue	13,501.3	17,159.1	22,219.5	23,509.5	22,179.2
Cost of Sales	8,868.7	1,1654.5	15,120.0	15,778.2	14,451.6
R&D Expense	1,836.2	2,629.2	3,495.7	3,657.4	3,499.3
SG&A Expense	3,422.9	4,492.3	5,863.0	6,011.2	5,869.9
Capital Expense	1,647.7	1,326.2	2,016.0	2,148.3	2,175.8
Pretax Income	661.9	397.6	566.0	993.9	1,099.6
Pretax Margin (%)	4.90	2.32	2.55	4.23	4.96
Effective Tax Rate (%)	58.00	58.00	56.00	56.00	54.00
Net Income	152.7	103.0	204.5	484.8	539.4
Shares Outstanding, Millions	1,387	1,408	1,469	1,494	1,520
Per Share Data					
Earnings	0.11	0.07	0.14	0.31	0.33
Dividend	0.05	0.06	0.07	0.07	0.07
Book Value	2.02	2.50	3.26	3.47	3.35
Exchange Rate (U.S.$1=¥)	178	146	124	133	158

Source: NEC Corporation
Annual Reports
Dataquest (October 1991)

Table 5
Key Financial Ratios
Fiscal Year Ending March 31

Key Financial Ratios	1986	1987	1988	1989	1990
Liquidity					
Current (Times)	1.09	1.19	1.15	1.21	1.14
Total Assets/Equity (%)	519.23	537.67	489.65	484.83	457.53
Current Liabilities/Equity (%)	285.45	288.44	269.18	255.02	243.49
Total Liabilities/Equity (%)	419.23	437.71	389.66	384.95	357.53
Profitability (%)					
Return on Assets	1.05	0.54	0.87	1.93	2.31
Return on Equity	4.56	2.92	4.27	9.34	10.58
Profit Margin	1.13	0.60	0.92	2.06	2.43
Other Key Ratios					
R&D Spending % of Revenue	13.60	15.32	15.73	15.56	15.78
Capital Spending % of Revenue	12.20	7.73	9.07	9.14	9.81
Employees	95,796	101,227	102,452	104,022	104,022
Revenue ($K)/Employee	140.94	169.51	216.88	226.01	213.22
Capital Spending % of Assets	11.34	7.00	8.61	8.54	9.33
Exchange Rate (U.S.$1=¥)	178	146	124	133	158

Source: NEC Corporation
Annual Reports
Dataquest (October 1991)

NEC Corporation

33-1 Shiba 5-chome
Minato-ku, Tokyo 108, Japan
Telephone: (03) 454-1111
Fax: (03) 452-6351
Dun's Number: 00-183-6014

Date Founded: July 1899

CORPORATE STRATEGIC DIRECTION

NEC Corporation (known as Nippon Electric Company, Ltd., prior to April 1, 1983) was founded in 1899 as a manufacturer of telephone sets and switchboards. NEC is a leading global supplier of a broad range of communications systems, computer and electronic systems, electronic devices, consumer electronics, and information services.

NEC is divided into five product groups:

- Communications Systems and Equipment (26 percent of net sales)—Carrier transmission, microwave and satellite communications, and mobile communications equipment; digital central office switching systems; facsimiles
- Computers and Industrial Electronic Systems (43 percent of net sales)—Mainframe, personal, and small business computers; building automation and communications network control systems
- Electronic Devices (19 percent of net sales)—Memories, microcomputers and software, linear ICs, gate arrays, standard cells
- Home Electronics Products (7 percent of net sales)—Color TV receivers and projectors, VCRs, videodisc players
- Other Operations (5 percent of net sales)—VAN services, electrical connectors, semiconductor equipment, measuring and testing systems

NEC reported consolidated revenue for fiscal year ending March 31, 1989, of $23.5 billion,* up 6 percent from fiscal 1988. Net income rose 137 percent from $205 million in fiscal 1988 to $485 million in fiscal 1989.

*All dollar amounts are in U.S. dollars.

Capital expenditures increased during fiscal 1989 to $2.1 billion, or 9.1 percent of total revenue. Research and development expenditures totaled $3.7 billion for fiscal 1989, representing 15.5 percent of revenue.

In order to increase its market penetration, NEC markets its products aggressively. Dataquest believes that 70 to 80 percent of the Company's products are sold domestically (in Japan) through distributors. NEC has 10 distributors in Japan, the top 4 of which are Ryosan, Sanshin, Satori, and Shinko. Approximately 22 percent of NEC's semiconductor production is consumed internally.

Overseas sales accounted for 25 percent of total sales in fiscal 1989, down from 27 percent and 28 percent in fiscal years 1988 and 1987, respectively.

More detailed information is available in Tables 1 through 3, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region and distribution channel. Table 4, a comprehensive financial statement, is at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Semiconductors

For the past two years, NEC has maintained its position as the world leader in semiconductor sales, with approximately 9 percent of the market and $4.5 billion in semiconductor revenue.

Dataquest estimates that 69 percent of NEC's 1988 semiconductor sales were MOS devices, or $3.1 billion in revenue. The largest product family in 1988 was again MOS memory, with sales of $1.5 billion. MOS memory sales grew 76.7 percent, MOS micro sales grew 39.6 percent, and MOS logic sales grew 40.0 percent in 1988. Optoelectronics sales increased approximately 60.0 percent, from $55 million in fiscal 1987 to $88 million in fiscal 1988.

Computer Systems

During fiscal year ending 1989, 43 percent of NEC's revenue came from products in the Computers and Industrial Electronic Systems Group.

Dataquest estimates that in 1988, NEC slipped one spot to fourth among PC vendors, behind third-ranked Compaq Computers. NEC added six new PC models during 1988 and 1989, including the UltraLite laptop computer; the PowerMate Portable SX computer, the first portable to use Intel's 386SX processor; the ProSpeed 386 modular portable PC, which provides 386-based power and full desktop expandability; the ProSpeed 286 laptop computer; and the PowerMate Portable Plus computer, a 286-based portable. The sixth model, introduced in September 1989, is the ProSpeed CSX personal computer, which is the first color laptop computer available for purchase in the United States.

The newest addition to NEC's supercomputer line was introduced in April 1989, the SX-3. The SX-3 is said to be up to eight times faster than U.S.-made supercomputers.

During 1988, NEC introduced the 3100 and 3050 series of small business computers.

Telecommunications

NEC holds the number five market share position in data communications. The Company is one of the largest suppliers of communications equipment to Nippon Telegraph and Telephone Corporation (NTT), formerly Japan's domestic telecommunications monopoly, as well as to the new common carriers (NCCs) that were created as a result of Japan's market liberalization.

Computer Storage

NEC ranked ninth in the 1988 3.5-inch disk drive market with less than 2 percent of the market. The top three players in this market, IBM, Miniscribe, and Conner, together held 60 percent of the market.

Printers

NEC's overall ranking for 1988 in the printer market by units shipped was eleventh, behind Citizen, Hewlett-Packard, and Seikosha.

Further Information

For further information about the Company's business segments, please contact the appropriate industry service.

Table 1
Five-Year Corporate Highlights (Millions of U.S. Dollars)

	1985	1986	1987	1988	1989
Five-Year Revenue	$9,232	$13,501	$17,159	$22,220	$23,510
Percent Change	-	46.24	27.09	29.49	5.81
Capital Expenditure	$1,472	$1,648	$1,326	$2,016	$2,148
Percent of Revenue	15.94	12.20	7.73	9.07	9.14
R&D Expenditure	$1,144	$1,836	$2,629	$3,496	$3,657
Percent of Revenue	12.39	13.60	15.32	15.73	15.56
Number of Employees	90,102	95,796	101,227	102,452	104,022
Revenue ($K)/Employee	$102.46	$140.94	$169.51	$216.88	$226.01
Net Income	$268	$153	$103	$205	$485
Percent Change	-	(42.92)	(32.55)	98.54	137.07

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	N/A	N/A	N/A	N/A
Quarterly Profit	N/A	N/A	N/A	N/A

N/A = Not Available

Source: NEC Corporation
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1985	1986	1987	1988	1989
Japan	66.00	67.00	72.00	73.00	75.00
All Others	34.00	33.00	28.00	27.00	25.00

Source: Dataquest (1990)

Table 3
Revenue by Distribution Channel (Percent)

Channel	1988
Direct Sales	N/A
Indirect Sales	N/A

N/A = Not Available

Source: Dataquest (1990)

1988 SALES OFFICE LOCATIONS

Japan—More than 200
Overseas—170

MANUFACTURING LOCATIONS

Japan

Ando Electric
  Measuring and testing systems
Anelva Corp.
  Semiconductor manufacturing equipment, vacuum equipment
Anritsu Corp.
  Communications and electronic equipment, measuring instruments
Anten Kogyo
  Antennas, related equipment
Japan Aviation Electronics
  Electrical connectors, electronic equipment
Kaijo Denki
  Industrial marine equipment
NEC Akita
  ICs, discrete semiconductor devices
NEC Data Terminals
  Computer terminals
NEC Fukui
  ICs, discrete semiconductor devices
NEC Fukuoka
  ICs
NEC Fukushima
  Communications equipment, related components
NEC Gunma
  Computers, related systems
NEC Hiroshima
  4Mb DRAMs
NEC Home Electronics
  TVs, home electronic appliances, electronic parts
NEC Hyogo
  Communications equipment parts
NEC Ibaraki
  Computers, related systems
NEC Kagoshima
  Electronic devices
NEC Kansai
  ICs, discrete semiconductor devices, electronic devices
NEC Kofu
  Development of computers
NEC Kumamoto
  ICs
NEC Kyushu
  ICs
NEC Miyagi
  Communications equipment, related components
NEC Nagano
  Home electrical appliances
NEC Niigata
  Computers, related systems
NEC Oita
  ICs
NEC Radio & Electronics
  Communications equipment, related components
NEC Saitama
  Communications equipment, related components
NEC San-ei Instruments
  Medical electronic equipment, industrial measuring systems
NEC Shizuoka
  Communications equipment, computer terminals
NEC Tohoku
  Communications equipment, computer terminals
NEC Toyama
  Electronic devices
NEC Yamagata
  ICs, discrete semiconductor devices
NEC Yamaguchi
  ICs
NEC Yonezawa
  Communications equipment, computer terminals
Nico Electronics
  Special communications equip, vending machines
Nippon Avionics
  Electronic equipment for aircraft
Nippon Electric Glass
  CRTs, other glass products
Nippon Electric Industry
  Electrical machinery, precision instruments
Nitsuko Ltd.
  Communications equipment and parts
Showa Koki Seizo
  Optical precision instruments
Takasago Ltd.
  Telephones, communications equipment
Tama Electric
  Resistors

Tohoku Metal Industries
  Magnetic materials
Tokin Corp.
  Magnetic materials, electric parts
Toyo Communication Equipment.
  Communications equipment and parts

North America

NEC America
  Faxes, printers, magnetic disk drives
NEC Electronics
  256K DRAMs
NEC Home Electronics
  Home electronic products, laptop PCs
NEC Information Systems
  Office computers, printers, etc.
NEC Research Institute
  R&D center

Europe

NEC Ireland
  ICs
NEC Semiconductor, United Kingdom
  256K DRAMs
NEC Technologies, United Kingdom
  VCRs, printers, car telephones, Faxes

Asia/Pacific

NEC Electronics Singapore
  Linear ICs, 256K DRAMs
NEC Home Electronics, Malaysia
  Home electronic products
NEC Semiconductor, Malaysia
  ICs, discrete semiconductor devices
NEC Technologies, Thailand
  Telephones
PERNAS NEC Telecommunications, Malaysia
  Communications equipment
Siam NEC Company (Thailand)
  Color TVs
Taiwan Telecommunications Ind.
  Communications equipment

ROW

NEC Australia
  ICs
NEC de Mexico
  Communications equipment
NEC do Brazil
  Telephone switching systems, radio equipment electronics
NEC Home Electronics, Australia
  Color TVs
PECOM-NEC, Argentina
  Digital electronic switching
Philco Argentina
  TVs, radios, etc.

SUBSIDIARIES

Japan

ANELVA Corporation
Ando Electric Company, Ltd.
Japan Aviation Electronics Industry, Ltd.
NEC Akita, Ltd.
NEC Data Terminals, Ltd.
NEC Engineering, Ltd.
NEC Factory Engineering, Ltd.
NEC Field Service, Ltd.
NEC Fukui, Ltd.
NEC Fukuoka, Ltd.
NEC Fukushima, Ltd.
NEC Gunma, Ltd.
NEC Home Electronics, Ltd.
NEC Hyogo, Ltd.
NEC Ibaraki, Ltd.
NEC Information Service, Ltd.
NEC Kagoshima, Ltd.
NEC Kansai, Ltd.
NEC Kumamoto, Ltd.
NEC Kyushu, Ltd.
NEC Miyagi, Ltd.
NEC Nagano, Ltd.
NEC Niigata, Ltd.
NEC Oita, Ltd.
NEC Radio & Electronics, Ltd.
NEC Saitama, Ltd.
NEC San-ei Instruments, Ltd.
NEC Shizuoka, Ltd.
NEC Software, Ltd.
NEC System Integration & Construction, Ltd.
NEC Tohoku, Ltd.
NEC-Toshiba Information Systems Inc.
NEC Toyama, Ltd.
NEC Warehouse and Distribution, Ltd.
NEC Yamagata, Ltd.
NEC Yamaguchi, Ltd.
NEC Yonezawa, Ltd.
Nippon Avionics Co., Ltd.

North America

NEC America, Inc. (United States)
NEC Electronics, Inc. (United States)
NEC Home Electronics, Inc. (United States)
NEC Industries, Inc. (United States)
NEC Information Systems, Inc. (United States)

Europe

NEC Deutschland GmbH (West Germany)
NEC Electronics GmbH (West Germany)
NEC Semiconductors (United Kingdom) Limited (United Kingdom)
NEC Semiconductors Ireland Limited (Ireland)
NEC (UK) Ltd. (United Kingdom)

Asia/Pacific

NEC Australia Pty. Ltd. (Australia)
NEC Electronics Singapore Pte. Ltd. (Singapore)
NEC Semiconductors Sdn. Bhd. (Malaysia)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

January 1989

MIPS Computer Systems
Siemens MIPS entered into a royalty-bearing technology exchange with Siemens and NEC for its RISC MPUs. NEC plans to manufacture the R2000A and R3000 devices and peripherals in Japan and Europe. Siemens will manufacture in Europe.

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Photodiodes

November 1988

Summit Microcircuits
64K/256K fast SRAMS

April 1988

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NEC Computer Systems and Honeywell Bull will cooperate in R&D of artificial intelligence.

Corvus Systems
NEC and Corvus Systems are involved in joint development of a CMOS single-chip controller.

Digital Research
NEC has a joint-marketing agreement with Digital Research regarding a CP/M operating system for the V Series.

Oki
NEC has developed a CMOS signal processor (uPD77C20) with Oki.

Sharp
NEC and Sharp agreed to jointly develop and produce V Series microperipherals. Under the agreement, NEC will provide its original microperipherals to Sharp on an OEM basis, and Sharp will develop new microprocessors for NEC.

Sharp and Sony
Sharp and Sony have been announced as second sources for the NEC V Series.

November 1987

Matra-Harris
16-bit single-chip MCUs

July 1987

SMC
Peripheral controllers

Cross-Licensing Partners, Patents, and Contract Terms

IBM Corporation
Information processing systems, N/A-12/90

Technology Export, Patents, and Contract Terms

Unisys Corporation
Optical character readers, 6/81-6/89

Honeywell Bull
Supercomputers, 3/84-3/94

Standard Microsystems
Controllers for microcomputers, 7/88-N/A

Indian Telephone Industries

Bharat Electronics
Digital microwave equipment, 8/88-N/A

China
Large-capacity microwave equipment, 9/88-N/A

KEY OFFICERS

Koji Kobayashi
Chairman emeritus

Atsuyoshi Ouchi
Chairman of the board

Kenzo Nakamura
Vice chairman of the board

Tadahiro Sekimoto
President

Yoshiteru Ishii
Senior executive vice president

Koji Maeda
Senior executive vice president

Toshio Egashira
Senior executive vice president

Shozo Shimizu
Senior executive vice president

PRINCIPAL INVESTORS

Sumitomo Life Insurance—7.2 percent
Sumitomo Trust & Banking—5.0 percent
Sumitomo Bank—4.8 percent
Mitsubishi Trust & Banking—3.5 percent
Nippon Life Insurance—3.3 percent
Dai-ichi Mutual Life Insurance—3.1 percent
Sumitomo Marine & Fire Insurance—2.7 percent
Toyo Trust & Banking—2.7 percent
Sumitomo Electric Industries—2.3 percent
Sumitomo Corporation—2.3 percent
Foreign-owned—7.0 percent

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of U.S. Dollars, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$7,087.3	$8,731.3	$12,052.2	$14,757.6	$15,971.4
Cash	533.0	822.6	1,229.0	1,685.9	2,930.5
Receivables	2,615.7	3,635.7	4,670.8	5,987.3	6,568.7
Marketable Securities	1,214.4	437.0	558.8	404.9	442.9
Inventory	2,096.4	3,087.9	4,100.2	5,243.0	5,140.1
Other Current Assets	627.8	748.1	1,493.4	1,436.5	889.2
Long-Term Receivables and Investments	$1,070.7	$1,563.9	$1,662.1	$2,101.1	$2,247.4
Net Property, Plants	$2,204.4	$3,621.0	$4,395.2	$5,490.5	$5,787.7
Other Assets	$439.0	$612.8	$834.9	$1,077.5	$1,154.6
Total Assets	$10,801.4	$14,529.0	$18,944.4	$23,426.7	$25,161.1
Total Current Liabilities	$6,280.4	$7,987.6	$10,162.9	$12,878.5	$13,234.8
Long-Term Debt	$2,527.4	$3,579.7	$5,052.8	$5,480.4	$6,431.1
Other Liabilities	$92.3	$163.7	$206.4	$283.9	$311.9
Total Liabilities	$8,900.1	$11,731.0	$15,422.1	$18,642.8	$19,977.8
Total Shareholders' Equity	$1,901.5	$2,798.1	$3,522.6	$4,784.2	$5,183.2
Common Stock	405.5	600.0	784.3	1,184.9	1,202.8
Additional Paid-In Capital	646.2	953.6	1220.0	1716.7	1842.9
Other Equity	52.9	44.9	49.1	64.0	75.1
Retained Earnings	797.4	1199.7	1470.0	1818.8	2068.9
Treasury Stock	(0.5)	(0.1)	(0.8)	(0.2)	(6.5)
Total Liabilities and Shareholders' Equity	$10,801.6	$14,529.1	$18,944.7	$23,427.0	$25,161.0
Income Statement	**1985**	**1986**	**1987**	**1988**	**1989**
Revenue	$9,232.0	$13,501.3	$17,159.1	$22,219.5	$23,509.5
Cost of Sales	$6,038.2	$8,868.7	$1,1654.5	$15,120.0	$15,778.2
R&D Expense	$1,144.2	$1,836.2	$2,629.2	$3,495.7	$3,657.4
SG&A Expense	$2,250.3	$3,422.9	$4,492.3	$5,863.0	$6,011.2
Capital Expense	$1,472.0	$1,647.7	$1,326.2	$2,016.0	$2,148.3
Pretax Income	$555.9	$661.9	$397.6	$566.0	$993.9
Pretax Margin (%)	6.02	4.90	2.32	2.55	4.23
Effective Tax Rate (%)	58.00	58.00	58.00	56.00	56.00
Net Income	$267.5	$152.7	$103.0	$204.5	$484.8
Shares Outstanding, Millions	1,177	1,309	1,380	1,398	1,438
Per Share Data					
Earnings	$0.19	$0.11	$0.07	$0.14	$0.31
Dividends	$0.03	$0.05	$0.06	$0.07	$0.07
Book Value	$1.62	$2.14	$2.55	$3.42	$3.60

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of U.S. Dollars, except Per Share Data)

Key Financial Ratios	1985	1986	1987	1988	1989
Liquidity					
Current (Times)	1.13	1.09	1.19	1.15	1.21
Quick (Times)	0.79	0.71	0.78	0.74	0.82
Fixed Assets/Equity (%)	115.93	129.41	124.77	114.76	111.66
Current Liabilities/Equity (%)	330.29	285.47	288.51	269.19	255.34
Total Liabilities/Equity (%)	468.06	419.25	437.80	389.67	385.43
Profitability (%)					
Return on Assets	-	1.21	0.62	0.97	2.00
Return on Equity	-	6.50	3.26	4.92	9.73
Profit Margin	2.90	1.13	0.60	0.92	2.06
Other Key Ratios					
R&D Spending % of Revenue	12.39	13.60	15.32	15.73	15.56
Capital Spending % of Revenue	15.94	12.20	7.73	9.07	9.14
Employees	90,102	95,796	101,227	102,452	104,022
Revenues($K)/Employee	$102.46	$140.94	$169.51	$216.88	$226.01
Capital Spending % of Assets	13.63	11.34	7.00	8.61	8.54

Source: NEC Corporation
Annual Reports
Dataquest (1990)

Nippon Telegraph and Telephone Corporation

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Chiyoda-ku, Tokyo 100, Japan
Telephone: 011-81 (3) 509-3101
Fax: 011-81 (3) 509-9104
Dun's Number: 69-053-5000

Date Founded: 1952

CORPORATE STRATEGIC DIRECTION

Nippon Telegraph and Telephone Public Corporation, incorporated in 1952 by the Nippon Telegraph and Telephone Public Corporation Law, was until 1985 the Japanese public telecommunications services company. The Public Corporation took over the telephone, telegraph, and related telecommunications services from the central government. Control of Nippon Telegraph and Telephone Public Corporation's business and financial activities was exercised by various governmental bodies, with principal supervision provided by the Ministry of Posts and Telecommunications (MPT).

Nippon Telegraph and Telephone Public Corporation remained a public company until 1985, at which point all assets and liabilities were transferred to Nippon Telegraph and Telephone Corporation (NTT). All shares of stock in the Public Corporation were transferred to the Japanese government upon dissolution of the Public Corporation. Since incorporation, the government of Japan has sold 5.4 million shares (32.5 percent of outstanding shares) of the Company's common stock to the general public. In *Business Week*'s 1989 rankings of the world's top 1,000 companies, NTT's market value was estimated at US$163.86 billion, making it the largest company in the world.

NTT is a telecommunications service company primarily involved in telephone, telegraph, leased circuit, data communications facility, digital data exchange, paging, and other services. The Company is also involved in various other related services, including sales of terminal equipment, telecommunications consulting, and operator information. The Company received 79.1 percent of its revenue from its primary telecommunications services in the fiscal year ending March 31, 1989, which is a decrease of 1.3 percent from the previous year.

Through its head office in Tokyo, NTT controls 11 Telecommunications Bureaus. These bureaus oversee field administrative division offices under five classifications: telecommunications, urban telecommunications, area telecommunications, carrier communications, and radio communications. Under these divisions, offices furnish telecommunications services directly to customers. NTT does not market its computer systems directly; revenue is generated through subscriptions and equipment leasing.

NTT operates in a highly regulated industry. The Japanese government began to deregulate the telecommunications services industry in 1986 when it opened the leased circuits services market. Subsequently, it opened the long distance telephone and paging services markets in 1987 and the mobile telephone services market in 1988. To operate in the industry, a new entrant must first seek approval from the MPT. Thirty-three Type I carriers (those who have their own telecommunications circuits and facilities) have been approved by the MPT.

Although NTT is a private company, the Japanese government maintains control of 67.5 percent of the outstanding stock. NTT must still apply to the MPT for approval of its business operation plan for the upcoming year. Furthermore, the government currently is considering a proposal to split NTT into separate operating companies. A five-year study has been undertaken to evaluate the effects of a divestiture and determine NTT's future structure.

Two main arguments support divesting NTT. The first is that NTT hinders fair and effective competition in the market through its established position. Currently, for an alternate long distance carrier to access a local loop, it must obtain services from NTT, which has a monopoly on the local telecommunications service market. The second argument is that NTT suffers from inherent management inefficiencies due to its size.

To combat the possibility of a divestiture, NTT has implemented an unusual corporate strategy. NTT is offering technical advice to its competitors to increase the competitiveness within the industry. The desired outcome of this strategy is that in five years, the telecommunications industry will display sufficient competition so as not to warrant a divestiture. Currently, Daini Denden, Japan Telecom, and Teleway Japan, the three largest long distance carriers other than NTT, together control 6 percent of the $20 billion domestic market.

To combat the second argument favoring divestiture, the Company has undertaken strategies to streamline the administrative structure, reduce rates, and divest Company interests. In April 1989, NTT reduced the number of administrative levels from four (headquarters, regional headquarters, district headquarters, and telephone offices) to three (headquarters, telecommunications service districts, and branches). Services were also integrated at the individual branches.

The Company also has been consistently reducing its service rates. In February, it reduced its long distance rates for the second year in a row and lowered charges for adjacent area telephone calls. Fees for pocket pagers and leased circuits were also reduced during 1989 by an average of 10 percent.

Lastly, by establishing affiliates, subsidiaries, and associated companies, NTT hopes to secure diversified sources of income. Since privatization, NTT has set up 131 companies. The most recent establishments have been through joint ventures with Battelle Memorial Institute, IBM Japan, Ltd., ITT-WD, and Moli Energy Ltd. of Canada. Through these joint ventures, NTT has expanded its interest in telecommunications-related businesses and has entered various other industries, such as lithium batteries and photonic research.

Additional corporate goals include the following:

- Digitize all telecommunications systems in order to implement Integrated Services Digital Network (ISDN) throughout Japan in the near future
- Introduce INS-Net 1500, the first commercial primary rate service in Japan
- Drastically increase the overall R&D expenditure over the next three years
- Further integrate the administrative structure, specifically the management, sales networks, and customer service operations in cellular phones and pocket pagers

Operating revenue in fiscal year ending March 31, 1989, continued to grow, but was overshadowed by efficiency-building expenses. Operating revenue increased 3.2 percent to ¥5,841.9 billion (US$45,551 million) in fiscal 1989 from ¥5,662.0 billion (US$41,020 million) in fiscal 1988. (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) The gain reflected favorable economic conditions and solid growth in the demand for leased circuit, digital data exchange (DDX), data communications facility, and telegraph services. Net income decreased 1.3 percent to ¥263.6 billion (US$2,055 million) in fiscal 1989 from ¥267.2 billion (US$1,936 million) in fiscal 1988.

NTT's operating revenue and profits for fiscal 1990 were released prior to NTT's fiscal 1990 Annual Report. Operating revenue increased 56.7 percent to ¥9,154.0 billion (US$64,254 million), while operating profits increased 23 percent to ¥273.7 billion (US$1,921 million). For 1990, Dataquest estimates that NTT acquired a 9 percent share of the worldwide telecommunications market and a 90 percent share of the Japanese telecommunications market, thereby ranking as the largest (by revenue) telecommunications company in the world.

R&D expenditure increased 22 percent to ¥221.7 billion (US$1.7 billion) in fiscal 1989 from ¥181.7 billion (US$1.3 billion) in fiscal 1988. As a percentage of revenue, R&D expenditure was 3.8 percent and 3.2 percent in fiscal 1989 and fiscal 1988, respectively. R&D efforts in 1989 focused on digital network technologies, intelligent processing technologies, nanoelectronics, and optoelectronics.

NTT's R&D system consists of 11 functionally grouped telecommunications laboratories, applied research sections in each of NTT's business divisions, and development centers for technology advances. The R&D system is coordinated by the Research and Development Headquarters. In all, there are approximately 6,000 scientists, engineers, and technicians.

More detailed information is available in Table 1, which appears after "Business Segment Strategic Direction" and presents corporate highlights. Information on revenue by region and distribution channel is not available. Tables 2 and 3, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Telephone Services

Operating revenue for the telephone services increased 1.5 percent to ¥4,622.7 billion (US$36.0 billion) in fiscal 1989 from ¥4,553.8 billion (US$33.0 billion) in fiscal 1988. The telephone services revenue represented 79.1 percent of NTT's total operating revenue in fiscal 1989. The revenue increase came despite growing competition from new common carriers (NCCs) and an average 10 percent reduction on all telephone service rates implemented during fiscal 1989.

The Company offers a wide range of telephone services, including telephone subscriber, public telephone, automobile telephone, and other services. Outstanding revenue performances came from the cellular telephone services, which increased 57.6 percent in sales volume, as well as the new autodial prepaid magnetic telephone card service, and the toll-free dialing service.

Telegraph Services

Operating revenue for the telegraph service increased 7 percent to ¥53.4 billion (US$416 million) in fiscal 1989 from ¥49.8 billion (US$361 million) in fiscal 1988. The telegraph service revenue represented 0.9 percent of NTT's total operating revenue.

Telegraph services consist of telegram and telex services. Telegraph transmissions gradually rose from 41 billion in the early 1980s to a peak of 44 billion in 1984. Since then, telegraph transmissions have hovered at around 41 billion. NTT has introduced value-added telegrams, such as musical and scented telegrams, to help boost the market and has computerized its telegram handling system in order to maximize efficiency.

Leased Circuit Services

Operating revenue for the leased circuit services increased 13 percent to ¥334.3 billion (US$2.6 billion) in fiscal 1989 from ¥295.4 billion (US$2.1 billion) in fiscal 1988. Leased circuit services operating revenue accounted for 5.7 percent of NTT's total 1989 operating revenue.

Leased circuit services consist of standard circuit, high-speed digital circuit, video communications, television relay, satellite communications, and other services. All of NTT leased circuit services showed stable growth, although high-speed digital leased circuits showed the largest growth with a 39.5 percent increase.

Data Communication Facility Services

Operating revenue for the data communication facility services increased 5.6 percent to ¥186.0 billion (US$1.5 billion) in fiscal 1989 from ¥176.1 billion (US$1.3 billion) in fiscal 1988. Data communication facility services operating revenue accounted for 3.2 percent of NTT's total 1989 operating revenue.

In May 1988, NTT established Data Communications Systems Corporation (NTT Data), a wholly owned subsidiary, to assume the responsibilities of NTT's Data Communications Sector. NTT Data designs, consults on, and contracts data communications systems for government organizations and private companies in various industries. NTT Data also provides ready-made services, such as Automatic Answer Network System for Electrical Request (ANSER) and Credit and Finance Information System (CAFIS). ANSER, used primarily by financial institutions, allows companies to supply customers automatically with account information requested via telephone, facsimile, personal computer, or videotex terminal. NTT Data also provides CAFIS, a nation-wide online network service that links credit card companies, banks, and retailers for credit-card and bank-card validations, billing status, and other account information.

Digital Data Exchange Services

Operating revenue for DDX services increased 48.8 percent to ¥33.3 billion (US$260 million) in fiscal 1989 from ¥22.4 billion (US$162 million) in fiscal 1988. DDX services accounted for 0.6 percent of NTT's total 1989 revenue.

NTT provides circuit-switching and packet-switching DDX services. In the near future, NTT expects to add packet-switching capabilities to INS-Net 64 (NTT's first commercial ISDN) and to INS-Net 1500 (NTT's upgraded ISDN with a transmission capacity approximately 12 times that of INS-Net 64).

Pocket Pager Services

Operating revenue for pocket pager services increased 1.3 percent to ¥94.5 billion (US$737 million) in fiscal 1989 from ¥93.3 billion (US$676 million) in fiscal 1988. Pocket pager services operating revenue accounted for approximately 1.6 percent of NTT's total 1989 operating revenue.

NTT has increased its competitiveness by reducing rates and introducing new products such as the card-type pocket pager, the pen-type display pager, and the large display pager. NTT also reorganized the sales network to enable customers to purchase a wider variety of products in one store.

Other Services

Operating revenue for NTT's other services remained fairly stable at ¥155.8 billion (US$1.2 billion), which accounted for 2.7 percent of NTT's total 1989 operating revenue.

Other services are facsimile network services, videoconference services, and videotex services. The most significant growth came in from the F-Net facsimile network services, which experienced a 55.9 percent increase in revenue and a 48.2 percent increase in subscriptions to ¥5.3 billion (US$41 million) and 297,800, respectively.

Related Businesses

NTT's related businesses brought in over ¥361 billion (US$2.8 billion) in operating revenue, which accounted for 6.2 percent of NTT's total 1989 operating revenue. Related businesses' operating revenue increased 14 percent from the previous year.

Related businesses include terminal equipment sales, operator information services, and telecommunications consulting services. The main revenue generator in this sector is terminal equipment sales, which rose 4.1 percent to approximately ¥259 billion (US$2.0 billion) in fiscal 1989 from approximately ¥249 billion (US$1.8 billion) in fiscal 1988. Terminal sales accounted for approximately 72 percent and 4 percent of the related business operating revenue and NTT's total operating revenue, respectively.

New Developments

NTT is currently investing heavily in X-ray lithography systems. It has thus far achieved an accuracy level of 0.07 microns; however, a level of 0.04 microns is necessary to achieve the 0.2-micron design rule. Results are expected to be three to six years away.

NTT has developed a compact, economical synchronic orbital radiation (SOR) facility using only a 2.5-meter by 8.0-meter superconductive storage ring and a 1.7-meter linear accelerator. The SOR facility is capable of extremely fine structure processing. NTT's Large-Scale Integrated (LSI) Circuit Laboratories are developing SOR lithography as a source for advanced LSI manufacturing.

Further Information

For further information about the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Corporate Highlights (Millions of US Dollars)

	1986	1987	1988	1989
Four-Year Revenue	$23,011	$33,561	$41,020	$45,551
Percent Change	-	45.85	22.23	11.05
Capital Expenditure	$7,144	$10,108	$13,013	$13,758
Percent of Revenue	31.04	30.12	31.72	30.20
R&D Expenditure	$616	$936	$1,317	$1,729
Percent of Revenue	2.68	2.79	3.21	3.79
Number of Employees	304,000	298,000	294,369	283,294
Revenue ($K)/Employee	$76	$113	$139	$161
Net Income	$839	$1,208	$1,936	$2,055
Percent Change	-	43.91	60.27	6.19
Exchange Rate (US$1=¥)	¥221.26	¥159.52	¥138.03	¥128.25
1989 Calendar Year	**Q1**	**Q2**	**Q3**	**Q4**
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Nippon Telegraph and Telepone Corporation
Annual Reports
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

North America—2
Europe—3
Asia/Pacific—More than 133
Japan—More than 130
ROW—2

MANUFACTURING LOCATIONS

North America

Photonic Integration Research Inc., United States
Optical waveguide products

Asia/Pacific

Business Communication System Engineering Co., Ltd., Japan
Software
Nippon Information and Communication Corp., Japan
VAN and other telecommunications network services
NTT Data Communications Systems Corp., Japan
VAN and software
NTT Leasing Co., Ltd., Japan
Terminal equipment

SUBSIDIARIES

North America

Advanced Energy Technologies Inc. (Canada)
NTT America, Inc. (United States)
NTT Data USA (United States)
Photonic Integration Research, Inc. (United States)

Europe

NTT Europe Limited (United Kingdom)
NTT Finance (Holland) BV (Netherlands)
NTT Finance (U.K.) Limited (United Kingdom)
NTT International Scandinavia (Finland)

Asia/Pacific

Advanced Telecommunications Research Institute International (Japan)
AIREC Engineering Corp. (Japan)
Amenity Service Kansai Co., Ltd. (Japan)
Business Communication System Engineering Co., Ltd. (BCSE) (Japan)
Captain Service Company Limited (Japan)
Healthynet Hiroshima Co. (Japan)
INS Engineering Corp. (Japan)
International Information Inc. (Japan)
Internetwork Inc. (Japan)
Kokyo Securities Co., Ltd. (Japan)
Nagoya Information Center Co. (Japan)
Nippon Airport Radio Service Co., Ltd. (Japan)
Nippon Computer Security Corp. (Japan)
Nippon Directory Development Co., Ltd. (Japan)
Nippon Information and Communication Corp. (NIC) (Japan)
Nippon Senpaku Tsushin K.K. (Japan)
Nippon Telematique, Inc. (Japan)
NTT Auto Leasing Co., Ltd. (Japan)
NTT Central Mobile Communications Corp. (Japan)
NTT Central Network System (Japan)
NTT Chugoku Mobile Communications Corp. (Japan)
NTT Data Communications Systems Corp. (Japan)
NTT Estate Co., Ltd. (Japan)
NTT Information Development Co., Ltd. (Japan)
NTT Intelligent Technology Co., Ltd. (Japan)
NTT International Corp. (Japan)
NTT Kansai Mobile Communications Corp. (Japan)
NTT Kansai Real Estate Corp. (Japan)
NTT Kansai Telecon Co. (Japan)
NTT Kyushu Mobile Communications Corp. (Japan)
NTT Kyushu Tele-control Corp. (Japan)
NTT Learning Systems Co. (Japan)
NTT Leasing Co., Ltd. (Japan)
NTT Off-Talk Tushin Co., Ltd. (Japan)
NTT PC Communications, Inc. (Japan)
NTT Rental Engineering Co., Ltd. (Japan)
NTT Software Corp. (Japan)
NTT Telemarketing Co., Ltd. (Japan)
NTT Tokai Mobile Communications Corp. (Japan)
NTT Tokai Real Estate Corp. (Japan)
NTT Tour-Media Company, Ltd. (Japan)
NTT Urban Development Co., Ltd. (Japan)
The Japan Utility Subway Company, Inc. (Japan)

ROW

NTT do Brasil Ltda. (Brazil)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1989

International Telecommunications Union
NTT joined this union to promote the worldwide standardization of telecommunications technologies.

IBM Japan
NTT and IBM Japan jointly formed Nippon Information and Communication Corporation.

Matsushita and Nissan Motor
NTT Data, Matsushita, and Nissan jointly formed Star Communication Planning Corp.

Nissan Motor
NTT Data and Nissan agreed to jointly develop IC credit cards.

Toshiba
NTT and Toshiba agreed to jointly develop PBX software.

Cincinnati Bell Information Systems
Cincinnati Bell agreed to supply its software network system.

American Telephone and Telegraph
The companies made a product development and marketing agreement.

ITT-WD
NTT and ITT-WD jointly formed Nippon Directory Development Co., Ltd., a telephone directory consulting company.

Battelle Memorial Institute
NTT and Battelle jointly formed Photonic Integration Research, Inc.

Moli Energy Ltd. of Canada
NTT and Moli jointly formed Advanced Energy Technologies Inc. to develop a rechargeable lithium battery.

Illinois Bell Telephone
NTT and Illinois Bell linked their ISDN services so that users in the companies' respective countries can access services of the other.

Schlumberger, Ltd.
NTT and Schlumberger formed a joint venture to construct an ASIC verification system based on an NTT tester design.

LM Ericsson Telefon AB
NTT and Ericsson formed a joint venture to a develop digital cellular telephone system for Japan.

Northern Telecom
A joint development effort has been undertaken to build systems for the TRON Operating System.

Fujitsu, Ltd.
A joint development effort has been undertaken to build systems for the TRON Operating System.

Hitachi, Ltd.
A joint development effort has been undertaken to build systems for the TRON Operating System.

Matsushita Electric Industrial Company
A joint development effort has been undertaken to build systems for the TRON Operating System.

Mitsubishi Electric Corp.
A joint development effort has been undertaken to build systems for the TRON Operating System.

Co Corp.
A joint development effort has been undertaken to build systems for the TRON Operating System.

Oki Electric Co.
A joint development effort has been undertaken to build systems for the TRON Operating System.

Toshiba Corp.
A joint development effort has been undertaken to build systems for the TRON Operating System.

MERGERS AND ACQUISITIONS

Information is not available.

KEY OFFICERS

Haru Yamaguchi
Chairman

Masashi Kojima
President

Shigeo Sawada
Senior executive vice president

Katsumi Iida
Senior executive vice president

Shozo Iwasaki
Senior executive vice president

Tomeo Kambayashi
Senior executive vice president

PRINCIPAL INVESTORS

Ministry of Finance—77.5 percent
Mitsubishi Trust & Banking—0.5 percent
Sumitomo Trust—0.4 percent
Toyo Trust—0.4 percent
Yasuda Trust—0.4 percent
Chuo Trust—0.3 percent
Japan Securities Clearing—0.3 percent
Nippon Life—0.3 percent
Sumitomo Life—0.3 percent

FOUNDERS

Information is not available.

Table 2
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of US Dollars, except Per Share Data)

Balance Sheet	1986	1987	1988	1989
Total Current Assets	$4,019	$6,255	$7,828	$9,707
Cash and Equivalents	1,798	2,822	3,198	3,542
Receivables	1,524	2,488	3,352	4,157
Inventory	178	232	290	377
Other Current Assets	519	712	988	1,631
Net Property, Plants	$45,905	$62,444	$72,017	$76,225
Other Assets	$1,457	$2,624	$3,152	$4,202
Total Assets	$51,381	$71,324	$82,996	$90,134
Total Current Liabilities	$7,028	$9,877	$11,962	$12,872
Long-Term Debt	$18,824	$25,130	$27,427	$28,607
Other Liabilities	$9,658	$13,828	$16,245	$17,761
Total Liabilities	$35,510	$48,835	$55,635	$59,239
Total Shareholders' Equity	$15,872	$22,489	$27,361	$30,895
Common Stock	15,032	20,851	24,097	25,934
Other Equity	-	73	141	213
Retained Earnings	839	1,565	3,123	4,747
Total Liabilities and Shareholders' Equity	$51,381	$71,324	$82,996	$90,134
Income Statement	**1986**	**1987**	**1988**	**1989**
Revenue	$23,011	$33,561	$41,020	$45,551
Operating Expense	$11,067	$15,610	$19,476	$22,199
R&D Expense	$616	$936	$1,317	$1,729
SG&A Expense	$7,904	$11,518	$13,602	$15,830
Capital Expense	$7,144	$10,108	$13,013	$13,758
Pretax Income	$1,688	$2,576	$4,176	$4,054
Pretax Margin (%)	7.33	7.68	10.18	8.90
Effective Tax Rate (%)	50.27	53.11	53.65	49.29
Net Income	$839	$1,208	$1,936	$2,055
Shares Outstanding, Millions	15.6	15.6	15.6	15.6
Per Share Data				
Earnings	$53.80	$77.42	$124.08	$131.76
Dividend	$22.60	$31.34	$36.22	$38.99
Book Value	$1,017	$1,442	$1,754	$1,980
Exchange Rate (US$1=¥)	¥221.26	¥159.52	¥138.03	¥128.25

Source: Nippon Telegraph and Telephone Corporation Annual Reports
Dataquest (1990)

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Balance Sheet	1986	1987	1988	1989
Total Current Assets	¥889,249	¥997,796	¥1,080,466	¥1,244,968
Cash and Equivalents	397,918	450,240	441,388	454,322
Receivables	337,133	396,901	462,696	533,104
Inventory	39,323	37,044	40,036	48,318
Other Current Assets	114,875	113,611	136,346	209,224
Net Property, Plants	¥10,156,968	¥9,961,092	¥9,940,441	¥9,775,823
Other Assets	¥322,420	¥418,646	¥435,018	¥538,866
Total Assets	¥11,368,637	¥11,377,534	¥11,455,925	¥11,559,657
Total Current Liabilities	¥1,555,078	¥1,575,512	¥1,651,159	¥1,650,816
Long-Term Debt	¥4,164,976	¥4,008,735	¥3,785,812	¥3,668,824
Other Liabilities	¥2,136,819	¥2,205,860	¥2,242,340	¥2,277,791
Total Liabilities	¥7,856,873	¥7,790,107	¥7,679,311	¥7,597,431
Total Shareholders' Equity	¥3,511,764	¥3,587,427	¥3,776,614	¥3,962,226
Common Stock	3,326,076	3,326,076	3,326,076	3,326,076
Other Equity	-	11,700	19,500	27,300
Retained Earnings	185,688	249,651	431,038	608,850
Total Liabilities and Shareholders' Equity	¥11,368,637	¥11,377,534	¥11,455,925	¥11,559,657

Income Statement	1986	1987	1988	1989
Revenue	¥5,091,409	¥5,353,582	¥5,662,001	¥5,841,897
Operating Expense	¥2,448,649	¥2,490,048	¥2,688,250	¥2,847,004
R&D Expense	¥136,209	¥149,255	¥181,718	¥221,692
SG&A Expense	¥1,748,804	¥1,837,353	¥1,877,527	¥2,030,231
Capital Expense	¥1,580,600	¥1,612,351	¥1,796,159	¥1,764,400
Pretax Income	¥373,421	¥410,911	¥576,457	¥519,887
Pretax Margin (%)	7.33	7.68	10.18	8.90
Effective Tax Rate (%)	50.27	53.11	53.65	49.29
Net Income	¥185,688	¥192,663	¥267,187	¥263,612
Shares Outstanding, Millions	15.6	15.6	15.6	15.6
Per Share Data				
Earnings	¥11,903	¥12,350	¥17,127	¥16,898
Dividend	¥5,000	¥5,000	¥5,000	¥5,000
Book Value	¥225,113	¥229,963	¥242,091	¥253,989

Table 3 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Key Financial Ratios	1986	1987	1988	1989
Liquidity				
Current (Times)	0.57	0.63	0.65	0.75
Quick (Times)	0.55	0.61	0.63	0.72
Fixed Assets/Equity (%)	289.23	277.67	263.21	246.73
Current Liabilities/Equity (%)	44.28	43.92	43.72	41.66
Total Liabilities/Equity (%)	223.73	217.15	203.34	191.75
Profitability (%)				
Return on Assets	-	1.97	2.51	2.37
Return on Equity	-	6.30	7.77	7.06
Profit Margin	3.65	3.60	4.72	4.51
Other Key Ratios				
R&D Spending % of Revenue	2.68	2.79	3.21	3.79
Capital Spending % of Revenue	31.04	30.12	31.72	30.20
Employees	304,000	298,000	294,369	283,294
Revenue (¥K)/Employee	¥76	¥113	¥139	¥161
Capital Spending % of Assets	13.90	14.17	15.68	15.26
Exchange Rate (US$1=¥)	¥221.26	¥159.52	¥138.03	¥128.25

Source: Nippon Telegraph and Telephone Corporation
Annual Reports
Dataquest (1990)

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Telephone: (03) 501-3111
Fax: (03) 508-9465
Dun's Number: 10-678-8169

Date Founded: 1881

CORPORATE STRATEGIC DIRECTION

Oki Electric Industry Company, Ltd., was established in 1881 as a pioneering Japanese telephone manufacturing company by Kibataro Oki, formerly a maker of traditional Japanese swords and armor. In 1916, the Company began quantity production of radio communications equipment. Today, Oki is a producer of advanced telecommunications systems, data processing systems, and electronic devices, including semiconductors. Oki began manufacturing semiconductors in the early 1960s, and was the first Japanese company to manufacture green light-emitting diodes (LEDs).

Oki's business is broken down into four product groups: telecommunications systems, information processing systems, electronic devices, and other products. The Company's total sales broken down by product group are 26.9, 43.6, 25.2, and 4.3 percent, respectively.

Oki reported total consolidated revenue of ¥556 million (US$4 billion) for the year ended March 31, 1989, a 16.6 percent increase over 1988. (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) According to Oki, this growth resulted from increased orders in all product groups, a combination of successful product development and marketing efforts, and relatively stable exchange rates. Net income increased over 300 percent in the year ended March 31, 1989, from ¥3 million (US$25 million) in 1988 to ¥15 million (US$119 million) in 1989. International sales accounted for 27 percent of Oki's total consolidated revenue in 1989.

Oki has a Central Research laboratory for general research, a Systems Research lab for basic R&D, and a Digital Communication lab for telecommunication and digital signal processing (DSP) R&D. Also, there are two semiconductor labs and R&D labs within each product group. Oki emphasizes R&D efforts in all four of its product groups. The Company targets advanced digital switching and multiplexers in its telecommunications group, artificial intelligence (AI) in its information processing group, advanced integrated circuit (IC) and DRAM developments in its electronic group, and operation-specific robots in its other products group. R&D expenditure constituted 23.3 percent of gross profit in 1989, a 55.4 percent increase over the previous year's levels.

Oki expanded its facilities during the past year. This includes expanding R&D facilities in Japan for computer system products, semiconductors, and software; constructing a manufacturing plant in Japan; and establishing two R&D centers in the United States. Consolidated capital expenditure totaled ¥60 million (US$453 million) in 1989, or 10.8 percent of revenue.

Oki has 12 overseas subsidiaries and affiliates, including 4 in the United States, 2 each in Germany and Singapore, and 1 each in Hong Kong, England, Scotland, and Taiwan. The Company's international semiconductor operations are handled by Oki Semiconductor Group in Santa Clara, California, and Oki Electric Europe in Dusseldorf, Germany. New Jersey-based Okidata markets peripherals for personal and business computers in the United States. Okidata, Oki Telecom, and Oki Semiconductor are divisions of US-based Oki America, Inc. Oki employs more than 18,000 people worldwide.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Informaton on revenue by distribution channel is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Telecommunications Systems

Making up 26.9 percent of Oki's year ended March 1989 revenue, telecommunications systems include products such as PBX, telex, central office exchanges, cellular mobile and push-button telephones, radio equipment, modems, TV converters, optical fiber communications systems, facsimiles, local area networks (LANs), IC cards, and teleconferencing systems.

This group experienced increases in sales due to strong demand from companies preparing for Integrated Services Digital Network (ISDN). As a result, Oki's D70 digital central office switching system and IOX and IX series of PBXs fared well. Additionally, Oki won a contract with the leading UK telecommunications equipment company to export systems to the United Kingdom. Equipment, facsimiles, cellular phones, and building management systems sales increased during the year as well.

Information Processing Systems

Oki's information processing products include laptop PCs, point-of-sale (POS) terminals and systems, minicomputers, ATM banking systems, medical electronics systems, data printers and other peripherals, text communications terminals, water resource control systems, intelligence-building systems, seismometric and disaster-prevention systems, radar and sonar systems, and underwater acoustic systems. This division accounts for the largest portion of Oki's revenue, more than 40 percent.

Sales of systems to Japan's financial industry is Oki's main area of strength in its information systems segment. Oki expects to ship at least 10,000 units of its high-speed ATM systems in 1990. In addition, through an original equipment manufacturer (OEM) agreement with Sun Microsystems, signed in May 1989, Oki plans to expand its offerings in financial software that can be customized for its financial clients.

Printers

Oki experienced strong dot matrix sales during business year 1989 and expanded its product line. Oki introduced two 9-pin printers, the Microline 320 and 321. Additionally, introductions of 24-pin printers included the Microline 390 and 391 models, which are manufactured in Europe by Oki (UK) Ltd.

Okidata, Oki's US printer arm, markets peripherals for personal and business computers, including dot matrix, laser, and thermal transfer printers and PC modems. Dataquest estimates that in 1989, Okidata ranked as one of the top five vendors in the serial printer market, along with Apple, Epson, IBM, and Panasonic.

Electronic Devices

Products in the electronic devices group include semiconductors, printed circuit boards, plasma display panel units, reed relays, and switches. This division accounts for approximately 25 percent of Oki's sales.

Semiconductors

Oki has more than 20 years of experience in all phases of semiconductor design and manufacturing. The Company manufactures devices encompassing a broad range of integrated circuits, discrete devices, and optoelectronics. It uses the following processes: CMOS, PMOS, NMOS, TTL, I2L, and ECL. Oki also manufactures specialty products that include sensor arrays, optical couplers, and LED lamps. New specialty products include speech recognition and synthesis chips.

For the year ended December 31, 1989, Dataquest estimates Oki's semiconductor sales to be ¥153.6 billion (US$1.2 billion), ranking the Company 17th in worldwide semiconductor market share. This represents an increase of 22 percent over Oki's semiconductor sales for 1988. Oki derives an estimated 89 percent of its semiconductor sales, ¥128 billion (US$1 billion), from its MOS digital products. Dataquest estimates Oki's ranking by product as 6th in MOS logic, 9th in MOS memory, and 14th in MOS microdevices. The balance of Oki's semiconductor revenue comes from its bipolar digital, discrete, and optoelectronic device sales.

Oki's strategy is to expand its memory IC and ASIC capabilities and product lines. In the past year, Oki completed construction of its Miyagi Plant and began production of 1MB and 4MB DRAMs. In addition to the Miyagi plant, Oki announced two new ASIC design centers, one in Detroit, Michigan, the other in Sunnyvale, California. The Company is also building a new semiconductor fab in Oregon.

Further Information

For further information about the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Millions of US Dollars)

	1985	1986	1987	1988	1989
Five-Year Revenue	$1,704.0	$1,777.0	$2,546.0	$3,271.0	$4,340.0
Percent Change	-	4.28	43.28	28.48	32.68
Capital Expenditure	$278.0	$158.0	$181.0	$181.0	$468.0
Percent of Revenue	16.31	8.89	7.11	5.53	10.78
R&D Expenditure	$69.0	$72.0	$112.0	$167.0	$281.0
Percent of Revenue	4.05	4.05	4.40	5.11	6.47
Number of Employees	18,134	18,649	19,375	18,659	18,440
Revenue ($K)/Employee	$93.97	$95.29	$131.41	$175.30	$235.36
Net Income	$37.0	($4.0)	$14.0	$25.0	$119.0
Percent Change	-	(110.81)	(450.00)	78.57	376.00
Exchange Rate (US$1=¥)	¥245	¥221	¥160	¥138	¥128

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Oki Electric Industry Company, Ltd.
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1985	1986	1987	1988	1989
Japan	69.00	74.00	75.00	75.00	73.00
International	31.00	26.00	25.00	25.00	27.00

Source: Oki Electric Industry Company, Ltd.
Annual Reports
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

Asia Pacific
Japan—58
International—11

MANUFACTURING LOCATIONS

North America

Oki America (United States)
Telecommunications equipment, data processing equipment
Okidata Group (United States)
Data processing equipment

Europe

Oki (UK) Ltd. (United Kingdom)
Dot-matrix printers

Asia/Pacific

Far Eastern Electric Industry Co., Ltd. (Taiwan)
Telecommunications equipment
Kinseki, Ltd. (Japan)
Quartz crystals, crystal filters, crystal oscillators, ultrasonic glass delay lines, synthetic quartz
Kuwano Electrical Instruments (Japan)
Measuring instruments
Miyagi Oki Electric (Japan)
256K DRAMs
Miyazaki Oki Electric (Japan)
LSIs, VLSIs
Nagano Oki Electric (Japan)
Computers, remote terminals, assembly of printed circuit boards
Niigata Oki Electric (Japan)
Printed circuit boards
Nikko Denki Seisakusho (Japan)
Switchboards, terminal blocks, distribution boxes, exchange parts
OF Engineering (Japan)
Sensors
Oki Ceramic Industry (Japan)
Tantalum electrolytic capacitors, hybrid integrated circuits, ceramic parts
Oki Electric Cable (Japan)
Printed circuit boards, connectors
Oki Seatec (Japan)
Research, consulting, and measurement for underwater acoustics
Oki Transmission Engineering (Japan)
Telecommunications equipment/systems
Oki Unisys (Japan)
Computers
Shizuoka Oki Electric (Japan)
Telecommunications equipment, control equipment, measuring equipment, acoustic equipment
Taiko Electric Works (Japan)
PBX and key telephone systems
Toho Electronics (Japan)
Transmission equipment and parts
Tohoku Oki Electric (Japan)
Data communications equipment

SUBSIDIARIES

North America

Oki America, Inc. (United States)
Oki Semiconductor Group (United States)
Oki Telecom Group (United States)
Okidata Group (United States)

Europe

Oki Electric Europe GmbH (Germany)
Oki Europe Ltd. (England)
Oki (UK) Ltd. (Scotland)
Okidata GmbH (Germany)

Asia/Pacific

Digiphonic Systems Pte. Ltd.
Far Eastern Electric Industry Co., Ltd. (Taiwan)
Kinseki, Ltd. (Japan)
Kuwano Electrical Instruments Co., Ltd. (Japan)
Mikuni Industry Co., Ltd. (Japan)
Miyagi Oki Electric Co., Ltd. (Japan)
Miyazaki Oki Electric Co., Ltd. (Japan)
Nagano Oki Electric Co., Ltd. (Japan)
Niigata Oki Electric Co., Ltd. (Japan)
Nikko Denki Seisakusho Co., Ltd. (Japan)
OF Engineering Co., Ltd. (Japan)
Oki Ceramic Industry Co., Ltd. (Japan)
Oki Electric Cable Co., Ltd. (Japan)
Oki Electronics (Hong Kong), Ltd. (Hong Kong)
Oki Electronics (Singapore) Pte. Ltd. (Singapore)
Oki FCS Systems Co., Ltd. (Japan)
Oki Firmware System Co., Ltd. (Japan)
Oki Hokuriku Systems Development Co., Ltd. (Japan)
Oki Information Systems Co., Ltd. (Japan)

Oki Medical Systems Co., Ltd. (Japan)
Oki Micro Design Miyazaki Co., Ltd. (Japan)
Oki Seatec Co., Ltd. (Japan)
Oki Software Co., Ltd. (Japan)
Oki Software Kansai Co., Ltd. (Japan)
Oki Software Kyushu Co., Ltd. (Japan)
Oki Software Okayama Co., Ltd. (Japan)
Oki Software Systems Hokkaido Co., Ltd. (Japan)
Oki Systek Co., Ltd. (Japan)
Oki System Development Niigata Co., Ltd. (Japan)
Oki Techno Systems Laboratory, Inc. (Japan)
Oki Telecommunications System Co., Ltd. (Japan)
Oki Thailand Co., Ltd. (Thailand)
Oki Transmission Engineering Co., Ltd. (Japan)
Oki Unisys Kaisha, Ltd. (Japan)
Shizuoka Oki Electric Co., Ltd. (Japan)
Taiko Electric Works, Ltd. (Japan)
Toho Electronics Co., Ltd. (Japan)
Tohoku Oki Electric Co., Ltd. (Japan)
Waratoku Steel Co., Ltd. (Japan)
Yamako Electric Manufacture Co., Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1989

Hewlett-Packard
Oki and HP entered into a joint venture to build printed circuit boards (PCBs) at a plant to be built in Puerto Rico.

Vitelic
Oki and Vitelic exchanged semiconductor production technology and marketing rights for ASIC memory products.

SGS-Thomson
Oki and SGS-Thomson expanded their DRAM agreement (see 1988 listing) to include 4MB DRAM chips.

Rockwell International
Oki signed an agreement to market Rockwell's Galaxy ISS-3000 PBX system in Japan.

Sun Microsystems
Oki signed an agreement with Sun Microsystems covering financial software products.

1988

Intel Corp.
Oki licensed the 80C51 8-bit MCU from Intel and added it to its macrocell library. In exchange, Intel gets royalties from Oki.

iLSi Yamaha
iLSi Yamaha signed a technology purchasing and licensing agreement with Oki, under which Oki will manufacture and sell gate arrays based on iLSi technology and provide foundry services.

Marshall Industries
Oki Semiconductor designated Marshall Industries to carry its entire line of standard CMOS ICs at Marshall's US and Canadian locations.

SGS-Thomson
The two companies made a cross-licensing agreement for the manufacture of DRAMs. SGS will assemble 256K and 1Mb DRAM modules; the products will be sold in Europe as Oki products.

Seattle Silicon
The companies agreed to promote joint development of designing tools for SRAMs.

1987

AT&T
Oki agreed to supply AT&T with GaAs multiplexer and demultiplexer devices for the development of optical transmission equipment.

Catalyst Semiconductor Inc.
The two companies entered into a long-term R&D agreement for NVRAMS, using CMOS EPROMs and EEPROMs.

Cross-Licensing Partners, Patents, and Contract Terms

AT&T
Carrier equipment, radio communications equipment, data processing equipment (expired 1/80) Semiconductors, devices, film devices (expired 1/83)

Hewlett-Packard
Computers, terminals, semiconductors (expired 9/83)

IBM
Data processing systems (expired 1/86)

Intel
Semiconductor materials, ICs (8/80 through 7/90)

National Semiconductors
Semiconductors (7/84 through 7/94)

Philips
Semiconductor devices (expired 10/83)

Texas Instruments
Semiconductors (4/87 through 11/90)

MERGERS AND ACQUISITIONS

1988

Far Eastern Electric Industry Co., Ltd. (FEE)
Oki Electric acquired the majority share of its Taiwanese subsidiary, FEE, which will become one of its manufacturing arms.

KEY OFFICERS

Namio Hashimoto
Chairman of the board

Nobumitsu Kosugi
President, chief executive officer

Yoshio Masuda
Executive vice president

Chikatomo Mitsuyasu
Executive vice president

PRINCIPAL INVESTORS

Yasuda Life—7.8 percent
Meiji Life—6.0 percent
Dai Ichi Life—5.6 percent
Fuji Bank—4.3 percent
Yasuda Trust—3.8 percent
Mitsubishi Trust—3.6 percent
Japan Securities Finance—3.3 percent
Yasuda F&M Insurance—2.4 percent
Sumitomo Trust—2.4 percent

FOUNDER

Kibataro Oki

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of US Dollars, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$1,122.0	$1,264.0	$2,104.0	$2,525.0	$3,003.0
Cash, Time Deposits	256.0	323.0	623.0	835.0	988.0
Receivables	388.0	471.0	779.0	862.0	1,090.0
Inventory	460.0	447.0	665.0	792.0	889.0
Other Current Assets	18.0	23.0	37.0	36.0	36.0
Long-Term Receivables	96.0	114.0	165.0	227.0	264.0
Net Property, Plants	$464.0	$502.0	$654.0	$762.0	$1,079.0
Other Assets	$40.0	$75.0	$308.0	$202.0	$200.0
Total Assets	$1,722.0	$1,955.0	$3,231.0	$3,716.0	$4,546.0
Total Current Liabilities	$2,423.0	$2,908.0	$4,706.0	$5,838.0	$2,266.0
Long-Term Debt	$450.0	$546.0	$721.0	$715.0	$1,072.0
Other Liabilities	$57.1	$32.1	$112.9	$87.4	$139.7
Total Liabilities	$2,930.1	$3,486.1	$5,539.9	$6,640.4	$3,477.7
Total Shareholders' Equity	$301.5	$489.8	$711.5	$950.4	$1,121.8
Common Stock	111.6	178.7	264.2	348.2	394.5
Other Equity	119.5	253.7	360.9	460.8	505.4
Retained Earnings	70.4	57.4	86.4	141.4	221.9
Total Liabilities and Shareholders' Equity	$3,231.6	$3,975.9	$6,251.4	$7,590.8	$4,599.5

Income Statement	1985	1986	1987	1988	1989
Revenue	$1,704.0	$1,777.0	$2,546.0	$3,271.0	$4,340.0
Japanese Revenue	1,176.0	1,314.0	1,909.4	2,436.0	3,172.0
International Revenue	528.0	463.0	637.0	835.0	1,168.0
Cost of Sales	$1,183.8	$1,632.6	$2,174.4	$2,652.7	$3,131.0
R&D Expense	$66.5	$90.3	$120.8	$185.5	$281.0
SG&A Expense	$361.6	$479.8	$611.0	$784.5	$646.0
Capital Expense	$270.8	$192.4	$159.2	$197.5	$468.0
Pretax Income	$81.8	$12.2	$27.8	$83.8	$195.3
Pretax Margin (%)	4.90	0.56	0.99	2.32	4.50
Effective Tax Rate (%)	58.00	58.00	58.00	56.00	56.00
Net Income	$36.6	($5.4)	$15.3	$27.9	$119.0
Shares Outstanding, Millions	459.6	480.4	500.9	519.5	572.5
Per Share Data					
Earnings	$0.08	($0.01)	$0.03	$0.05	$0.21
Dividend	$0.02	$0.03	$0.02	$0.04	$0.04
Book Value	$0.66	$1.02	$1.42	$1.83	$1.96
Exchange Rate (US$1=¥)	¥245	¥221	¥160	¥138	¥128

Source: Oki Electric Industry Company, Ltd.
Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	¥275.0	¥279.0	¥337.0	¥348.0	¥385.0
Cash, Time Deposits	63.0	71.0	100.0	115.0	127.0
Receivables	95.0	104.0	125.0	119.0	140.0
Inventory	113.0	99.0	106.0	109.0	114.0
Other Current Assets	5.0	5.0	6.0	5.0	5.0
Long-Term Receivables	¥23.0	¥25.0	¥26.0	¥31.0	¥34.0
Net Property, Plants	¥114.0	¥111.0	¥105.0	¥105.0	¥138.0
Other Assets	¥10.0	¥17.0	¥23.0	¥29.0	¥26.0
Total Assets	¥422.0	¥432.0	¥491.0	¥513.0	¥583.0
Total Current Liabilities	¥234.0	¥217.0	¥267.0	¥295.0	¥291.0
Long-Term Debt	¥112.0	¥121.0	¥115.0	¥99.0	¥137.0
Other Liabilities	¥1.0	¥6.0	¥6.0	0	¥7.0
Total Liabilities	¥347.0	¥344.0	¥388.0	¥394.0	¥435.0
Total Shareholders' Equity	¥75.0	¥88.0	¥103.0	¥119.0	¥148.0
Common Stock	28.0	32.0	38.0	44.0	52.0
Other Equity	30.0	46.0	52.0	58.0	67.0
Retained Earnings	18.0	10.0	13.0	18.0	29.0
Total Liabilities and Shareholders' Equity	¥422.0	¥432.0	¥491.0	¥513.0	¥583.0

Income Statement	1985	1986	1987	1988	1989
Revenue	¥418.0	¥393.0	¥407.0	¥451.0	¥556.0
Japanese Revenue	288.0	291.0	307.0	336.0	407.0
International Revenue	130.0	102.0	100.0	115.0	149.0
Cost of Sales	¥296.0	¥294.0	¥315.0	¥332.0	¥401.0
R&D Expense	¥17.0	¥16.0	¥18.0	¥23.0	¥36.0
SG&A Expense	¥90.0	¥86.0	¥89.0	¥98.0	¥83.0
Capital Expense	¥68.0	¥35.0	¥29.0	¥25.0	¥60.0
Pretax Income	¥20.0	¥2.0	¥4.0	¥10.0	¥25.0
Pretax Margin (%)	4.78	0.51	0.98	2.22	0.59
Effective Tax Rate (%)	58.00	58.00	58.00	56.00	56.00
Net Income	¥9.0	(¥1.0)	¥2.0	¥3.0	¥15.0
Shares Outstanding, Millions	459.6	480.4	500.9	519.5	572.5
Per Share Data					
Earnings	¥20.20	(¥2.10)	¥4.50	¥6.80	¥28.00
Dividend	¥6.00	¥6.00	¥3.00	¥6.00	¥6.00
Book Value	¥0.16	¥0.18	¥0.21	¥0.23	¥0.26

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Key Financial Ratios	1985	1986	1987	1988	1989
Liquidity					
Current (Times)	0.18	1.29	1.26	1.18	1.32
Quick (Times)	0.69	0.83	0.87	0.81	0.93
Fixed Assets/Equity (%)	152.00	126.14	101.94	88.24	93.24
Current Liabilities/Equity (%)	312.00	246.59	259.22	247.90	196.62
Total Liabilities/Equity (%)	462.67	390.91	376.70	331.09	293.92
Profitability (%)					
Return on Assets	-	(0.23)	0.43	0.60	2.74
Return on Equity	-	(1.23)	2.09	2.70	11.24
Profit Margin	2.15	(0.25)	0.49	0.67	0.36
Other Key Ratios					
R&D Spending % of Revenue	4.07	4.07	4.42	5.10	0.86
Capital Spending % of Revenue	16.27	8.91	7.13	5.54	1.43
Employees	18,134	18,649	19,375	18,659	18,440
Revenue (¥M)/Employee	¥23.05	¥21.07	¥21.01	¥24.17	¥30.15
Capital Spending % of Assets	16.11	8.10	5.91	4.87	10.29
Exchange Rate (US$1=¥)	¥245	¥221	¥160	¥138	¥128

Source: Oki Electric Industry Company, Ltd.
Annual Reports
Dataquest (1990)

Ricoh Company, Ltd.

15-5, Minami-Aoyama 1-chome
Minato-ku, Tokyo 107, Japan
Telephone: (03) 479-3111
Fax: (03) 403-1578
Dun's Number: 10-277-1235

Date Founded: February 1936

CORPORATE STRATEGIC DIRECTION

Ricoh Company, Ltd., founded in 1936 by Kiyoshi Ichimura, has an estimated revenue of ¥729.4 billion (US$5.7 billion) for the fiscal year ending March 1989. The Company has four major lines of business: copiers and related supplies, facsimile equipment, data processing systems, and other products (cameras, lenses, integrated circuits and other electronic devices, educational machines, measuring devices, and thermal paper). Copiers and related supplies represented 55.0 percent of net sales for the fiscal year ending March 1989; facsimile equipment, 15.2 percent; data processing systems, 15.4 percent; and other products, 14.4 percent.

Ricoh entered the business machine market by introducing a diazo copier in 1955. The Company introduced a plain paper copier in 1972, facsimile machines in 1974, text and graphic-image editing systems and ink jet printers in 1980, and laser printers in 1983.

The Japan-based Company is not a member of any larger industrial group. Ricoh is organized along product and regional lines, with centralized manufacturing and marketing organizations in North America and Europe as well as in Japan. The Company is convinced that the creation of independent overseas operations to plan, procure, manufacture, and market its products locally is the key to long-term international success. Ricoh also intends to increase product development and continue diversifying its product lines with the development of new R&D facilities.

Ricoh's estimated revenue for the fiscal year ending March 1990 was ¥810 billion (US$5.7 billion). Ricoh reported total revenue of ¥729.4 billion (US$5.7 billion) in the fiscal year ending March 1989, an increase of 8.2 percent over the fiscal year ending March 1988 figure of ¥674.2 billion (US$4.9 billion). (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) This increase can be attributed largely to the 21.0 percent increase in sales of other products for fiscal 1989, reflecting strong demand for the Company's electronic devices. Sales in Japan rose 10.0 percent to ¥461 billion (US$3.6 billion) while sales in North America and Europe rose 2.7 percent and 8.3 percent, respectively. Ricoh's estimated net income for the fiscal year ending March 1990 was ¥20 billion (US$140.4 million). The Company's net income rose 4.1 percent to ¥17.8 billion (US$138.8 million) in 1989 from ¥17.1 billion (US$123.9 million) in fiscal 1988.

The Company's estimated capital expenditure for the fiscal year ending March 1990 was ¥46.8 billion (US$328.5 million), representing 5.8 percent of total revenue. Capital expenditure totaled ¥59.3 billion (US$462 million) for fiscal 1989, representing 8.13 percent of revenue. This is an increase of nearly 72.0 percent over the fiscal 1988 figure of ¥34.5 billion (US$177.5 million). This increase was due primarily to Ricoh's expanding manufacturing into Europe and North America. Ricoh also built or modified three manufacturing plants in Japan to increase production capacity of printed circuit boards, copiers, laser printers, and electronic devices.

Ricoh's estimated research and development expenditure for the fiscal year ending March 1990 was ¥52.3 billion (US$367.1 million), representing 6.5 percent of revenue. Research and development expenditure totaled ¥46.5 billion (US$362.5 million) for fiscal 1989, representing 6.4 percent of total revenue. This is an increase of 8.4 percent over the fiscal 1988 figure of ¥42.9 billion (US$310.8 million).

Most of Ricoh's products are marketed under the Ricoh brand name, but the Company also produces components and finished goods for OEMs including Savin and Pitney Bowes. Ricoh has major subsidiaries in Europe and the United States. These subsidiaries manufacture copiers and facsimiles and sell them and other Ricoh products into their local markets. Ricoh's Taiwanese subsidiary manufactures cameras for worldwide sale, and its Korean subsidiary manufactures copiers and facsimile machines.

Ricoh employed approximately 12,700 people in fiscal 1989.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Copiers

According to Ricoh, the sale of copiers and copier-related products generated approximately ¥401.1 billion (US$3.13 billion) or 47.0 percent of total revenue in fiscal 1989. Dataquest estimates that Ricoh held 5.7 percent of the US copier market, ranking fifth in the market. Ricoh has 300 dealers with two branch offices in the United States and uses such alternate channels as manufacturers' representatives, distributors, wholesalers, and retailers to distribute its products. Dataquest believes that Ricoh can increase its market share by expanding its product offerings and services. As products are becoming more similar, vendors can differentiate themselves from their competitors through after-sales support. In addition, because of improved product design, more low-end copier users are doing their own maintenance, and alternate channels are increasing in popularity. Dataquest estimates that 16 percent of placements will go through alternate channels by 1994. Dataquest ranks Ricoh third in the worldwide plain paper copier market, with 14 percent of market share.

Ricoh released the FT9100 in Japan during the first quarter of 1989. The FT9100 is able to throughput 101 A4 copies per minute. Also released were the FW7120D, Ricoh's first digital copier for technical drawings. Internationally, Ricoh's best-performing products were the FT4480 desktop model, the FT6620 high-speed model, and the FT2260 compact copier with zoom functions. Also introduced in 1989 were the FT2220, FT4400, FT4460, FT4490, FT5540, FT5570, FT 7770, and the LR-2.

Ricoh released the NC-100 in April 1990. The NC-100 is a xerographic full-color copier that also provides full-featured black-and-white capabilities. The Company also demonstrated a full-color copier prototype called the AGX-1, developed in a joint venture with Polaroid Corporation. The AGX-1 uses photographic technology similar to that used in Polaroid cameras.

Facsimiles

Facsimile equipment sales rose by 7.0 percent in fiscal 1989 to ¥111 billion (US$865.5 million), with overseas sales increasing by 20.9 percent to ¥65 billion (US$506.8 million). Revenue generated by the sale of facsimile machines represents 15.2 percent of total revenue. Ricoh introduced the Rifax 2000 series, a family of compact plain paper laser facsimile machines, as well as the L series of speaking facsimile machines in 1989. Ricoh also introduced the Rifax 7200S plain paper facsimile machine that has provisions for incorporating a bar-code scanner. The Rifax D7000 and the Rifax T80 were introduced in the fall of 1989. To help reduce its reliance on exports and therefore ensure steady, long-term growth, Ricoh has stepped up production of facsimiles overseas through such subsidiaries as Ricoh Electronics, Inc., in the United States and Ricoh Industrie France S.A.

According to Dataquest, Ricoh ranked fifth, with 7.9 percent share of the facsimile market in the United States and sales of 118.6 million machines in calendar 1989. In the plain paper facsimile market, Ricoh ranked third in United States in 1989. Dataquest ranks Ricoh sixth in the United Kingdom, with 11.6 million units shipped and 5.6 percent of the market in fiscal 1989. Ricoh ranked first in the Japanese market in calendar 1989, with 20.3 percent share, according to Nikkei, Sangyo Shimbun, a source of information in Japan.

Computer Storage

Ricoh competes in two of the six Dataquest segments of the worldwide computer storage market. Ricoh ranks first through Maxoptix Corporation, a joint venture with Maxtor, in the 5.25-inch write-once read-many (WORM) market, with a 36 percent market share. Dataquest estimates that Maxoptix shipped

7,500 units, contributing ¥1.24 billion (US$9.7 million) to total revenue.

Ricoh/Olympus ranks second behind Sony in the rewritable disk drives worldwide market, with an 18 percent share in fiscal 1989. Dataquest estimates that Ricoh shipped 6,000 units, which contributed ¥1.5 billion (US$11.7 million) to revenue in fiscal 1989. The computer storage segment of Ricoh's business contributes a total of ¥2.74 billion (US$21 million), or less than 1 percent of the Company's total revenue.

Semiconductors

Dataquest estimates that Ricoh generated ¥12.6 billion (US$91 million) in semiconductor revenue for fiscal 1989, a 7 percent increase over fiscal 1988. This revenue represents nearly 2 percent of Ricoh's total revenue generated in fiscal 1989. Ricoh's largest single market is Japan, which contributes ¥12.1 billion (US$88 million) in semiconductor revenue, representing 96 percent of the Company's semiconductor revenue. In Japan, Ricoh ranks 23rd and controls less than 1 percent of the market.

Ricoh produces a variety of NMOS, PMOS, CMOS, and BiCMOS memory, microdevices, and logic chips. Dataquest estimates that Ricoh generated ¥4.9 billion (US$38 million) in MOS logic chips, ¥3.9 billion (US$31 million) in MOS memory, and ¥2.8 billion (US$22 million) in MOS microdevices in fiscal 1989. A majority of the Company's semiconductors use CMOS technology.

Information Systems

Ricoh continued its aggressive expansion into domestic information systems, selling Hitachi Ltd. PCs and IBM System/55s and System/36s on an OEM basis. Ricoh also acts as a sales agent for NEC Corp. selling its office computers. These OEM policies resulted in office and personal computer sales of ¥17.4 billion (US$126 million) and ¥22.3 billion (US$161.5 million), respectively. Profit remained at a low of 4 percent, largely because Ricoh does not sell its own hardware. Ricoh's use of OEM equipment has made it difficult for the Company to continue its efforts to expand its information systems business overseas because of difficulty in maintaining after-sales maintenance and software compatibility problems.

Personal Computers

Ricoh produces and markets personal computers. The best selling Ricoh computer is the MR. MyTool II/III, with an estimated 40,000 units sold worldwide in 1989. The Company entered the desktop publishing market with the Riport Star 9000 in 1989.

Printers

Ricoh produces a line of printers and laser printers, including the PC Laser 6000/PS (1060-SP3 in Japan). Other Ricoh printers include the LP-4400 and LP 5400 introduced in 1985. Dataquest estimates that Ricoh had approximately 2 to 4 percent of the US market page printer in 1989.

Revenue from computer storage devices, semiconductors, personal computers, and printers is included in the data processing systems figure of approximately ¥110.8 billion (US$863.9 million), which represented 15.4 percent of total revenue for fiscal 1989.

Further Information

For further information about the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Billions of US Dollars)

	1985	1986	1987	1988	1989
Five-Year Revenue	$2.2	$2.7	$3.7	$4.9	$5.7
Percent Change	-	19.82	38.32	31.56	16.44
Capital Expenditure	$0.2	$0.2	$0.2	$0.2	$0.5
Percent of Revenue	9.24	8.13	4.20	5.12	8.13
R&D Expenditure	$0.1	$0.2	$0.2	$0.3	$0.4
Percent of Revenue	5.35	6.10	6.16	6.36	6.38
Number of Employees	25,000	26,500	28,000	33,000	12,700
Revenue ($K)/Employee	$0.09	$0.10	$0.13	$0.15	$0.45
Net Income	$0.1	$0.1	$0.1	$0.1	$0.1
Percent Change	-	1.54	(2.48)	81.35	12.03
Exchange Rate: US$1=¥	¥243.51	¥221.26	¥159.56	¥138.03	¥128.25

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Ricoh Company, Ltd.
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1985	1986	1987	1988	1989
Japan	61.00	60.00	66.00	62.00	63.00
International	39.00	40.00	34.00	38.00	37.00
North America	27.00	25.00	20.00	22.00	21.00
Europe	8.00	10.00	10.00	11.00	11.00
All Others	4.00	5.00	4.00	5.00	5.00

Source: Ricoh Company, Ltd.
Annual Reports
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

North America—3
Europe—4
Asia/Pacific—14

MANUFACTURING LOCATIONS

North America

Ricoh Corp.
Facsimiles and R&D of OA equipment
Ricoh Electronics
Copiers, facsimiles, toners

A new manufacturing site will be completed in 1990 in Lawrenceville, Georgia, which will produce copier supplies.

Europe

Ricoh Industries (France)
Copiers, facsimiles, supplies
Ricoh UK Products (United Kingdom)
Copiers, facsimiles, toners

Asia/Pacific

AT&T Ricoh (Japan)
Key telephone sets, office automation (OA) equipment and peripherals
Hasama Ricoh (Japan)
Copier parts, photographic equipment
Ricoh Denshi (Japan)
Data processing equipment
Ricoh Elemex (Japan)
Watches, OA equipment, copier parts, FDDs, measuring instruments, semiconductor
Ricoh Keiki (Japan)
Copier parts, data processing equipment
Ricoh Microelectronics (Japan)
Printed circuit boards
Ricoh Optical Industries (Japan)
Photographic equipment
Ricoh Research Institute of General Electronics (Japan)
R&D of materials, applied electronics technologies
Ricoh Tokki (Japan)
Facsimiles, copiers, microfilm equipment
Sindo Ricoh, South Korea (Korea)
Copiers, facsimiles
Taiwan-Ricoh (Taiwan)
Cameras, photographic equipment
Tohoku Ricoh (Japan)
Offset printing equipment, stencil duplicators, educational equipment, printers, copier parts

SUBSIDIARIES

North America

Ricoh Corporation (Canada), Ltd. (Canada)
Ricoh Corporation (United States)
Ricoh Development of California, Inc. (United States)
Ricoh Electronics, Inc. (United States)
Ricoh Finance Corporation (United States)
Ricoh Thermal Systems, Inc. (United States)

Europe

Ricoh Deutschland GmbH (West Germany)
Ricoh Europe B.V. (Netherlands)
Ricoh France S.A. (France)
Ricoh Industries France S.A. (France)
Ricoh UK Ltd. (United Kingdom)
Ricoh UK Products Ltd. (United Kingdom)
Saitama Ricoh Co., Ltd.

Asia/Pacific

Aichi Ricoh Co., Ltd. (Japan)
Daiichi Ricoh Co., Ltd. (Japan)
Fukuoka Ricoh Co., Ltd. (Japan)
Hasama Ricoh Co., Ltd. (Japan)
Hokkaido Ricoh Co., Ltd. (Japan)
Hyogo Ricoh Co., Ltd. (Japan)
Kanagawa Ricoh Co., Ltd. (Japan)
Kinki Ricoh Co., Ltd. (Japan)
Miyagi Ricoh Co., Ltd. (Japan)
Nihon Business Supply Co., Ltd. (Japan)
Ricoh Denshi Co., Ltd. (Japan)
Ricoh Educational Equipment Co., Ltd. (Japan)
Ricoh Information System Co., Ltd. (Japan)
Ricoh Keiki Co., Ltd. (Japan)
Ricoh Microelectronics Co., Ltd. (Japan)
Ricoh Office System Co., Ltd. (Japan)
Ricoh Optical Industries Co., Ltd. (Japan)
Ricoh Research Institute of General Electronics Co., Ltd. (Japan)
Ricoh Tecnonet Co., Ltd. (Japan)
Ricoh Tokki Co., Ltd. (Japan)
Taiwan-Ricoh (Korea)
Taiwan-Ricoh Co. (Taiwan)
Tohoku Ricoh Co., Ltd. (Japan)
Tokyo Ricoh Co., Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

Tokyo Computer Service Co., Ltd., and Computron
Ricoh, Tokyo Computer, and Computron will jointly establish a computer software development firm that will produce software for office computers and mainframes made by IBM Corporation.

IBM Japan, Ltd.
Ricoh and IBM Japan will establish Rios Systems Co., Ltd., a joint venture company. The new company will develop office systems, which will include computers and other office equipment. IBM Japan also will supply the AS/400 Model C to Ricoh, which will begin to ship the computer products as the Ricoh I-Series Model 740 computer.

1989

International Chip Corporation
Ricoh and International Chip have developed the Knowledge-Based Silicon Compiler (KBSC), a CAD tool that automates the chip-development process from the logic synthesis level.

IBM Corp.
Ricoh began marketing the Ricoh PS-Series Model 5530-T, a 32-bit PC made by IBM.

Caere Corporation
Ricoh is to OEM Caere's Omnipage page-recognition software for sale with its 286 and 386 PCs.

September 1988

Olympus Optical
The companies agreed to jointly develop, produce, and market erasable optical disk drives.

April 1988

Canon
The companies agreed to exchange each other's plain-paper copiers on an OEM basis.

March 1988

IBM Japan
The companies agreed to market the System/55 and System/36 small business computers in Japan. Ricoh acquired a production plant in Tustin, California, which began operations in mid-1988.

February 1987

Advanced Silicon
Ricoh signed a five-year contract under which Ricoh will fabricate Advanced Silicon's custom ICs.

1982

Pitney Bowes
Ricoh and Pitney Bowes entered into an OEM agreement whereby Pitney Bowes will sell copiers manufactured by Ricoh.

1973

Savin Corporation
Ricoh and Savin entered into an OEM agreement whereby Savin will sell copiers manufactured by Ricoh.

KEY OFFICERS

Hiroshi Hamada
President

Kenji Hiruma
Executive vice president

Hisashi Kubo
Executive vice president

Morio Onoe
Executive vice president

PRINCIPAL INVESTORS

Nippon Life—6.0 percent
Sumitomo Trust—4.5 percent
Asahi Mutual Life Insurance—3.3 percent
Fuji Bank—2.8 percent
Tokai Bank—2.8 percent
Toho Mutual Life Insurance—2.9 percent
Mitsubishi Bank—3.7 percent
Koa Fire & Marine Insurance—3.1 percent
Non-Japanese ownership—4.0 percent

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of US Dollars, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$1.5	$1.5	$2.4	$3.2	$3.8
Cash	0.3	0.3	0.7	1.0	1.1
Receivables	0.5	0.6	0.8	1.1	1.3
Marketable Securities	0.2	0.2	0.3	0.3	0.4
Inventory	0.3	0.4	0.5	0.7	0.8
Other Current Assets	0.1	0.1	0.1	0.1	0.2
Net Property, Plants	$0.5	$0.6	$0.8	$0.9	$1.3
Investments, Other Assets	$0.2	$0.2	$0.4	$0.5	$0.6
Total Assets	$2.1	$2.4	$3.5	$4.6	$5.7
Total Current Liabilities	$0.9	$1.0	$1.5	$2.1	$2.5
Long-Term Debt	$0.3	$0.4	$0.6	$0.3	$0.6
Other Liabilities	$0.1	$0.1	$0.1	$0.1	$0.1
Total Liabilities	$1.3	$1.4	$2.2	$2.5	$3.2
Total Shareholders' Equity	$0.8	$0.9	$1.3	$2.1	$2.5
Common Stock	0.1	0.1	0.2	0.5	0.6
Other Equity	0.3	0.3	0.4	0.7	0.9
Retained Earnings	0.4	0.5	0.7	0.9	1.1
Total Liabilities and Shareholders' Equity	$2.1	$2.4	$3.5	$4.6	$5.7
Income Statement	**1985**	**1986**	**1987**	**1988**	**1989**
Revenue	$2.2	$2.7	$3.7	$4.9	$5.7
US Revenue	1.4	1.6	2.4	3.0	3.6
Non-US Revenue	0.9	1.1	1.3	1.9	2.1
Cost of Sales	$1.4	$1.7	$2.4	$3.1	$3.6
R&D Expense	$0.1	$0.2	$0.2	$0.3	$0.4
SG&A Expense	$0.7	$0.8	$1.1	$1.5	$1.8
Capital Expense	$0.2	$0.2	$0.2	$0.2	$0.5
Pretax Income	$0.1	$0.1	$0.2	$0.3	$0.3
Pretax Margin (%)	6.64	5.24	4.25	5.21	5.05
Effective Tax Rate (%)	57.80	60.90	66.20	61.00	63.00
Net Income	$0.1	$0.1	$0.1	$0.1	$0.1
Shares Outstanding, Millions	406.6	413.1	452.3	581.5	599.7
Per Share Data					
Earnings	$0.15	$0.15	$0.15	$0.21	$0.22
Dividend	$0.04	$0.05	$0.06	$0.07	$0.08
Book Value	0	0	0	0	0
Exchange Rate: US$1 = ¥	¥243.51	¥221.26	¥159.56	¥138.03	¥128.25

Source: Ricoh Company, Ltd.
Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Balance Sheet	1985*	1986	1987	1988	1989
Total Current Assets	¥354.0	¥341.7	¥382.1	¥446.1	¥488.0
Cash	83.5	68.9	110.0	138.0	145.6
Receivables	124.8	128.3	133.1	149.5	170.3
Marketable Securities	48.0	45.2	46.3	48.2	46.4
Inventory	82.7	83.2	76.3	90.7	106.3
Other Current Assets	15.0	16.1	16.4	19.7	19.4
Net Property, Plants	¥119.8	¥131.9	¥124.6	¥129.6	¥165.8
Investments, Other Assets	¥38.7	¥47.0	¥56.0	¥64.8	¥76.4
Total Assets	¥512.5	¥520.6	¥562.7	¥640.5	¥730.2
Total Current Liabilities	¥230.7	¥216.2	¥237.4	¥286.8	¥319.9
Long-Term Debt	¥73.8	¥83.1	¥97.1	¥46.5	¥73.1
Other Liabilities	¥15.8	¥15.0	¥15.1	¥15.7	¥16.6
Total Liabilities	¥320.3	¥314.3	¥349.6	¥349.0	¥409.6
Total Shareholders' Equity	¥192.2	¥206.3	¥213.1	¥291.5	¥320.6
Common Stock	26.8	28.5	29.2	63.1	70.6
Other Equity	68.3	69.8	69.5	102.1	112.4
Retained Earnings	97.1	108.0	114.4	126.3	137.6
Total Liabilities and Shareholders' Equity	¥512.5	¥520.6	¥562.7	¥640.5	¥730.2
Income Statement	**1985***	**1986**	**1987**	**1988**	**1989**
Revenue	¥545.5	¥593.9	¥592.4	¥674.2	¥729.4
US Revenue	332.2	358.5	389.5	418.8	460.8
Non-US Revenue	213.3	235.4	202.9	255.4	268.6
Cost of Sales	¥348.5	¥378.2	¥381.0	¥426.5	¥463.9
R&D Expense	¥29.2	¥36.2	¥36.5	¥42.9	¥46.5
SG&A Expense	¥163.3	¥184.0	¥183.0	¥207.3	¥231.0
Capital Expense	¥50.4	¥48.3	¥24.9	¥34.5	¥59.3
Pretax Income	¥36.2	¥31.1	¥25.2	¥35.1	¥36.8
Pretax Margin (%)	6.64	5.24	4.25	5.21	5.05
Effective Tax Rate (%)	57.80	60.90	66.20	61.00	63.00
Net Income	¥16.8	¥15.5	¥10.9	¥17.1	¥17.8
Shares Outstanding, Millions	406.6	413.1	452.3	581.5	599.7
Per Share Data					
Earnings	¥37.14	¥33.93	¥24.09	¥29.48	¥28.04
Dividend	¥10.00	¥10.00	¥10.00	¥10.00	¥10.00
Book Value	¥0.47	¥0.50	¥0.47	¥0.11	¥0.12

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Key Financial Ratios	1985*	1986	1987	1988	1989
Liquidity					
Current (Times)	1.53	1.58	1.61	1.56	1.53
Quick (Times)	1.18	1.20	1.29	1.24	1.19
Fixed Assets/Equity (%)	62.33	63.94	58.47	44.46	51.72
Current Liabilities/Equity (%)	120.03	104.80	111.40	98.39	99.78
Total Liabilities/Equity (%)	166.65	152.35	164.05	119.73	127.76
Profitability (%)					
Return on Assets	-	3.00	2.01	2.84	2.60
Return on Equity	-	7.78	5.20	12.38	9.83
Profit Margin	3.08	2.61	1.84	2.54	2.44
Other Key Ratios					
R&D Spending % of Revenue	5.35	6.10	6.16	6.36	6.38
Capital Spending % of Revenue	9.24	8.13	4.20	5.12	8.13
Employees	25,000	26,500	28,000	33,000	12,700
Revenue (¥K)/Employee	¥21.82	¥22.41	¥21.16	¥20.43	¥57.43
Capital Spending % of Assets	9.83	9.28	4.43	5.39	8.12
Exchange Rate: US$1=¥	¥243.51	¥221.26	¥159.56	¥138.03	¥128.25

*Fiscal 1985 has been translated at the rate of ¥259 to US$1.

Source: Ricoh Company, Ltd.
Annual Reports
Dataquest (1990)

Sanken Electric Co., Ltd.

3-6-3 Kitano
Niiza City, Saitama 352, Japan
Telephone: (0484) 72-1111
Fax: (0484) 71-6249
Dun's Number: 69-056-6211

Date Founded: 1946

CORPORATE STRATEGIC DIRECTION

Sanken Electric Co., Ltd. (Sanken), is one of 18 member companies of the Sanken Group. Sanken Group is organized so that each member company is integrated with and offers maximum support to the whole. Sanken Electric acts as coordinator as well as taking the main role in R&D, applications engineering, and sales for the group.

Sanken Electric was founded in 1946 as a manufacturer specializing in the power electronics field. Today, the Company is a manufacturer of semiconductors, switching power supplies, and power supply equipment incorporating its original technologies.

During fiscal year ended March 1990, Sanken almost met its corporate goal of sales of ¥100 million (US$244.6 million). Total revenue for fiscal year ended March 1990 reached ¥97.5 million (US$706.5 million), an increase of 10.1 percent from fiscal year ended March 1989 of ¥81 million (US$587 million). (Percentage changes refer to ¥ amounts only; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) Total net income for fiscal year ended March 1990 totaled ¥2.3 million (US$16.3 million). Sanken Electric employs 5,500 people worldwide.

Most of Sanken's 1989 revenue came from semiconductors, which accounted for 52.6 percent of the Company's revenue. The Switching Power Supply Division accounted for another 31.4 percent, and Power Supply Equipment Division 16 percent.

Sanken Electric's capital expenditure for fiscal 1989 amounted to ¥2.4 million (US$17.3 million). Including investments made by member companies of the Sanken Group, capital investment totaled ¥17.1 million (US$123.9 million) during the fiscal 1989. In March 1989, to help meet the expanding demand for semiconductors, Yamagata Sanken Co., Ltd., opened a new plant. This facility, representing a capital investment of ¥7.4 billion (US$53.6 million), has enabled semiconductor chip production to be doubled. All semiconductor production is in Japan. This does not apply to switching power supply.

Research and development expenditure totaled ¥4 billion (US$29 million) for fiscal 1989.

The translation of yen amounts into US dollar amounts is included for convenience and has been made as a matter of arithmetical computation only, at a rate of US$1 equals ¥138, the rate prevailing on December 31, 1989.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this backgrounder.

BUSINESS SEGMENT STRATEGIC DIRECTION

Sanken's three major divisions are Semiconductor, Switching Power Supply, and Power Supply Equipment.

Semiconductor Division

According to Sanken, Semiconductor Division sales in fiscal 1989 totaled ¥51.3 billion (US$371 million). The Division's share of total sales was 52.6 percent. Factors contributing to the semiconductor demand were color TVs and other home appliances, automobile electronic devices, and computer peripheral and communications equipment.

Sanken has been able to differentiate itself from its competitors by developing the specialized technologies that are required to supply high-voltage and high-power products meeting customers' applications. Sanken has been a pioneer in the production of power hybrid ICs, which mainly combine power semiconductor chips and thick-film circuits.

According to Dataquest estimates, Sanken Electric ranks 13th in worldwide semiconductor market share for total discrete products and 18th in worldwide semiconductor market share for total analog products.

Switching Power Supply Division

The Switching Power Supply Division's sales in fiscal 1989, including circuit protector sales, totaled ¥30.6 billion (US$221.7 million), or 31.4 percent of total sales.

Switching power supplies are used to convert commercial alternating current into stable direct current using high frequency. Office automation and factory automation equipment employ switching power supplies.

Power Supply Equipment Division

The Power Supply Equipment Division's sales in fiscal 1989 amounted to ¥15.6 million (US$112.9 million), accounting for 16 percent of total sales.

This division encompasses the entire range of power supply units except for switching power supplies. The major products are large-size power supply equipment for on-line information and communications systems, and inverters for motor control.

Further Information

For further information about the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Millions of US Dollars)

	1985	1986	1987	1988	1989
Five-Year Revenue	$259.4	$372.8	$455.2	$632.8	$706.5
Percent Change	-	43.70	2.10	39.03	11.65
Capital Expenditure	$37.7	$59.2	$34.5	$54.7	$123.2
Percent of Revenue	14.52	15.87	7.58	8.64	17.35
R&D Expenditure	$4.2	$5.9	$6.9	$7.8	$29.0
Percent of Revenue	-	40.50	16.95	13.04	271.79
Number of Employees	4,749	4,830	4,760	5,000	5,500
Revenue ($K)/Employee	$54.63	$77.18	$95.62	$126.56	$128.50
Net Income	$8.4	$5.9	$6.9	$23.4	$21.7
Percent Change	-	(29.29)	16.55	239.84	(7.25)
Exchange Rate (US$1=¥)	¥239	¥169	¥145	¥128	¥138

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Sanken Electric Co., Ltd.
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1985	1986	1987	1988	1989
Asia/Pacific	90.00	90.00	89.00	86.00	85.00
Japan	90.00	90.00	89.00	86.00	85.00
All Others	10.00	10.00	11.00	14.00	15.00

Source: Sanken Electric Co., Ltd.
Annual Reports

1989 SALES OFFICE LOCATIONS

North America—1
Europe—1
Asia/Pacific—7
ROW—2

Europe

Sanken Electric Europe Ltd. (United Kingdom)

North America

Sanken Electric U.S.A. Corp. (United States)

MANUFACTURING LOCATIONS

Asia/Pacific

Fukushima, Japan
  Production facility for LEDs, ceramic varistors
Ishisawa, Japan
  Highly automated mass assembly of diodes, transistors, hybrid ICs
Kashima, Japan
  Assembly
Kawagow Works, Japan
  Production of power supply equipment
Ogose Denshi, Japan
  Production of switching power supplies
Saitama, Japan
  Fabrication facility for power transistors, diodes, LEDs
Yamagata, Japan
  Fabrication of power transistors, diodes, LEDs

SUBSIDIARIES

Asia/Pacific

Chiba Sanken Co., Ltd. (Japan)
Fukushima Sanken Co., Ltd. (Japan)
Ishikawa Sanken Co., Ltd. (Japan)
Kashima Sanken Co., Ltd. (Japan)
Korea Sanken Co., Ltd. (South Korea)
Ogose Denshi Co., Ltd. (Japan)
Ogose Koden Co., Ltd. (Japan)
Saiden Co., Ltd. (Japan)
Sanshin Electric Co., Ltd. (Japan)
Sanken Electric Hong Kong Co., Ltd. (Hong Kong)
Sanken Densetsu Co., Ltd. (Japan)
Sanken Dosan Co., Ltd. (Japan)
Sanken Kosan Co., Ltd. (Japan)
Sanken-Sirpax Co., Ltd. (Japan)
SET Engineering Co., Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1988

Airpax Corporation
  Sanken formed a joint venture with US company Airpax Corporation called Sanken Airpax Company, Ltd., to develop new products that will be produced in the United States.

1987

International Rectifier
  Sanken would package and market US company International Rectifier's HEXFET power MOSFET.

MERGERS AND ACQUISITIONS

Information is not available.

KEY OFFICERS

Goryosaku Matsumoto
  Chairman

Koichi Kotani
  President

Koichiro Morita
  Executive vice president

PRINCIPAL INVESTORS

Daihyaku Life Insurance—5.8 percent
Saitama Bank—4.9 percent

FOUNDERS

Information is not available.

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of US Dollars)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$184.1	$224.9	$303.4	$276.2	$364.0
Cash	33.5	47.3	69.0	71.1	125.5
Receivables	85.9	100.6	144.8	125.5	138.1
Inventory	54.6	71.0	82.8	62.8	79.5
Other Current Assets	2.9	5.9	6.9	16.7	4.2
Net Property, Plants	$63.5	$124.3	$137.9	$87.9	$133.9
Other Assets	$10.8	$23.7	$34.5	$16.7	$33.5
Total Assets	$258.4	$372.8	$475.9	$380.8	$531.4
Total Current Liabilities	$142.3	$183.4	$206.9	$320.3	$355.1
Long-Term Debt	$20.9	$41.4	$89.7	$171.9	$333.3
Other Liabilities	$8.4	$11.8	$13.8	$23.4	0
Total Liabilities	$171.5	$236.7	$310.3	$515.6	$688.4
Total Shareholders' Equity	92.1	136.1	165.5	265.6	268.1
Common Stock	33.5	47.3	62.1	101.6	101.4
Other Equity	37.7	53.3	62.1	109.4	108.7
Retained Earnings	20.9	35.5	475.9	789.1	971.0
Total Liabilities and Shareholders' Equity	$263.6	$372.8	$475.9	$789.1	$971.0
Income Statement	**1985**	**1986**	**1987**	**1988**	**1989**
Revenue	$259.4	$372.8	$455.2	$632.8	$706.5
Cost of Sales	$200.8	$313.6	$379.3	$515.6	$572.5
SG&A Expense	$20.9	$35.5	$48.3	$70.3	$72.5
R&D Expense	$4.2	$5.9	$6.9	$7.8	$29.0
Capital Expense	$37.7	$59.2	$34.5	$54.7	$17.3
Net Income	$8.4	$5.9	$6.9	$23.4	$21.7
Exchange Rate (US$1=¥)	¥239	¥169	¥145	¥128	¥138

Source: Sanken Electric Co., Ltd.
Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of Yen*)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	¥44,000	¥38,000	¥44,000	¥66,000	¥87,000
Cash	8,000	8,000	10,000	17,000	30,000
Receivables	21,000	17,000	21,000	30,000	33,000
Inventory	14,000	12,000	12,000	15,000	19,000
Other Current Assets	1,000	1,000	1,000	4,000	1,000
Net Property, Plants	¥16,000	¥21,000	¥20,000	¥21,000	¥32,000
Other Assets	¥3,000	¥4,000	¥5,000	¥4,000	¥8,000
Total Assets	¥63,000	¥63,000	¥69,000	¥101,000	¥134,000
Total Current Liabilities	¥34,000	¥31,000	¥30,000	¥41,000	¥49,000
Long-Term Debt	¥5,000	¥7,000	¥13,000	¥22,000	¥46,000
Other Liabilities	¥2,000	¥2,000	¥2,000	¥3,000	0
Total Liabilities	¥41,000	¥40,000	¥45,000	¥66,000	¥95,000
Total Shareholders' Equity	¥22,000	¥23,000	¥24,000	¥34,000	¥37,000
Converted Preferred	8,000	8,000	9,000	13,000	14,000
Other Equity	9,000	9,000	9,000	14,000	15,000
Retained Earnings	5,000	6,000	69,000	101,000	134,000
Total Liabilities and Shareholders' Equity	¥63,000	¥63,000	¥69,000	¥101,000	¥134,000

Income Statement	1985	1986	1987	1988	1989
Revenue	¥62,000	¥63,000	¥66,000	¥81,000	¥97,500
Cost of Sales	¥48,000	¥53,000	¥55,000	¥66,000	¥79,000
SG&A Expense	¥5,000	¥6,000	¥7,000	¥9,000	¥10,000
R&D Expense	¥1,000	¥1,000	¥1,000	¥1,000	¥4,000
Capital Expense	¥9,000	¥10,000	¥5,000	¥7,000	¥17,000
Net Income	¥2,000	¥1,000	¥1,000	¥3,000	¥3,000

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of Yen*)

Key Financial Ratios	1985	1986	1987	1988	1989
Liquidity					
Current (Times)	1.29	1.23	1.47	1.61	1.78
Quick (Times)	0.88	0.84	1.07	1.24	1.39
Fixed Assets/Equity (%)	72.73	91.30	83.33	61.76	86.49
Current Liabilities/Equity (%)	154.55	134.78	125.00	120.59	132.43
Total Liabilities/Equity (%)	186.36	173.91	187.50	194.12	256.76
Profitability (%)					
Return on Assets	-	1.59	1.52	3.53	2.55
Return on Equity	-	4.44	4.26	10.34	8.45
Profit Margin	3.23	1.59	1.52	3.70	3.06
Other Key Ratios					
R&D Spending % of Revenue	8.06	9.52	10.61	11.11	10.20
Capital Spending % of Revenue	14.52	15.87	7.58	8.64	17.35
Employees	4,749	4,830	4,760	5,000	5,000
Revenue (¥K)/Employee	¥13,055.38	¥13,043.48	¥13,865.55	¥16,200.00	¥19,600.00
Capital Spending % of Assets	14.29	15.87	7.25	6.93	12.69
Exchange Rate (US$1=¥)	¥239	¥169	¥145	¥128	¥138

*Rounded

Source: Sanken Electric Co., Ltd.
Annual Reports
Dataquest (1990)

Sanyo Electric Company, Ltd.

18, Keihan-Hondori 2-chome
Moriguchi, Osaka 570 Japan
Telephone: (06) 991-1181
Fax: (06) 991-5411
Dun's Number: 08-190-0144

Date Founded: 1950

CORPORATE STRATEGIC DIRECTION

Sanyo Electric Company, Ltd., was established in 1950. The Company manufactures a wide range of electric and electronic equipment, including audio and video equipment, information and communications equipment, home appliances, commercial refrigerators and freezers, batteries, solar batteries, semiconductors, compressors, and electronic devices.

Sanyo Electric Company also is the core company of the Sanyo Group, a multinational enterprise with production and sales operations throughout the world. In December 1986, the two largest companies in the Sanyo Group—Sanyo Electric Company, Ltd., and Tokyo Sanyo Electric Company, Ltd. (the semiconductor manufacturer)—merged to form a new Sanyo Electric Company, Ltd. Having absorbed Tokyo Sanyo, the Company is streamlining its product line and trying to boost its position in the semiconductor industry with relatively high investments in plants and equipment.

Sanyo's total revenue increased by 12.4 percent to ¥1.4 trillion (US$10.2 billion) in fiscal 1989 from ¥1.2 trillion (US$9.6 billion) in fiscal 1988. Domestic sales grew 13.6 percent, contributing ¥833.7 billion (US$6.1 billion) to total revenue, while international sales grew 5.8 percent, accounting for ¥555.9 billion (US$4.1 billion) of total revenue.

Sanyo's net income totaled ¥16.8 billion (US$0.1 billion) in fiscal 1989, an increase of 173 percent over the fiscal 1988 figure of ¥6.1 billion (US$47.5 million). Research and development (R&D) totaled ¥66.5 billion (US$487.6 million) and was 7.6 percent of revenue in fiscal 1989. This increase is 19.8 percent over the fiscal 1988 figure of ¥55.5 billion (US$432.6 million). Part of this expenditure was invested in the development of a high-luminance blue light-emitting diode (LED), a full-color LED, a four-beam visible ray semiconductor laser, and a high-performance satellite broadcasting converter.

Sanyo's capital expenditure totaled ¥105.8 billion (US$775.8 million), representing 7.6 percent of total revenue. This increase is 88.0 percent over the previous fiscal year figure of ¥56.3 billion (US$438.8 million). A significant portion of this expenditure was used to expand production facilities for semiconductors and batteries.

The Company employed approximately 55,526 people in fiscal 1989.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information is not available on revenue by distribution channel. Tables 3 and 4, which are comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Semiconductors

As mentioned previously, Sanyo Electric merged with Tokyo Sanyo Electric, the Sanyo Group's manufacturing arm for semiconductor operations. The Company has seven product areas: bipolar digital, MOS microcomponents, analog, optoelectronics, MOS memory, MOS logic, and discrete. Dataquest estimates that Sanyo ranked seventh among Japanese semiconductor manufacturers and twelfth in the worldwide semiconductor market with a 2.1 percent market share and ¥184 billion (US$1.36 billion).

Sanyo's analog chips contributed nearly 39.0 percent of the Company's total semiconductor revenue in 1989. Dataquest estimates that Sanyo generated ¥73.1 billion (US$530 million) in the analog market and ranked first in Japan with a 10.8 percent market share with ¥55.3 billion (US$401 million) in revenue in 1989.

Sanyo's second largest market is in the MOS logic chip segment, which generated ¥24.0 billion (US$178 billion) worldwide in 1989. MOS memory chips contributed ¥17.9 billion (US$130 million), while the MOS microcomponents contributed ¥9.7 billion (US$70 billion) worldwide in 1989. The technology used in these chips was 93 percent CMOS and 7 percent N/PMOS.

The Company ranked eighth in the Japanese bipolar digital logic market with a 3.5 percent market share of ¥8.6 billion (US$62 million) in 1989. Sanyo generated ¥9.3 billion (US$67 million) in revenue for worldwide sales of the bipolar digital logic chip in 1989. All bipolar digital chips were designed in TTL bipolar.

Sanyo increased its semiconductor capital spending more than 100 percent in fiscal 1989 over 1988. Approximately 40 percent will be used for DRAM development, and 60 percent will be used for expanding the capacity of microcomponents. The Company established the VLSI research center in Gifu prefecture to do R&D on 16Mb and 64Mb DRAMs and ASICs. Sanyo announced plans to enter the BiCMOS market. The Company is developing a proprietary bipolar technology and will make proprietary logic ICs at the Niigata facility.

In the memory segment, Sanyo developed 60 to 80ns, 4Mb DRAMs with Mosaid of Canada both in anticipation of HDTV-related applications and to diversify the IC product base. Sanyo began production of 1 Mb DRAMs and announced the start of 256K SRAM production at its VLSI center. Sanyo has shifted its emphasis by decreasing production of the 16K and 64K SRAMs and increasing production of the more powerful 256K SRAMs and 1Mb DRAMs.

The Company's most successful products are in the analog area. A leading supplier of IC kits for VCRs, Sanyo has developed a single-chip solution for 1990/1991 VCR signal processing and introduced a 1-chip HDTV converter LSI to process video signals for MUSE/NTSC converters.

Copiers

Sanyo produces plain paper copiers (PPCs) at its Information Systems Business Headquarters. The Company supplies PPCs to Apeco and TOWA to market in Europe and to TOWA and Uchida to market in Japan. Sanyo now distributes its copiers in the United States through three distributors/wholesalers to its 320 dealers across the country. According to Dataquest, Sanyo ranked eighteenth in the US market with 3,100 units shipped in 1989. A majority of these units were shipped in the PC segment and Segment 1 of the market, although Sanyo is active in Segments 2 and 3. The models include the SFT-50, the SFT-50L, the SFT-62, the SFT-70, the SFT-Z90 (introduced in January 1990), the SFT-100, the SFT-Z120, and the SFT-133.

Personal Computers

According to Dataquest, Sanyo sold 147,000 PCs worldwide during 1989, with an if-sold value (ISV) of ¥53.9 billion (US$390.9 million) with less than 1 percent of worldwide market share. However, Sanyo is the fourth largest Japanese PC supplier in the world. Sanyo's most lucrative computers include the MBC-25FK, which shipped 30,000 units worldwide, and the MBC-17 Plus Series, which shipped 93,000 units worldwide (30,000 of which were in the United States).

Facsimile

Sanyo produces a full line of fascimile machines that include the SF-2U, the SF-5U, the SANFAX 200, the SANFAX-515H, the SANFAX-520, the SANFAX-525, the SANFAX-725, and the SANFAX-735. Sanyo is not a major player in the fax market but is looking to expand into it.

Consumer Products

Sanyo Electronics is a major consumer electronics equipment manufacturer located in the United States. More than 700 companies manufacture consumer electronics equipment in the United States, accounting for more than $20 billion in revenue. Dataquest does not track consumer electronics, which are a major part of Sanyo's business.

Further Information

For further information pertaining to the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Billions of US Dollars)

	1985	1986	1987	1988	1989
Five-Year Revenue	$6.3	$7.3	$8.0	$9.6	$10.2
Percent Change	-	16.45	9.64	20.01	5.71
Capital Expenditure	$0.3	$0.3	$0.3	$0.4	$0.5
Percent of Revenue	4.31	3.64	4.06	4.55	7.61
R&D Expenditure	$0.1	$0.2	$0.4	$0.4	$0.5
Percent of Revenue	1.63	2.12	4.48	4.49	4.79
Number of Employees	25,429	25,599	40,590	39,179	55.526
Revenue (US$K)/Employee	$0.2	$0.3	$0.2	$0.2	$0.2
Net Income	$0.2	0	($0.1)	0	$0.1
Percent Change	-	(94.41)	(883.30)	164.30	164.30
Exchange Rate (US$1=¥)	¥238.41	¥161.21	¥147.70	¥128.30	¥136.37

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Sanyo Electric Company
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1985	1986	1987	1988	1989
Japan	34.60	45.50	53.70	59.00	60.00
International	65.40	54.50	46.30	41.00	40.00
North America	40.60	33.30	23.20	16.00	17.00
Europe	8.00	9.00	10.20	12.00	11.00
Asia/Pacific	8.60	6.00	8.10	9.00	9.00
ROW	8.20	6.20	4.80	4.00	3.00

Source: Sanyo Electric Company
Annual Reports
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

North America—6
Europe—7
Asia/Pacific—27

MANUFACTURING LOCATIONS

Information is not available.

SUBSIDIARIES

North America

Sanyo Fisher Corporation (United States)

Asia/Pacific

Niigata Sanyo Electronic Co., Ltd. (Japan)
Sanyo Electric Chubu Sales Co., Ltd. (Japan)
Sanyo Electric Chugoku Sales Co., Ltd. (Japan)
Sanyo Electric Credit Co., Ltd. (Japan)
Sanyo Electric Hokkaido Sales Co., Ltd. (Japan)
Sanyo Electric Kinki Sales Co., Ltd. (Japan)
Sanyo Electric Kyushu Sales Co., Ltd. (Japan)
Sanyo Electric Tohoku Sales Co., Ltd. (Japan)
Sanyo Electric Tokki Co., Ltd. (Japan)
Sanyo Electric Tokyo Sales Co., Ltd (Japan)
Sanyo Electric Trading Co., Ltd. (Japan)
Sanyo Electronics (Singapore)
Sanyo Manufacturing Corporation (Japan)
Sanyo Semiconductor Co., Ltd. (Hong Kong)
Tottori Sanyo Electric Co., Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

SGS-Thomson Microelectronics
SGS-Thomson and Sanyo have agreed to use each others' sales channels in Europe and Asia.

Olivetti
Olivetti, Sanyo, and Mitsui jointly formed Olivetti Sanyo Industriale (Italy) to produce 200,000 facsimile machines.

MERGERS AND ACQUISITIONS

Information is not available.

KEY OFFICERS

Satoshi Iue
President

Masaru Yamano
Executive vice president

Yasuaki Takano
Executive vice president

Meiji Kurahashi
Executive vice president

PRINCIPAL INVESTORS

Information is not available.

FOUNDERS

Information is not available.

Table 3
Comprehensive Financial Statement
Fiscal Year Ending November
(Billions of US Dollars, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$3.7	$4.7	$7.0	$8.8	$10.1
Cash	1.1	1.3	1.7	2.7	3.2
Receivables	1.4	2.0	2.5	3.0	3.0
Marketable Securities	0.2	0.1	1.4	1.5	1.3
Inventory	0.8	1.1	1.3	1.4	2.2
Other Current Assets	0.1	0.1	0.2	0.2	0.3
Net Property, Plants	$0.8	$1.2	$2.4	$2.7	$3.4
Other Assets	$0.8	$1.2	$1.1	$1.5	$1.4
Total Assets	$5.3	$7.1	$10.5	$13.0	$14.9
Total Current Liabilities	$3.0	$3.9	$4.6	$6.1	$7.1
Long-Term Debt	$0.2	$0.2	$1.2	$1.2	$1.9
Other Liabilities	$0.2	$0.3	$0.4	$0.5	$0.5
Total Liabilities	$3.4	$4.4	$6.2	$7.8	$9.6
Minority Interest	$0.1	$0.1	$0.1	$0.1	$0.1
Total Shareholders' Equity	$1.8	$2.6	$4.2	$5.1	$5.2
Converted Preferred Stock	0	0	0	0	0
Common Stock	0.3	0.4	0.7	1.0	1.1
Other Equity	0.5	0.7	2.2	2.6	2.6
Retained Earnings	1.1	1.5	1.4	1.6	1.5
Total Liabilities and Shareholders' Equity	$5.3	$7.1	$10.5	$13.0	$14.9
Income Statement	**1985**	**1986**	**1987**	**1988**	**1989**
Revenue	$6.3	$7.3	$8.0	$9.6	$10.2
US Revenue	2.2	3.3	4.3	5.7	6.1
Non-US Revenue	4.1	4.0	3.7	3.9	4.1
Cost of Sales	$5.1	$6.2	$6.8	$8.1	$8.0
R&D Expense	$0.1	$0.2	$0.4	$0.4	$0.5
SG&A Expense	$1.0	$1.2	$1.4	$1.6	$1.9
Capital Expense	$0.3	$0.3	$0.3	$0.4	$0.8
Pretax Income	$0.3	$0.1	0	$0.2	$0.3
Pretax Margin (%)	4.50	1.06	0.05	1.96	3.35
Effective Tax Rate (%)	57.50	57.50	56.00	56.00	56.00
Net Income	$0.2	0	($0.1)	0	$0.1
Shares Outstanding, Millions	1,188.9	1,133.6	1,654.9	1,749.9	2,013.0
Per Share Data					
Earnings	$0.13	$0.01	0	$0.03	$0.06
Dividends	$0.03	$0.05	$0.05	$0.06	$0.06
Book Value	0	0	0	0	0
Exchange Rate (US$1=¥)	¥238.41	¥161.21	¥147.70	¥128.30	¥136.37

Source: Sanyo Electric Company
Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending November
(Billions of Yen, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	¥876.2	¥751.0	¥1,032.9	¥1,124.7	¥1,373.5
Cash	267.3	216.0	251.8	341.8	441.9
Receivables	326.3	320.9	363.7	390.1	409.1
Marketable Securities	55.0	20.1	201.4	186.6	183.5
Inventory	197.7	172.4	187.5	179.4	298.2
Other Current Assets	29.9	21.6	28.5	26.8	40.8
Net Property, Plants	¥189.9	¥195.3	¥352.8	¥352.6	¥465.6
Other Assets	¥193.6	¥199.2	¥168.3	¥191.7	¥187.9
Total Assets	¥1,259.7	¥1,145.5	¥1,554.0	¥1,669.0	¥2,027.0
Total Current Liabilities	¥723.3	¥632.9	¥680.6	¥788.3	¥972.9
Long-Term Debt	¥54.7	¥40.3	¥180.3	¥149.9	¥260.9
Other Liabilities	¥39.7	¥40.8	¥57.9	¥61.1	¥72.1
Total Liabilities	¥817.7	¥714.0	¥918.8	¥999.3	¥1,305.9
Minority Interest	¥21.5	¥16.9	¥10.4	¥9.7	¥7.6
Total Shareholders' Equity	¥420.6	¥414.6	¥624.8	¥660.0	¥713.5
Converted Preferred Stock	0	0	0	0	0
Common Stock	61.6	64.1	105.7	128.8	153.6
Other Equity	108.6	107.6	308.6	330.2	358.5
Retained Earnings	250.4	242.9	210.5	201.0	201.4
Total Liabilities and Shareholders' Equity	¥1,259.7	¥1,145.5	¥1,554.0	¥1,669.0	¥2,027.0
Income Statement	**1985**	**1986**	**1987**	**1988**	**1989**
Revenue	¥1,500.0	¥1,181.1	¥1,186.4	¥1,236.8	¥1,389.6
US Revenue	519.0	537.4	637.1	729.7	833.7
Non-US Revenue	981.0	643.7	549.3	507.1	555.9
Cost of Sales	¥1,214.3	¥995.4	¥997.8	¥1,032.9	¥1,084.9
R&D Expense	¥24.4	¥25.0	¥53.2	¥55.5	¥66.5
SG&A Expense	¥232.7	¥197.6	¥199.5	¥208.1	¥259.4
Capital Expense	¥64..7	¥43.0	¥48.2	¥56.3	¥105.8
Pretax Income	¥67.6	¥12.5	¥608.0	¥24.3	¥46.6
Pretax Margin (%)	4.50	1.06	51.25	1.96	3.35
Effective Tax Rate (%)	57.50	57.50	56.00	56.00	56.00
Net Income	¥36.2	¥2.1	(¥17.5)	¥6.1	¥16.8
Shares Outstanding, Millions	1,188.9	1,133.6	1,654.9	1,749.9	2,013.0
Per Share Data					
Earnings	¥30.90	¥1.90	(¥10.60)	¥3.50	¥8.80
Dividend	¥8.00	¥8.00	¥8.00	¥8.00	¥8.00
Book Value	¥0.35	¥0.37	¥0.38	¥0.38	¥0.35

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending November
(Billions of Yen, except Per Share Data)

Key Financial Ratios	1985	1986	1987	1988	1989
Liquidity					
Current (Times)	1.21	1.19	1.52	1.43	1.41
Quick (Times)	0.94	0.91	1.24	1.20	1.11
Fixed Assets/Equity (%)	45.15	47.11	56.47	53.42	65.26
Current Liabilities/Equity (%)	171.97	152.65	108.93	119.44	136.36
Total Liabilities/Equity (%)	194.42	172.21	147.06	151.41	183.03
Profitability (%)					
Return on Assets	-	0.21	(1.34)	0.41	0.88
Return on Equity	-	0.60	(3.48)	1.02	2.37
Profit Margin	2.41	0.18	(1.48)	0.50	1.21
Other Key Ratios					
R&D Spending % of Revenue	1.63	2.12	4.48	4.49	4.79
Capital Spending % of Revenue	4.31	3.64	4.06	4.55	7.61
Employees	25,429	25,599	40,590	39,179	55,526
Revenue ($K)/Employee	¥0.20	¥0.3	¥0.2	¥0.2	¥0.2
Capital Spending % of Assets	5.14	3.75	3.10	3.37	5.22
Exchange Rate (US$1=¥)	¥238.41	¥161.21	¥147.70	¥128.30	¥136.37

Source: Sanyo Electric Company
Annual Reports
Dataquest (1990)

Seiko Epson Corporation

3-5, 3-chome, Awe, Suwa-shi
Nagno-ken 392, Japan
Telephone: 0266 (52) 3131
Fax: 0266 (53) 4844
Dun's Number: Not available

Date Founded: 1985

CORPORATE STRATEGIC DIRECTION

Seiko Epson Corporation is a privately held parent company of Epson America, which produces and markets Epson's products in North America. The Seiko Epson Corporation was established in 1985 through the merger of Suwa Seikosha Co., Ltd., and Epson Corporation. In 1942, Suwa Seikosha began manufacturing Seiko-brand watches and in 1961 established a subsidiary, Epson Corporation, to produce watch parts. In response to opportunities arising from the 1964 Tokyo Olympic Games, Suwa Seikosha developed quartz watch mechanisms and Epson-refined devices that record and print time-related statistics. Today, Seiko Epson is a $3 billion* worldwide, diversified, multinational group of manufacturing and marketing companies that produce and distribute a broad array of electronic and other high-technology products. These products include printers, computers, office machines, watches, semiconductor devices, liquid crystal displays, disk drives, electronic components, assembly robots, FA systems, and corrective lenses. Epson America along with Epson Canada, Ltd., and Epson Latin America, Inc., form the western hemisphere marketing affiliate of Seiko Epson.

Seventy percent of Seiko Epson's products are sold abroad, outside of Japan. The Company has been aggressively expanding its international operations, focusing strongly on reinforcing marketing and production networks and established R&D facilities outside of Japan. Seiko Epson employs 8,150 people worldwide.

Epson America, recognized as the world leader in 9-pin and 24-pin dot matrix printer technology, was established in 1975 and is headquartered in Torrance, California. Epson America is the US high-tech operating unit of Seiko Epson, providing comprehensive marketing, customer service, OEM products, finance, sales, and administrative services to support Epson products to resellers and end users in North America. Epson America is a leading manufacturer of microcomputer printers. In fiscal 1989, Epson America had sales of $300 million and employed 1,000 people.

Seiko Epson's overseas production strategy has been to establish production facilities closer to the Company's overseas markets, notably in Europe and North America. In 1983, Seiko Epson began assembling PC printers at Epson France S.A., which also sells the Company's products in several European countries and in French-speaking parts of Africa. The initial step toward full-scale production in the United States was initiated in 1985 with the establishment of Epson Portland Inc. to assemble terminal printers. In July 1986, Epson Portland commenced production of these items using many locally procured materials and components. Furthermore, the Company's UK affiliate, Epson Telford, Ltd., will be manufacturing printers featuring a high percentage of locally produced parts.

In addition to establishing subsidiaries overseas, Seiko Epson is strengthening its marketing and production networks through the establishment of joint ventures and prominent organizations in various nations. In 1985 the Company established Epson Italia S.p.A., together with a leading Italian distributor of office automation equipment, to market computers and peripheral devices. In 1986, Seiko Epson established a company in Spain with a local distributor of information processing systems. The new company, Epson-STI S.A., sells computers and peripheral devices and provides maintenance, repair, and other after-sales services. In addition, the Company has formed four joint ventures that are actively promoting Seiko Epson's products in Central America and South America.

* All dollar amounts are in US dollars.

No financial statements are included because Seiko Epson is a privately held company. Dataquest did make attempts to acquire financial data from Epson but was refused.

BUSINESS SEGMENT STRATEGIC DIRECTION

Printers

Epson's involvement in printers began in 1964 with the development of a high-speed, lightweight printer for the Tokyo Olympic Games. The technology created for that project was used subsequently to produce printer mechanisms for calculators and cash registers, culminating in the introduction in 1968 of the world's first commercially successful miniature printer. This history formed the beginnings of the Company's involvement in personal computers and peripheral devices.

The MX series of dot matrix printers, first marketed in 1980, propelled Epson as a market leader. Compact, versatile, economical, and compatible with most popular personal computers, MX printers have been among the Company's top sellers. Currently, the Company has more than 50 patents for technology incorporated in the MX series. Dataquest estimates Epson to be the top-ranking vendor of serial, impact, dot matrix printers.

Also, the Company provides page printer products and presently acts as the original equipment manufacturer.

Epson has increased its line of dot matrix printers with the addition of the FX, RX, LQ, and EPL series.

Computers and Office Machines

Epson began marketing personal computers worldwide in 1982. The development of the HX-20 portable computer marked the Company's entry in the PC market. In 1983, Epson introduced a line of desktop personal computers for business applications. According to Dataquest, Epson held 1.5 percent of the worldwide personal computer market, ranking in the top 10 in 1988, based on factory revenue.

Semiconductor Devices

Epson began commercial production of semiconductor devices at its Fujimi plant in Japan. Devices manufactured at that plant are incorporated into Epson's products and marketed to electronic manufacturers worldwide. Currently, the Company is focusing on CMOS processing technology. In using CMOS technology, the Company has developed a number of sophisticated products, including 256-kilobit static random-access memories. Dataquest ranks Epson 30 in the worldwide semiconductor market in 1988.

Liquid Crystal Displays

Epson is among the world's leading manufacturer of liquid crystal displays (LCDs). The Company entered the LCD market in 1973 with the production of an LCD for watch displays. The variety of products incorporating these devices has since expanded to include calculators, pocket color televisions, and instrument panels for automobiles and aircraft.

In 1984, Epson successfully developed the world's first LCD pocket color television. Advances in LCD technologies promise to play a central role in the development of next-generation image-processing devices and systems.

Disk Drives

Epson began developing floppy disk drives (FDDs) in 1983. Currently, the Company produces a line of 5.25-inch and 3.5-inch FDDs. Also, Epson has introduced a 1-inch-height, 3.5-inch FDDs. The Company also has entered the hard disk drive (HDD) market. Dataquest estimates Epson to hold 5 percent of the 5.25-inch floppy market in 1988, based on factory revenue.

Electronic Components and Assembly Robots

In electronic components, the Company is concentrating on the production and sale of such devices as color filters, displays, and modules for LCD pocket color televisions. Also, the Company is involved in hard-disk media and components for PCs, peripherals, and videocassette recorders, as well as for precision watch parts.

The Company is involved also in the production of small-scale assembly robots and other precision production equipment. Seiko Epson currently is marketing assembly robots both in Japan and overseas.

Further Information

For more information about the Company's business segments, please contact the appropriate industry service.

1989 SALES OFFICE LOCATIONS

North America—18
Europe—6
Asia/Pacific—10
  Japan—15
ROW—Not available

MANUFACTURING LOCATIONS

North America

Portland, Oregon
  Manufacture and assembly of personal computers and terminal printers

Europe

Levallois, France
  Assembly of terminal printers

Asia/Pacific

Chinop, Japan
  Production of LCD panels and masks for display monitors
Fujimi, Japan
  Production of semiconductor equipment
Hirooka, Japan
  Design and production of printers and electronic equipment
Kanbayashi, Japan
  Assembly of electronic equipment and printers
Matsumoto, Japan
  Production of LCD panels and modules
Matsushima, Japan
  Production of spectacle and contact lenses
Murai, Japan
  Production of watch parts; assembly of printer heads
Okaya, Japan
  Assembly of printer mechanisms
Shoen, Japan
  Production of plastic products
Suwa, Japan
  Production of watch parts and electronic components; assembly of precision instruments and robots
Takaki, Japan
  Production of FDDs, stepping motors, and samarium magnets
Tomisato, Japan
  Assembly of semiconductor devices
Toyoshina, Japan
  Production of LCD panels and modules
Seoul, Korea
  Production of PCs

SUBSIDIARIES

North America

Epson America Inc. (United States)
Epson El Paso Inc. (United States)
Epson Portland Inc. (United States)
S MOS Systems Inc. (United States)

Europe

Epson Deutschland GmbH (Germany)
Epson Europe BV (The Netherlands)
Epson France S.A. (France)
Epson Italia S.p.A. (Italy)
Epson STI S.A. (Spain)
Epson Telford Ltd. (United Kingdom)
SNW Uhrenwerk GmbH (Germany)
Epson (UK) Ltd. (United Kingdom)

Asia/Pacific

Epson Australia Pty. Ltd. (Australia)
Epson Electronics (Singapore) Pte. Ltd. (Singapore)
Epson Electronics Trading Ltd. (Taiwan)
Epson Engineering (Shenzhen) Ltd. (PRC)
Epson Industrial (Taiwan) Corporation (Taiwan)
Epson New Zealand Ltd. (New Zealand)
Epson Precision Hong Kong Ltd. (Hong Kong)
Asia Precision (Malaysia) Sdn. Bhd. (Malaysia)
Asian Precision (Singapore) Pte. Ltd. (Singapore)
Tenryu (Singapore) Pte. Ltd. (Singapore)

ROW

Epson Argentina S.A. (Argentina)
Epson de Brasil Industria e Comercio, Ltda. (Brazil)
Epson Chile S.A. (Chile)
Epson Latinoamerica S.A. (Venezuela)
Lentes Plasticos S.A. de C.V. (Mexico)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1988

ComputerLand
Epson America and ComputerLand entered into an agreement, under which ComputerLand will distribute Epson's personal computers and computer printers through ComputerLand stores nationwide.

MERGERS AND ACQUISITIONS

1987

Technology Resources (France)
Epson (Japan) acquired 95.2 percent of Technology Resources (France), a computer and peripherals firm. The acquisition was followed by the formation of Epson Trading (France), a new computer and peripherals firm. The new firm will be formed by the merger of Technology Resources and Epson France.

KEY OFFICERS

Reijiro Hattori
Chairman

Tsuneya Nakamura
President

Koichi Hama
Executive vice president

Hidsseaki Yasukawa
Executive vice president

Katsumi Yamamura
Senior managing director

Susumu Aizawa
Senior managing director

Mitsuhiro Tsuchihashi
Senior managing director

Minoru Usami
Senior managing director

PRINCIPAL INVESTORS

Information is not available.

Sharp Corporation

22-2, Nagaike-cho
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Osaka 545, Japan
Telephone: (06) 621-1221
Fax: (06) 628-1653
Dun's Number: 69-053-6925

Date Founded: 1912

CORPORATE STRATEGIC DIRECTION

Sharp Corporation is a Japanese electronics manufacturer founded in 1912 by Tokuji Hayakawa. The Company's first major product was a mechanical pencil, called the Ever-Sharp Pencil, invented by the founder.

Today, Sharp conducts a full range of business operations, from product development to production and marketing, in the fields of consumer appliances, office equipment, industrial equipment, and electronic components.

Sharp is divided into four product groups. Sales breakdown by product category as a percentage of total revenue is as follows:

- Electronic equipment (TV and video systems group)—27 percent
- Audio equipment (tape, stereo equipment, and digital audio equipment)—9 percent
- Consumer electronics (refrigerators, washing machines, microwave ovens and other home appliances)—18 percent
- Information equipment and electronic parts (PCs, CAD systems, facsimiles, copiers, ICs, optoelectronics, pocket computers)—46 percent

Sharp also has branched out into the telecommunications field.

Sharp is not a member of any of Japan's large industrial groups; however, it does have loose connections with the Sanwa Group, centered on the Sanwa Bank. Sharp is a member of the Sanwa Group's policy-making council, called *Sansui-Kai*, or Third Wednesday Conference. This council is composed of the presidents of 42 Sanwa Group companies or related companies.

Sharp's estimated revenue for the year ending March 1990 is ¥1.4 trillion (US$9.6 billion). Sharp reported revenue of ¥1.3 trillion ($US9.8 billion) in fiscal 1989, a 4.2 percent decrease over fiscal 1988 revenue of ¥1.3 trillion (US$9.5 billion). (Percentage changes refer only to ¥ amounts; US$ percentage rates will differ because of fluctuations in Dataquest exchange rates.) Domestic sales increased by 18 percent in 1989 over sales in 1988; the steady growth in sales of camcorders, electronic organizers, and word processors stimulated the increase. International growth increased by 11.9 percent in 1989, mainly because of the growth in sales of facsimile machines, video cassette recorders, and copiers. As a result, domestic sales accounted for 51.0 percent in 1989, compared with 55.0 percent in 1988. International sales accounted for 49.0 percent in 1989, which reinforces Sharp's strategy of increasing worldwide sales.

Sharp's estimated net income for year ending March 1990 was ¥42.0 billion (US$294.8 million). Net income for 1989 increased 29.9 percent to ¥29.1 billion (US$222.2 million), compared with ¥22.4 billion (US$147.0 million). The increase is due in large part to cost and expense reductions throughout the group companies, and moderate rate fluctuations during the year.

Sharp's estimated capital investments for year ending March 1990 was ¥100 billion (US$702 million), representing 13.7 percent of the estimated revenue for March 1990. Capital expenditure for year ending March 1989 increased 46.0 percent to ¥80.7 billion (US$629.2 million) over the ¥55.3 billion (US$400.6 million) in 1988. The 1989 figure represents 6.4 percent of total revenue. This spending was for construction of a second factory in Fukuyama, Japan, designed to expand production capacity for the LSI chips and to strengthen the production capacity for core products such as liquid crystal displays, optoelectronic components, and hologram laser units. Sharp also opened a new factory for production of precision stamping and press metal parts for video cassette recorders, compact disc players, and microwave ovens. Construction is under way for a new copier and facsimile machine factory in France; in Thailand, a second factory was completed for the production of radio cassette recorders, facsimile machines, microwave ovens, and electric refrigerators.

A design center in Germany was completed in summer 1989. This center reports to Sharp Electronics Europe GmbH and designs custom mask ROMs and gate arrays. There are no future plans for local production in Europe. In the United States, a semiconductor R&D lab and clean rooms were completed in summer 1989 in Washington state.

Currently, Sharp is developing products based on technology using voice synthesis, voice recognition, and artificial intelligence, such as an English-Japanese electronic translation system that takes advantage of artificial intelligence. Additionally, Sharp is working on a word processor that relies on vocal entry of documents and a natural language processing computer that uses everyday language instead of computer language.

Sharp's estimated R&D expenditure for year ending March 1990 was ¥79.0 billion (US$554.5 million). R&D expenditure was ¥68.5 billion (US$534.1 million) in year ending March 1989 and represented 6 percent of revenue. This was a 43 percent increase over year ending March 1988 R&D spending, which totaled ¥47.8 billion (US$346.3 million). Technologies being researched include 16 to 64Mb ULSIs, three-dimensional LSIs, and microwave devices.

Sharp employs more than 32,000 people worldwide.

Sharp has 25 manufacturing facilities around the world specializing in different products offered by the Company. Sharp has 20 factories in Asia/Pacific, including 11 in Japan, 4 in Malaysia, and 1 each in the Philippines, Korea, Thailand, Taiwan, and Australia; 1 in North America; 3 in Europe; 1 in South America. Sharp hopes to minimize fluctuations in exchange rates and meet local requirements by increasing overseas production.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Semiconductors

Dataquest estimates that Sharp's 1989 revenue in the worldwide semiconductor market was ¥147.6 billion (US$1.2 billion), representing approximately 13 percent of total revenue. The estimated sales in Japan made it Sharp's largest market, contributing ¥142.5 billion (US$1 billion) to revenue. The Company had 4.3 percent market share of the total semiconductor market in Japan for 1989. Estimated revenue in North America was ¥1.18 billion (US$83 million), which represents a 48 percent increase over the previous fiscal year. Dataquest estimates that Sharp ranked fifteenth in the 1989 worldwide semiconductor market.

Sharp's product line in the semiconductor market includes MOS memory, microcomponents, and logic; and analog, optoelectronic, and ASIC components. Sharp's strength lies in its MOS memory chips and optoelectronics, representing revenue of ¥67.8 billion (US$476 million) and ¥46.7 billion (US$328 million), respectively. Combined, these two chips represent 65 percent of the Company's total semiconductor revenue. Revenue for MOS logic totaled ¥35.4 billion (US$249 million) in 1989, showing an increase of 15 percent over the previous fiscal year and representing 20 percent of total semiconductor revenue. MOS microcomponents generated approximately ¥15.3 billion (US$112 million) and represented 9 percent of total semiconductor revenue. Analog components contributed ¥8.8 billion (US$65 million) to revenue and represented the remaining 6 percent of total semiconductor revenue.

During 1990, Sharp developed and introduced a full line of CMOS dual-port static RAMs (DP-SRAMs) that allow two independent devices to have access to the same array. Sharp also introduced a new generation of intelligent solid state relays, incorporating a variety of IC and SSR functions.

Copiers and Page Printers

Dataquest estimates that Sharp had a 14.5 percent market share in the plain paper copier (PPC) market with 178,500 units sold in the United States during fiscal 1989. This is an increase of 10,000 units over fiscal 1988. Dataquest believes that the copier market has matured, opportunities are becoming fewer, distribution channels are changing at a fast pace, service is becoming increasingly important, and companies must compete in all market segments in order to be successful. Sharp is a major player in five of the seven copier market segments as defined by Dataquest, with 51 percent of its total US shipments occurring in Dataquest-defined Segment 1: low end, low technology. Dataquest estimates that Sharp ranks fifth in the United States color copier market, with 5.5 percent share in 1989. However, on a worldwide basis, Sharp resides with over 40 other manufacturers that control 52 percent of the market, each having less than 5 percent of the $14.8 billion market.

In 1990, Sharp has introduced two new copiers: the SF-8350 and the SF-9800. Sharp's 1989 introductions were the CX 4500 and the CX 7500 full-color copiers.

Facsimiles

In the facsimile market, Dataquest estimates that Sharp ranked number one in the United States in 1989, with 22.5 percent market share on 323,900 units shipped. Sharp also competes in the European, East Asian, and Japanese facsimile markets. According to Dataquest, Sharp had a 9.1 percent market share in the United Kingdom with 18,820 units shipped, ranking it fourth in that market. Sharp introduced a photo-quality, full-color desktop facsimile machine in 1990. Sharp's strength in the international facsimile market was primarily responsible for its increase in revenue for fiscal 1989.

Printers

Sharp competes in the printer market but holds less than 1 percent of the total worldwide market. The Company's printer products include the JX-9300 laser printer, the JX-730 color ink jet printer, the JX-720 ink jet color image printer, the JX-725 ink jet printer, and the JX-550 thermal printer. Sharp also has a color scanner.

Personal Computers

Dataquest estimates that Sharp sold 123,000 units in the worldwide personal computer market, generating ¥49.4 billion (US$347 million) in revenue for fiscal 1989 and capturing less than 1 percent of the world market. However, the revenue generated by the sale of personal computers was nearly 4 percent of total revenue for the year. Sharp sold an estimated 67,000 personal computers in the United States, with ¥22.5 billion (US$158 million) in revenue for 1989, also capturing less than 1 percent of the market. The two largest-selling products were the x-68000, PC-7000A/7000 series and the PC-4500 series, accounting for 85 percent of units sold worldwide. Sharp introduced the PC-5542, 286-based clamshell laptop computer in 1990. Also introduced in 1990 was the PC-5541, a similar laptop powered by the 286 microprocessor. Sharp's strategy for the 1990s is small laptop and palmtop computers.

Other Products

Sharp also produces televisions, microwave ovens, VCRs, electronic typewriters, audio equipment, refrigerators, and washing machines.

Further Information

For further information on the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Billions of US Dollars)

	1985	1986	1987	1988	1989
Five-Year Revenue	$4.8	$5.5	$7.6	$9.5	$9,8
Percent Change	-	14.72	38.63	24.92	3.13
Capital Expenditure	$0.4	$0.4	$0.4	$0.4	$0.6
Percent of Revenue	7.86	6.74	5.16	4.21	6.41
R&D Expenditure*	$0.2	$0.2	$0.3	$0.3	$0.5
Percent of Revenue	4.09	3.27	3.79	3.64	5.44
Number of Employees	28,221	28,873	29,346	29,351	32,298
Revenue ($K)/Employee	$0.17	$0.19	$0.26	$0.32	$0.30
Net Income	$0.2	$0.2	$0.2	$0.2	$0.2
Percent Change	-	(1.14)	(15.58)	(13.21)	23.24
Exchange Rate (US$1=¥)	¥243.52	¥221.26	¥150.76	¥138.03	¥128.25

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

*Dataquest estimate
NA = Not available

Source: Sharp Corporation
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1985	1986	1987	1988	1989
Asia/Pacific	41.00	41.00	50.00	55.00	51.00
Japan	41.00	41.00	50.00	55.00	51.00
All Others	59.00	59.00	50.00	45.00	49.00

Source: Sharp Corporation
Annual Reports
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

Asia/Pacific—More than 200
Japan—More than 200
All others—13

MANUFACTURING LOCATIONS

North America

Sharp Manufacturing Co. of America
Color TVs, microwave ovens, personal computers

Europe

Sharp Electronic Espana
Color TVs
Sharp Manufacturing Co. of U.K.
Microwave ovens, VCRs, electronic typewriters, copiers
Sharp Manufacturing France S.A.
Facsimile, copiers

Asia/Pacific

Cosmo Denki (Japan)
Electric equipment
Kanto Tatsumi Electronics (Japan)
VCRs
Kure Nissei (Japan)
Audio equipment
Nara Nissei (Japan)
Business machines
Raiton Denshi Kogyo (Japan)
Electronic equipment
Sharp (Philippines)
TVs, refrigerators, washing machines, radio-cassette tape recorders
Sharp Appliances (Thailand)
Appliances, facsimiles, word processors, radio-cassette tape recorders
Sharp Corporation of Australia (Australia)
Color TVs
Sharp Electronics (Taiwan)
Tuners for VCRs
Sharp Hiroshige (Japan)
Electronic equipment
Sharp Korea (South Korea)
Electronic calculators, electronic typewriters
Sharp Manufacturing (Malaysia)
VCRs
Sharp Niigata Electronics Corporation (Japan)
Business machines
Sharp Precision Machinery (Japan)
Automated production systems
Sharp-Roxy Appliances Corp. (Malaysia)
Refrigerators
Sharp-Roxy Corp. (Malaysia)
Radio-cassette tape recorders, headphone stereos
Sharp-Roxy Electronics Corp. (Malaysia)
TVs
Sharp Takaya Electronics Industry (Japan)
VLSIs
Sharp Tokusen Kogyo (Japan)
Electric/electronic equipment
Takahata Denshi (Japan)
PC boards

ROW

Sharp de Brasil
Calculators, TVs, stereos, VCRs, CTRs

SUBSIDIARIES

North America

Sharp Electronics Corporation (United States)
Sharp Electronics of Canada Ltd. (Canada)
Sharp Electronics (U.K.) Limited (United Kingdom)

Europe

Sharp Electronics GmbH (Germany)
Sharp Manufacturing France S.A. (France)

Asia/Pacific

Nishi-Nippon Sharp Equipment Apparatus Co., Ltd. (Japan)
Sharp Corporation of Australia Pty. Ltd. (Australia)
Sharp Electronics Sales Corporation (Japan)
Sharp Engineering Corporation (Japan)
Sharp Finance Corporation (Japan)
Sharp Niigata Electronics Corporation (Japan)
Sharp Precision Machinery Co. Ltd. (Japan)
Sharp System Products Co. Ltd. (Japan)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

Nihon Semiconductor
Sharp has agreed to allow Nihon Semiconductor to produce 64-Kbit SRAMs.

Pyramid Technology Corporation
Sharp has a distribution agreement with Pyramid Technology to market Pyramid's UNIX-based systems.

Dexter Corporation
Sharp and Dexter's Electronic Materials Division have agreed to develop chip-in-board technology.

Oxford Science Park
Sharp established an R&D group with Oxford Science Park for £10 million (US$16.4 million).

1989

Hycom Inc.
Hycom assumed marketing responsibilities in the United States for all Sharp computer peripheral products sold to OEMs.

Texas Instruments
Sharp has an agreement with Texas Instruments to manufacture the Sharp 16-bit IBM-compatible personal computers.

LSI Logic Corporation
Sharp has commissioned LSI Logic Corporation to produce its 256-Kbit SRAMs.

Standard Microsystems Corp.
Standard Microsystems agreed to a series of patent and cross-licensing agreements covering semiconductor technology with Sharp.

MERGERS AND ACQUISITIONS

Information is not available.

KEY OFFICERS

Haruo Tsuji
President

Akira Saeki
Chairman

Akira Tobe
Senior executive vice president

Taizo Katsura
Senior executive vice president

Atsushi Asada
Senior executive vice president

PRINCIPAL INVESTORS

Nippon Life—5.5 percent
Fuji Bank—4.4 percent
Daiwa Bank—4.3 percent
Sanwa Bank—4.1 percent
Yasuda Life—4.0 percent
Dai Ichi Life—3.9 percent
Sumitomo Life—3.7 percent
Foreign-Owned—3.25 percent
Taisho Marine & Fire—3.0 percent
Yasuda Trust & Banking—3.0 percent
DKB—2.8 percent

FOUNDER

Tokuji Hayakawa

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of US Dollars, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$2.8	$3.6	$6.4	$8.1	$9.5
Cash	0.6	1.1	2.7	3.5	3.9
Receivables	1.1	1.2	1.8	2.2	3.0
Marketable Securities	0.1	0.1	0.1	0.3	0.6
Inventory	0.9	1.0	1.6	1.7	1.8
Other Current Assets	0.1	0.2	0.2	0.3	0.2
Net Property, Plants	$1.1	$1.3	$1.9	$2.0	$2.3
Investments, Other Assets	$0.7	$0.7	$1.0	$1.6	$1.5
Total Assets	$4.6	$5.6	$9.3	$11.7	$13.3
Total Current Liabilities	$2.5	$3.2	$5.8	$7.1	$8.7
Long-Term Debt	$0.5	$0.6	$0.8	$1.1	$0.7
Other Liabilities	$0.1	$0.1	$0.1	$0.1	$0.1
Total Liabilities	$3.1	$3.9	$6.7	$8.3	$9.6
Total Shareholders' Equity	$1.5	$1.7	$2.6	$3.5	$4.1
Common Stock	0.2	0.2	0.3	0.7	0.8
Other Equity	0.6	0.6	0.9	1.3	1.5
Retained Earnings	0.7	0.9	1.3	1.5	1.8
Total Liabilities and Shareholders' Equity	$4.6	$5.6	$9.3	$11.7	$13.7
Income Statement	**1985**	**1986**	**1987**	**1988**	**1989**
Revenue	$4.8	$5.5	$7.6	$9.5	$9.8
Japanese Revenue	2.0	2.3	3.8	5.2	5.0
Non-Japanese Revenue	2.8	5.5	3.8	4.3	4.8
Cost of Sales	$3.6	$4.2	$6.1	$7.1	$7.4
R&D Expense*	$0.2	$0.2	$0.3	$0.3	$0.5
SG&A Expense	$0.9	$1.1	$1.5	$1.6	$2.0
Capital Expense	$0.4	$0.4	$0.4	$0.4	$0.6
Pretax Income	$0.3	$0.3	$0.3	$0.3	$0.5
Pretax Margin (%)	6.71	5.83	3.73	3.29	5.45
Effective Tax Rate (%)	49.60	49.70	53.40	NA	56.00
Net Income	$0.2	$0.2	$0.2	$0.2	$0.2
Shares Outstanding, Millions	731.3	733.2	736.9	907.9	936.6
Per Share Data					
Earnings	$0.22	$0.22	$0.19	$0.16	$0.22
Dividend	$0.05	$0.05	$0.07	$0.08	$0.07
Book Value	0	0	0	0	0
Exchange Rate (US$1=¥)	¥243.52	¥221.26	¥150.76	¥138.03	¥128.25

*Dataquest estimate
NA = Not available

Source: Sharp Corporation Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	¥682.4	¥799.3	¥970.0	¥1,113.5	¥1,279.8
Cash	152.1	245.7	403.6	485.2	87.5
Receivables	271.0	269.0	266.1	307.9	387.8
Marketable Securities	19.0	20.5	21.2	40.5	551.1
Inventory	209.0	229.3	241.4	236.3	224.8
Other Current Assets	31.3	34.8	37.6	43.6	28.6
Net Property, Plants	¥258.0	¥283.0	¥282.8	¥279.0	¥292.8
Investments, Other Assets	¥169.8	¥150.4	¥147.6	¥226.1	¥191.4
Total Assets	¥1,110.1	¥1,232.7	¥1,400.4	¥1,618.6	¥1,763.9
Total Current Liabilities	¥608.7	¥706.6	¥872.4	¥980.8	¥1,120.6
Long-Term Debt	¥130.4	¥128.4	¥125.9	¥145.8	¥96.1
Other Liabilities	¥13.1	¥18.1	¥12.0	¥14.1	¥13.3
Total Liabilities	¥752.2	¥853.2	¥1,010.2	¥1,140.7	¥1,229.9
Total Shareholders' Equity	¥357.9	¥379.4	¥390.1	¥478.0	¥534.8
Common Stock	50.3	50.6	51.6	90.7	109.3
Other Equity	134.4	136.6	138.9	178.8	197.7
Retained Earnings	173.2	192.2	199.6	208.6	227.7
Total Liabilities and Shareholders' Equity	¥1,110.1	¥1,232.6	¥1,400.3	¥1,618.7	¥1,764.7

Income Statement	1985	1986	1987	1988	1989
Revenue	¥1,166.7	¥1,216.0	¥1,148.7	¥1,313.7	¥1,258.9
Japanese Revenue	478.4	498.5	574.4	722.5	642.0
Non-Japanese Revenue	688.3	717.5	574.3	591.2	616.9
Cost of Sales	¥881.1	¥932.7	¥913.1	¥977.9	¥943.1
R&D Expense*	¥47.8	¥39.7	¥43.5	¥47.8	¥68.5
SG&A Expense	¥220.1	¥240.0	¥219.2	¥226.6	¥262.1
Capital Expense	¥91.8	¥82.0	¥59.3	¥55.3	¥80.7
Pretax Income	¥78.3	¥70.9	¥42.8	¥43.2	¥68.6
Pretax Margin (%)	6.71	5.83	3.73	3.29	5.45
Effective Tax Rate (%)	49.60	49.70	53.40	NA	56.00
Net Income	¥54.6	¥49.0	¥28.2	¥22.4	¥29.1
Shares Outstanding, Millions	731.3	733.2	736.9	907.9	936.6
Per Share Data					
Earnings	¥54.56	¥49.01	¥28.19	¥22.40	¥31.07
Dividend	¥11.00	¥11.00	¥11.00	¥11.00	NA
Book Value	¥0.49	¥0.52	¥0.53	¥0.53	¥0.57

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Key Financial Ratios	1985	1986	1987	1988	1989
Liquidity					
Current (Times)	1.12	1.13	1.11	1.14	1.14
Quick (Times)	0.78	0.81	0.84	0.89	0.94
Fixed Assets/Equity (%)	72.08	74.60	72.49	58.36	54.75
Current Liabilities/Equity (%)	170.06	186.25	223.62	205.19	209.55
Total Liabilities/Equity (%)	210.16	224.88	258.95	238.64	229.99
Profitability (%)					
Return on Assets	9.83	4.18	2.14	1.48	1.72
Return on Equity	30.49	13.29	7.33	5.16	5.75
Profit Margin	4.68	4.03	2.45	1.71	2.31
Other Key Ratios					
R&D Spending % of Revenue	4.09	3.27	3.79	3.64	5.44
Capital Spending % of Revenue	7.86	6.74	5.16	4.21	6.41
Employees	28,221	28,873	29,346	29,351	32,298
Revenue (¥K)/Employee	¥41.34	¥42.12	¥39.14	¥44.76	¥38.98
Capital Spending % of Assets	8.26	6.65	4.24	3.42	4.58
Exchange Rate (US$1=¥)	¥243.52	¥221.26	¥150.76	¥138.03	¥128.25

*Dataquest estimate
NA = Not available

Source: Sharp Corporation Annual Reports
Dataquest (1990)

Sony Corporation

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Tokyo 141, Japan
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Fax: (03) 448-2244
Dun's Number: 04-065-3636

Date Founded: 1946

CORPORATE STRATEGIC DIRECTION

Sony Corporation, founded in Tokyo in 1946, is one of the world's leading manufacturers of video and audio equipment, televisions, displays, semiconductors, computers, computer peripherals, factory automation equipment, and engineering workstations.

Sony's business philosophy is to provide innovative and attractive products to its customers worldwide. Sony is one of Japan's leaders in global marketing; it had ¥3.6 trillion (U.S.$25.6 billion) in revenue for the fiscal year ended March 31, 1991. Because of its strong international customer base, the company is especially susceptible to fluctuations in international trade markets. The Gulf War, which occurred during fiscal 1991, had severe repercussions in the world economy and directly affected Sony's performance. The United States entered a recession in the second half of the year, the European economy evidenced sluggish performance, and the Japanese economy faced higher interest rates. Even with this difficult environment, Sony attained the highest sales and profit figures in the company's history. Sony points to strong growth in its electronics and entertainment industries as the key factors in its growth.

Sony's long-term strategy to improve product performance and meet customer expectations includes the following policies:

- In consumer electronics, Sony will strive to accelerate the development and marketing of attractive and original products. Expansion will occur in such areas as high-definition television (HDTV) products and information-related equipment for the home.
- In industrial electronics, Sony will seek to strengthen its operations in broadcast- and professional-use videocassette recorders and players (VTRs) and displays while addressing a varied spectrum of market needs. Other areas of targeted growth include recording media, semiconductors, electronic components, computer systems, information processing, and telecommunications.
- Sony will intensify its activities in the entertainment field by strengthening its music and image-based software operations, and by creating synergy with its electronics business. Efforts will be centered on Sony Music Entertainment Inc. (known before January 1, 1991, as CBS Records Inc.) and Columbia Pictures Entertainment Inc.
- Sony has committed to a companywide efficiency upgrade in all areas of business, as well as to the promotion of more efficient allocation of the company's capital, personnel, and management resources.
- Sony will seek to bring all facets of its overseas operations, including procurement of components, R&D, production, and marketing, in closer contact with local communities.

Sony's ¥3.6 trillion (U.S.$25.6 billion) total revenue for the year ended March 31, 1991, represents an increase of 27.11 percent over the year ended March 31, 1990. The increase in sales was led by a 178.4 percent increase in filmed entertainment revenue. Television sales increased 33.2 percent, video equipment sales grew 23.7 percent, and audio equipment sales increased 23.5 percent. Growth of 30.6 percent in the other products group can be attributed to the strong growth of information-related equipment. (Percentage changes refer to U.S. dollar amounts.)

Sony is an international company with 26.3 percent of its sales occurring in Japan, 29.2 percent in the United States, 28.1 in Europe, and 16.4 percent in all other regions. Europe posted the highest growth rate, increasing sales 43.9 percent, while the United States grew 24.4 percent and other international markets grew 37.3 percent. The Japanese market grew at a significantly lower rate of 10.9 percent.

Net income increased 13.7 percent to ¥116.9 billion (U.S.$829.3 million) in fiscal year 1991 from ¥102.8 billion (U.S.$654.8 million) for fiscal 1990. Sony employed approximately 112,900 people in 1990, an increase of 18.1 percent over the 1990 year-end total of 95,600 employees.

R&D expenditure increased 24.6 percent to ¥205.8 billion (U.S.$1.2 billion) for the year ended March 31, 1991, from ¥165.2 billion (U.S.$1.2 billion) in the year ended March 31, 1990. R&D represented 5.7 percent of revenue for the year ended March 31, 1991. Capital expenditure for the year ended March 31, 1991, increased 27.1 percent from the previous year's ¥323.8 billion (U.S.$2.3 billion) to ¥411.7 billion (U.S.$2.9 billion), representing 11.4 percent of total revenue. The increased expenditure primarily was used for expanding production facilities for semiconductors; image-based devices such as color picture tubes; magnetic products; and audio and video equipment. About 35 percent of the capital development expenses were appropriated for overseas facilities. Sony intends to maintain a high level of capital investment and expects next year's expenditure to exceed this year's figure.

Sony's policy is to base its manufacturing operations in markets where its products are sold. By doing this, Sony brings its products closer to customers and avoids trade problems and exchange rate variations. Accordingly, Sony maintains its principal manufacturing facilities in Japan, the United States, and Europe.

In January 1991, Sony Music Entertainment Inc. (SMEI) and a subsidiary of Time-Warner Inc. formed The Columbia House Company, a 50:50 partnership consisting of the former Columbia House Division of SMEI. Columbia House is a direct marketer of music and home video products in the United States and Canada.

In November 1989, Sony purchased Columbia Pictures Entertainment, adding image-based software to its software business. This purchase emphasized strengthening of the company's software operations primarily through the record and video business.

On January 5, 1988, Sony purchased CBS Records Inc. and now holds 100 percent of the shares. The U.S.$2 billion (¥256.5 billion) acquisition was based on Sony's belief in the important relationship between the software and hardware sides of the consumer electronics business.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 through 7 at the end of this backgrounder present comprehensive financial information.

BUSINESS SEGMENT STRATEGIC DIRECTION

Lines of Business

Video Equipment

The video equipment product group revenue totaled ¥908 billion (U.S.$6.4 billion) for the year ended March 31, 1991, or 25.1 percent of sales. Products include VTRs, video cameras, camcorder systems, videotapes, optical videodisk players, and high-definition video systems.

Audio Equipment

The audio equipment product group revenue totaled ¥883 billion (U.S.$6.2 billion) for the year ended March 31, 1991, or 24.4 percent of total sales. Products include tape recorders, audiotapes, cassette players, car stereos, amplifiers, tuners, turntables, speaker systems, CD players, digital audiotape (DAT) recorders, headphones, microphones, and compact discs.

Music Entertainment

Sony's music entertainment business reported revenue of ¥474 billion (U.S.$3.4 billion) for the year ended March 31, 1991, or 13.1 percent of total revenue. Performers on the Sony label include Mariah Carey, New Kids on the Block, George Michael, Billy Joel, Michael Bolton, Gloria Estefan, the Vaughan Brothers, and Harry Connick, Jr.

TV Equipment

Sony's television product group reported revenue of ¥553.4 billion (U.S.$3.9 billion) for the year ended March 31, 1991, or 15.3 percent of total revenue. Key products include color TVs and monitors, projection TVs, JumboTRON, direct broadcasting satellite reception systems, and security systems.

Filmed Entertainment

Sony's filmed entertainment reported revenue of ¥257 billion (U.S.$1.8 billion), or 7.1 percent of sales for the year ended March 31, 1991. Fiscal 1991 film releases included *Total Recall, Look Who's Talking Too, Misery, Awakenings, Postcards from the Edge,* and *Flatliners.*

Other Products

The groups producing other products reported revenue of ¥543 billion (U.S.$3.8 billion) for the year ended March 31, 1991. Key products include the 3.5-inch microfloppy disk systems, microcomputers, workstations, CD-ROM systems, information processing systems, semiconductor devices, electronic components, dictating machines, word processors, induction cooking ranges, telephones, telecommunications systems, factory automation systems, batteries, accessories, and audio and video software.

Company Positioning

Computer Storage

Sony was one of the leading flexible disk drive (FDD) vendors in 1990. Dataquest estimates that Sony maintained its market leadership in the worldwide 3.5-inch FDD market with a 25 percent market share and $226.5 million in factory revenue. We estimate that Sony shipped 5 million 3.5-inch disk drives in 1989. In the worldwide overall FDD (3.5-inch and 5.25-inch) market, Sony dropped from third in 1989 to fourth in 1990, with a market share of 13.6 percent. Sony continues to emphasize the 3.5-inch market, beginning production of 3.5-inch drives in Malaysia in May 1990.

According to Dataquest estimates, Sony ranked first in the optical disk drive market in 1990 with $125.6 million in factory revenue and a 36.2 percent market share. Sony dominates the rewritable market in optical disk drives with 49.0 percent of the market, 39,200 units shipped, and $49 million in factory revenue. Sony also moved up to second in the 12-inch write-once, read-many (WORM) drive market with a 29.9 percent market share and $19.4 million in factory revenue.

Sony has entered the 3.5-inch rigid disk drive market. Dataquest expects Sony to offer a broad range of rigid drives with capacities between 40MB and 200MB and access times of less than 20ms.

Workstations

Sony Microsystems was formed in February 1988 to market Sony's NEWS workstation, a 32-bit UNIX workstation designed primarily for software development applications. Dataquest estimates that Sony had 6.6 percent of the worldwide workstation market share for calendar 1989. Dataquest estimates that Sony ranked fourth in the entry-level workstation market with U.S.$137.2 million in factory revenue for 1989. Dataquest also estimates that Sony ranked third in the Japanese workstation market, with a 9.8 percent market share and $133.7 million in factory revenue.

In May 1990, Sony introduced its laptop NEWS workstation to the European market and later to the Japanese market. Sony had two major design goals for its new workstation, as follows:

- The same level of performance and functionality as the NEWS desktop workstation
- Compatibility with NEWS software and hardware products

The laptop workstation is priced between $10,000 and $15,000 and is targeted toward the technical user with a requirement for a transportable, fully functional technical workstation.

In 1989, Sony introduced a RISC-based workstation using MIPS R3000 processors. Sony expanded its NEWS line to include lower-priced models, and high-performance 32-bit CPU versions. Sony added desktop publishing software to the NEWS line of workstations.

Personal Computers

In July 1991, Sony released a new PalmTop series of personal computers, featuring the ability to input characters with a light pen. The PTC-300, weighing in at 355g, offers significant improvements in portability. Sony does not market its computers in the United States and held less than 1 percent of the worldwide PC market, according to Dataquest estimates.

Semiconductors

Sony began marketing semiconductors in 1984 and currently produces a range of devices, including static random-access memory (SRAM) chips, charge-coupled devices (CCDs), and bipolar ICs for consumer audiovisual equipment. In capital expansion, Sony completed a new wing at Sony Nagasaki Corporation with a clean room for the manufacture of

SRAMs and other leading-edge semiconductor devices and a design center for large-scale integration (LSI) technologies. In addition, Sony began operations at its first overseas semiconductor manufacturing facility, Sony Semiconductor (Thailand) Company Ltd., which will center on the assembly of bipolar ICs.

In the area of research and development, Sony announced in October 1990 the successful development of the world's fastest large-scale gallium arsenide gate array. The device will be used in workstations, image-processing equipment, and other equipment requiring high-speed data processing capabilities.

Dataquest estimates that Sony's 1990 worldwide semiconductor market share was 1.9 percent, with U.S.$1.1 billion in revenue. Dataquest estimates that Sony ranks 19th in the total worldwide semiconductor market, while in Japan, Sony ranked 9th for the third year in a row, with a 4.0 percent market share. Japan represented 77.7 percent of Sony's semiconductor revenue for 1990.

Computer Software

Sony Computer Science Laboratory Inc. was established by Sony Corporation to develop distributed operating systems, programming languages, system architectures, and user interfaces.

Further Information

For further information about the company's business segments, please contact the appropriate Dataquest industry services.

Table 1
Five-Year Corporate Highlights (Billions of U.S. Dollars)

	1987	1988	1989	1990	1991
Five-Year Revenue	3.4	10.4	16.7	20.1	25.6
Percent Change	-42.67	202.02	41.94	20.84	27.11
Capital Expenditure	0.6	1.0	1.7	2.3	2.9
Percent of Revenue	18.55	9.33	10.05	11.25	11.38
R&D Expenditure	0.8	0.9	1.1	1.2	1.5
Percent of Revenue	9.27	8.91	6.62	5.74	5.69
Number of Employees	47,583	71,000	78,900	95,600	112,900
Revenue (U.S.$K)/Employee	72.15	146.04	212.01	210.76	226.84
Net Income	0.1	0.3	0.6	0.7	0.8
Percent Change	-55.98	218.98	112.61	27.23	15.10
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

1991 Fiscal Year	Q1	Q2	Q3	Q4
Quarterly Revenue	5.41	6.23	7.84	6.34
Quarterly Profit	0.16	0.19	0.39	0.11

Source: Sony Corporation
Annual Reports
Dataquest (January 1992)

Table 2
Revenue by Geographic Region (Percent)

Region	1987	1988	1989	1990	1991
United States	27	28	27	30	29
Japan	35	35	34	30	26
Europe	24	23	23	25	28
All Other Regions	14	14	16	15	17

Source: Sony Corporation
Annual Reports
Dataquest (January 1992)

1990 SALES OFFICE LOCATIONS (Includes sales subsidiaries only)

Asia/Pacific—19
International—14

MANUFACTURING LOCATIONS

North America

Digital Audio Disc (United States)
CDs
Sony Engineering and Manufacturing of America (United States)
TVs, CRTs, 32-bit workstations, 3.5-inch FDDs, CD-ROM drives, monitors, audio speakers, factory automation equipment
Sony Magnetic Products Inc. (United States)
Magnetic tapes, flexible disks
Sony Microelectronics Corporation (United States)
Semiconductors
Sony Music Entertainment (United States)
Phonograph records, tapes, CDs
Sony Professional Products Company (United States)
Professional AV equipment
Sony USA (United States)
Electronic equipment

Europe

DADC Austria (Austria)
CDs
Sony (United Kingdom)
TVs, CRTs
Sony Espana (Spain)
TVs, VCRs
Sony France (France)
CD players, video cameras, VHS video decks
Sony-Wega Productions (United Kingdom)
TVs
Television Division Europe (France)
Development, design of TVs

Asia/Pacific

Aiwa Company (Japan)
High-fidelity audio systems, headphone stereos
Hagiwara Electronics (Japan)
TV/video equipment
Mac Precision Products (Japan)
Precision parts
Miyagi Video-Tech (Japan)
Magnetic tapes
Motomiya Denshi (Japan)
Trinitron gun, security systems, flat display tubes, TV parts
Nakada Magnetics (Japan)
Ferrites
Sony Akebono Denshi (Japan)
Printed circuit boards
Sony Audio (Japan)
Audio, video, camera, and optical systems
Sony Bonson (Japan)
Tape recorders, flat TVs, radios
Sony Chemicals (Japan)
Magnetic tapes, chemical products
Sony Computer Science Lab (Japan)
R&D of computer systems/software
Sony Denshi (Japan)
TVs and parts
Sony Electronics (Japan)
Radiocassette tape recorders
Sony Ichinomiya (Japan)
VCRs, color TVs
Sony Inazawa (Japan)
Color CRTs
Sony Itakura (Japan)
CD players, radiocassette recorders
Sony Kisarazu (Japan)
VCRs, CD players
Sony Kohda (Japan)
Video equipment
Sony Kokubu Semiconductor (Japan)
Bipolar ICs, CCDs
Sony Magnescale (Japan)
Electronic measuring instruments
Sony Magnetic Products (Japan)
Magnetic tapes, ferrites, videotapes
Sony Minokama (Japan)
Video equipment
Sony Mizunami (Japan)
Color CRTs
Sony Nagasaki (Japan)
Semiconductors
Sony Oita (Japan)
Semiconductors
Sony Precision Engineering (Japan)
Precision parts for audio equipment for Sony's subsidiaries worldwide
Sony Semiconductor (Japan)
Bipolar ICs

Sony Shiroishi Semiconductor (Japan)
  Semiconductors
Sony Sound Tec (Japan)
  Microphones, PA systems, furniture, hearing aids
Sony TV-Video (Japan)
  Color TVs
Sony Tektronix (Japan)
  Electronic measurements, displays, control instruments, computer graphics products
Sony Video Taiwan (Taiwan)
  VCRs
Sound Magnetics (Japan)
  Magnetic heads
Sound System (Japan)
  VCRs, CD players
Taron Corporation (Japan)
  Audio and video products
Tohkai Electronics (Japan)
  PC boards
Toyo Radio (Japan)
  Audio products
Video Magnetics (Japan)
  Ferrites

ROW

Magneticos de Mexico (Mexico)
  Magnetic tapes, floppy disks
Sony da Amazonia (Brazil)
  VCRs
Sony de Venezuela (Venezuela)
  Color TVs
Sony Videobras (Brazil)
  Video cameras, video equipment
Videotec de Mexico (Mexico)
  Video equipment

SUBSIDIARIES

As of March 31, 1991, Sony had 625 consolidated subsidiaries. The list below gives the company's principal subsidiaries and affiliated companies as of April 30, 1991.

North America

Digital Audio Disc Corporation (United States)
Materials Research Corporation (United States)
Sony Corporation of America (United States)
Sony Music Entertainment Inc. (United States)
Sony of Canada Ltd. (Canada)
Sony Pictures Entertainment (United States)
Sony Trans Com Systems Division (United States)
Sony USA Inc. (United States)

Europe

DADC Austria GesmbH (Austria)
Sony Belgium N.V. (Belgium)
Sony Broadcast & Communications Limited (United Kingdom)
Sony Communication Products B.V. (Netherlands)
Sony Deutschland GmbH (Germany)
Sony Espana S.A. (Spain)
Sony Euro-Finance B.V. (Netherlands)
Sony Europa GmbH (Germany)
Sony France S.A. (France)
Sony GesmbH (Austria)
Sony Italia S.p.A. (Italy)
Sony Nederland B.V. (Netherlands)
Sony Overseas S.A. (Switzerland)
Sony Portugal Lda. (Portugal)
Sony Scandinavia A/S (Denmark)
Sony (Schweiz) A.G. (Switzerland)
Sony Service Centre (Europe) N.V. (Belgium)
Sony (U.K.) Limited (United Kingdom)
Sony-Wega Productions GmbH (Germany)

Asia/Pacific

Aiwa Co. Ltd. (Japan)
Akebono Electronics Inc. (Japan)
CBS/Sony Group Inc. (Japan)
Hasso Electronics Corporation (Japan)
Korea Toyo Radio Co. Ltd. (South Korea)
Max Precision Products Corporation (Japan)
Motomiya Denshi Corporation (Japan)
Sony (Australia) Pty. Limited (Australia)
Sony Asco Inc. (Japan)
Sony Bonson Corporation (Japan)
Sony Broadcast Products Corporation (Japan)
Sony Chemicals Corporation (Japan)
Sony Corporation of Hong Kong Limited (Hong Kong)
Sony Creative Products Inc. (Japan)
Sony Denshi Corporation (Japan)
Sony Electronics (Malaysia) Sdn. Bhd. (Malaysia)
Sony Energytec Inc. (Japan)
Sony Engineering Corporation (Japan)
Sony Enterprise Co. Ltd. (Japan)
Sony Finance International Inc. (Japan)
Sony Ichinomiya Corporation (Japan)
Sony Inazawa Corporation (Japan)
Sony International (Singapore) Pte. Ltd. (Singapore)

Sony Kisarazu Corporation (Japan)
Sony Kohda Corporation (Japan)
Sony Kokubu Semiconductor Corporation (Japan)
Sony Logistics (Singapore) Pte. Ltd. (Singapore)
Sony Logistics Corporation (Japan)
Sony Magnescale Inc. (Japan)
Sony Magnetic Products Inc. (Japan)
Sony Magnetic Products (Thailand)
Sony Magnetic Tape Sales Corporation (Japan)
Sony Minokamo Corporation (Japan)
Sony Mizunami Corporation (Japan)
Sony Nagasaki Corporation (Japan)
Sony Oita Corporation (Japan)
Sony PCL Inc. (Japan)
Sony Plaza Co. Ltd. (Japan)
Sony Precision Engineering Center (Singapore) Pte. Ltd. (Singapore)
Sony Procurement Service Corporation (Japan)
Sony Pruco Life Insurance Co. Ltd. (Japan)
Sony Service Co. Ltd. (Japan)
Sony Shiroishi Semiconductor Inc. (Japan)
Sony Shoji Corporation (Japan)
Sony Singapore Pte. Ltd. (Singapore)
Sony Sound Tec Corporation (Japan)
Sony TV Video (Malaysia) Sdn. Bhd. (Malaysia)
Sony Trading Corporation (Japan)
Sony Tsukuba Corporation (Japan)
Sony Video Taiwan Co. Ltd. (Taiwan)
Sony/Tektronix Corporation (Japan)
Sound System Corporation (Japan)
Taron Corporation (Japan)
Tohkai Electronics Corporation (Japan)

ROW

Magneticos de Mexico, S.A. de C.V. (Mexico)
Sony CSA, S.A. (Panama)
Sony Chile Ltda. (Chile)
Sony Corporation of Panama S.A. (Panama)
Sony da Amazonia Ltda. (Brazil)
Sony de Venezuela S.A. (Venezuela)
Sony Saudi Arabian Company Ltd. (Saudi Arabia)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1991

Advanced Micro Devices Inc. (AMD)
Sony and AMD signed a broad patent and copyright cross-licensing agreement covering wafer processes, design, and architectures for integrated circuits.

Apple Computer Inc.
Sony will manufacture major portions of the laptop Macintosh computer under development by Apple.

Bell Microproducts Inc.
Bell added Sony's read-write optical drives to its current franchise list.

Digital Equipment Corporation
Digital and Sony entered an agreement through which Digital will produce optical subsystems based on Sony optical disk drives.

Matsushita Electric Industrial
Matsushita Electric Industrial and seven other companies (Kyushu Matsushita Electric, Sega Enterprises, Chinon Industries, Casio Computer, Ricoh, Canon, and Sanyo Electric) will make CD-ROMs based on Sony specifications.

Nihon Silicon Graphics K.K. (NSG)
Sony and NSG signed a marketing agreement in which Sony will market a high-definition computer graphics system for NSG's Iris 4-D Power Vision graphics workstation.

Ricoh Company
Ricoh will provide its Design Base Jr. three-dimensional model-generation software package to Sony to be bundled with Sony's new NWB-236 processor.

SGS-Thomson Microelectronics
SGS-Thomson Microelectronics will second-source a chip set for high-speed serial digital video transmission developed by Sony.

Software Toolworks
Sony and Software Toolworks signed a licensing agreement allowing Sony to use special versions of Software Toolworks' CD-ROM software with Sony's CD-ROM optical disk player.

VideoLogic Inc.
Sony signed an agreement with VideoLogic allowing Sony to sell multimedia products through computer resellers and video dealers.

Wave Front Technologies
Wave Front will supply Sony with its TPV computer graphics software, to be bundled with Sony's latest three-dimensional computer graphics board, the NWB-256.

1990

Exabyte Corporation
Exabyte renewed a supply agreement with Sony under which Sony will supply Exabyte with 5.25-inch form factor tape drives.

Compression Labs Inc.
Sony entered into a reseller agreement with Compression Labs under which Sony will resell Compression Labs video coder/decoders. The agreement marks Sony's entry into the U.S. videoconferencing market.

Texas Instruments
Texas Instruments agreed to produce semiconductors in Europe for Sony on a consignment basis.

NJK Ltd.
NJK Ltd. signed as a distributor for Sony's NEWS workstations.

Fujitsu
Sony and Fujitsu jointly developed a trial common rule to develop CD-ROM XA software for their personal computers.

Oracle Corporation
Oracle agreed to supply the Oracle relational database management systems and applications development software products for the Sony NEWS family of UNIX workstations.

Novell K.K.
Novell K.K. was formed as a joint marketing venture to sell NetWare products in Japan. Novell and six partners—Canon, Fujitsu, NEC, Softbank, Sony, and Toshiba—helped fund the project.

Advanced Micro Devices (AMD)
AMD agreed to enter a joint manufacturing and educational pact with Sony to manufacture SRAMs.

Summus Computer Systems
Summus agreed to sell, distribute, and service 4mm DAT drives from Sony. Summus agreed to be an original equipment manufacturer (OEM) of Sony and to integrate hardware and software that offers turnkey storage subsystems for the Apple Macintosh, Digital, and Sun Microsystems Inc. PC markets.

1989

Parallex Graphics Inc.
Sony Microsystems agreed to incorporate Parallex's color graphics and video graphics controllers in Sony's workstations.

Matsushita Philips
Sony, Matsushita, and Philips agreed to develop, manufacture, and market interactive compact disk drives.

Apple Computer Inc.
Sony signed a contract with Apple to supply 40MB rigid disk drives for the Macintosh.

Hewlett-Packard Company (HP)
Sony agreed to supply 5.25-inch rewritable optical disk storage products to HP for the new HP C17QA Optical Disk Library System.

Pinnacle Micro
Sony announced plans to supply $1 million (¥128.3 million) worth of 5.25-inch rewritable optical disk storage products to Pinnacle Micro.

Advanced Micro Devices (AMD)
Sony and AMD entered a joint venture agreement for an SRAM memory product.

1988

Daewoo Electronics
Sony and Daewoo agreed to jointly develop 256K SRAMs, 64K SRAMs, 8- and 16-bit MPUs, and other microchips.

Engineering Mechanics Research (EMR)
Sony and EMR agreed to a joint venture in CAE software technology and sales. EMR is marketing Sony's engineering workstations (EWSs) that employ its software in the United States while Sony supports sales agents of EMR's software in Japan by supplying its EWS.

N.V. Philips Gloeilampenfabrieken
Sony and Philips agreed to a joint development of extended architecture CD-ROMs for audio use.

Motorola Inc.
Sony Microsystems agreed to incorporate dual Motorola 68030 MPUs in high-end models of Sony's NEWS UNIX workstation family.

Symbolics
Sony and Symbolics completed a sales agreement for Sony's workstations in the U.S. market. Sony Microsystems began supplying its workstations to Symbolics in May 1988 for sale in the United States under the Symbolics brand name. The two companies agreed to jointly develop a new model of workstation using Symbolics' A1 chips.

Texas Instruments Inc. (TI)
TI Japan and Sony jointly developed the CXD1144AP high-performance digital filter LSI for digital audio equipment.

Advanced Micro Devices (AMD)
Sony and AMD agreed to a sales tie-up for Sony's workstations in South Korea.

MERGERS AND ACQUISITIONS

1991

National Broadcasting Company
Sony purchased NBC's 50 percent stake in RCA/Columbia Home Video, resulting in Sony's complete ownership of the company.

1989

Trans Com Systems Division
Sony purchased all assets and liabilities of Trans Com Systems, a division of Sundstrand Corporation. Trans Com designed, manufactured, and installed in-flight AV entertainment systems in commercial aircraft worldwide.

Materials Research Corporation (MRC)
Sony acquired all of the outstanding shares of common stock of MRC and its affiliates. MRC manufactured and supplied sputtering and etching equipment, high-purity metals, and ceramics.

Columbia Pictures Entertainment
Sony acquired all of the outstanding shares of common stock of Columbia Pictures, which was primarily in the filmmaking business.

Guber-Peters Entertainment Company (GPEC)
Sony acquired GPEC, which was in the filmmaking business.

1988

CBS Records Inc.
Sony purchased CBS Records for U.S.$2 billion (¥256.5 billion) and held 100 percent of the shares. (The acquisition was made using U.S. currency.)

KEY OFFICERS

Akio Morita
Chairman and representative director

Norio Ohga
President and chief executive officer

Masaaki Morita
Deputy president

Nobuo Kanoi
Deputy president

Ken Iwaki
Deputy president

Tsunao Hashimoto
Deputy president

PRINCIPAL INVESTORS

Information is not available

FOUNDERS

Masaru Ilsuka
Akio Morita

Table 3
Balance Sheet
Fiscal Year Ending March 31
(Billions of U.S. Dollars)

Balance Sheet	1987*	1988	1989	1990	1991
Cash	1.0	1.6	2.3	3.2	3.1
Receivables	1.6	2.4	3.4	5.8	5.8
Marketable Securities	0.8	0.7	0.7	0.4	0.2
Inventory	1.9	2.4	3.8	4.8	5.2
Other Current Assets	0.5	0.7	1.0	1.2	1.5
Total Current Assets	5.8	7.8	11.2	15.4	15.8
Net Property, Plants	2.2	3.1	4.2	6.1	7.4
Other Assets	0.9	2.6	3.0	9.1	9.4
Total Assets	8.8	13.5	18.4	30.6	32.6
Total Current Liabilities	3.7	6.8	8.7	14.0	14.9
Long-Term Debt	0.9	1.4	1.7	4.5	4.9
Other Liabilities	0.5	0.6	0.8	2.0	2.3
Total Liabilities	5.0	8.8	11.2	20.5	22.1
Converted Preferred Stock	0	0	0	0	0
Common Stock	0.1	0.2	0.9	1.9	2.1
Other Equity	0.4	0.4	1.5	3.3	2.9
Retained Earnings	3.4	4.1	4.8	4.9	5.4
Total Shareholders' Equity	3.8	4.7	7.2	10.1	10.5
Total Liabilities and Shareholders' Equity	8.8	13.5	18.4	30.6	32.6
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

*For the five-month period ending March 31, 1987. Effective March 31, 1987, the parent company and almost all subsidiaries and affiliates changed their fiscal year-end from October 31 to March 31. Accordingly, the fiscal period ended March 31, 1987, included only 5 months of operations, whereas other fiscal years consisted of 12 months.

Source: Sony Corporation Annual Reports
Dataquest (January 1992)

Table 4
Consolidated Income Statement
Fiscal Year Ending March 31
(Billions of U.S. Dollars, except Per Share Data)

Consolidated Income Statement	1987*	1988	1989	1990	1991
Revenue	3.4	10.4	16.7	20.1	25.6
Japanese Revenue	1.1	3.5	5.7	6.1	6.7
Non-Japanese Revenue	2.3	6.9	11.0	14.1	18.9
Cost of Sales	2.6	7.7	11.5	13.6	17.7
R&D Expense	0.8	0.9	1.1	1.2	1.5
SG&A Expense	0.8	2.4	4.4	5.0	6.3
Capital Expense	0.6	1.0	1.7	2.3	2.9
Pretax Income	0.1	0.5	1.3	1.6	1.9
Pretax Margin (%)	4.36	5.14	7.71	7.90	7.32
Effective Tax Rate (%)	58.00	56.00	56.00	54.00	51.00
Net Income	0.1	0.3	0.6	0.7	0.8
Shares Outstanding, Thousands	231,236	238,769	282,603	331,929	338,593
Per Share Data					
Earnings	0.34	1.04	1.88	2.15	2.02
Dividend	0.12	0.32	0.28	0.32	0.32
Book Value	16.50	19.71	25.57	30.50	30.88
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

*For the five-month period ending March 31, 1987. Effective March 31, 1987, the parent company and almost all subsidiaries and affiliates changed their fiscal year-end from October 31 to March 31. Accordingly, the fiscal period ended March 31, 1987, included only 5 months of operations, whereas other fiscal years consisted of 12 months.

Source: Sony Corporation Annual Reports
Dataquest (January 1992)

Table 5
Balance Sheet
Fiscal Year Ending March 31
(Billions of Yen)

Balance Sheet	1987*	1988	1989	1990	1991
Cash	152.9	218.0	297.9	451.7	442.9
Receivables	256.6	325.7	433.4	832.9	815.1
Marketable Securities	132.2	99.4	91.1	54.8	33.5
Inventory	302.9	334.7	483.7	693.0	731.7
Other Current Assets	77.6	99.1	127.7	169.2	211.2
Total Current Assets	922.2	1,076.9	1,433.8	2,201.6	2,234.4
Net Property, Plants	343.1	426.3	544.7	868.1	1,046.8
Other Assets	145.9	363.7	386.2	1,300.4	1,321.2
Total Assets	1,411.2	1,866.9	2,364.7	4,370.1	4,602.4
Total Current Liabilities	587.0	945.0	1,119.0	1,995.9	2,104.6
Long-Term Debt	143.4	196.0	220.8	646.0	694.5
Other Liabilities	72.1	76.3	98.2	281.3	327.0
Total Liabilities	802.5	1,217.3	1,438.0	2,923.2	3,126.1
Converted Preferred Stock	0	0	0	0	0
Common Stock	12.0	23.7	114.6	278.0	296.4
Other Equity	56.5	60.9	195.6	473.4	413.5
Retained Earnings	540.2	565.0	616.5	695.5	766.4
Total Shareholders' Equity	608.7	649.6	926.7	1,446.9	1,476.3
Total Liabilities and Shareholders' Equity	1,411.2	1,866.9	2,364.7	4,370.1	4,602.4
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Sony Corporation
Annual Reports
Dataquest (January 1992)

Table 6
Consolidated Income Statement
Fiscal Year Ending March 31
(Billions of Yen, except Per Share Data)

Consolidated Income Statement	1986	1987	1988	1989	1990
Revenue	547.8	1,431.2	2,145.3	2,879.9	3,616.5
Japanese Revenue	177.5	479.4	731.3	869.5	952.5
Non-Japanese Revenue	370.3	951.8	1,414.0	2,010.4	2,664.0
Cost of Sales	407.8	1,064.6	1,475.4	1,938.0	2,505.6
R&D Expense	131.2	127.5	142.1	165.2	205.8
SG&A Expense	131.0	336.3	565.6	712.0	887.8
Capital Expense	101.6	133.5	215.6	324.0	411.7
Pretax Income	23.6	73.5	165.5	227.4	264.6
Pretax Margin (%)	4.36	5.14	7.71	7.90	7.32
Effective Tax Rate (%)	58.00	56.00	56.00	54.00	51.00
Net Income	13.3	36.7	72.5	102.8	116.9
Shares Outstanding, Thousands	231,236	238,769	282,603	331,929	338,593
Per Share Data					
Earnings	54.2	143.8	219.7	279.0	285.9
Dividend	18.5	44.6	40.5	45.5	45.5
Book Value	0	0	0	0	0
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

*For the five-month period ending March 31, 1987. Effective March 31, 1987, the parent company and almost all subsidiaries and affiliates changed their fiscal year-end from October 31 to March 31. Accordingly, the fiscal period ended March 31, 1987, included only 5 months of operations, whereas other fiscal years consisted of 12 months.

Source: Sony Corporation
Annual Reports
Dataquest (January 1992)

Table 7
Key Financial Ratios
Fiscal Year Ending March 31

Key Financial Ratios	1987	1988	1989	1990	1991
Liquidity					
Current (Times)	1.57	1.14	1.28	1.10	1.06
Total Assets/Equity (%)	231.85	287.39	255.17	302.03	311.75
Current Liabilities/Equity (%)	96.44	145.47	120.75	137.94	142.56
Total Liabilities/Equity (%)	131.84	187.39	155.17	202.03	211.75
Profitability (%)					
Return on Assets	0.94	2.24	3.43	3.05	2.23
Return on Equity	2.19	5.83	9.20	8.66	6.96
Profit Margin	2.43	2.56	3.38	3.57	2.84
Other Key Ratios					
R&D Spending % of Revenue	23.95	8.91	6.62	5.74	4.57
Capital Spending % of Revenue	18.55	9.33	10.05	11.25	8.96
Employees	47,583	71,000	78,900	95,600	112,900
Revenue (¥M)/Employee	11.51	20.16	27.19	30.12	32.03
Capital Spending % of Assets	7.20	7.15	9.12	7.41	7.04
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Sony Corporation
Annual Reports
Dataquest (January 1992)

Sony Corporation

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Telephone: (03) 448-2111
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Dun's Number: 04-065-3636

Date Founded: 1946

CORPORATE STRATEGIC DIRECTION

Sony Corporation, founded in Tokyo in 1946, is one of the world's leading manufacturers of video and audio equipment, televisions, and other products including semiconductors, computer peripherals, factory automation equipment, and engineering workstations.

Sony's business philosophy is to provide products and services that bring pleasure to its customers worldwide. Sony is one of Japan's leaders in global marketing with ¥2.9 trillion (US$20.2 billion) in revenue for the fiscal year ended March 31, 1990. The main characteristics of the global business environment are uncertainty and volatility. Increasing trade friction with the United States, the long-term appreciation of the yen relative to the US dollar, and growing competition from Asia's newly industrializing countries (NICs) are all creating a more competitive operating environment.

Sony's strategy to improve product performance and meet customer expectations includes the following policies:

- Sony will seek to actively develop and introduce attractive consumer new products, strengthen its marketing and service structure, and keep a closer watch over product quality control.
- Sony intends to add further strength to such operations as video equipment and displays and, by incorporating cutting-edge technologies, to develop its business industrial products to meet a wider range of market needs. Sony also will continue to actively develop new technologies and expand the scope of operations through products that support a vast spectrum of business areas such as semiconductors, electronic devices, and equipment related to computers, information processing, and telecommunication.
- By adding image-based software primarily from Columbia Pictures Entertainment (CPE) to its music software business, which has been led chiefly by the CBS Records Group, Sony will strive to further expand and develop its software business while gaining synergy with its hardware business.
- While promoting local procurement of components and production, Sony will upgrade all facets of its operations from R&D to marketing to bring its overseas operations in even closer contact with local communities.
- Sony will continue to improve its profitability and financial soundness by reducing costs and streamlining operations in all fields—from design and manufacturing through sales and distribution—and by conducting stricter inventory control and carefully appropriated capital expenditure.

Sony's ¥2.9 trillion (US$20.2 billion) total revenue for the year ended March 31, 1990, represents an increase of 34.2 percent over the year ended March 31, 1989. (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) The increase in revenue was led by a 30.6 percent increase in television sales and a 29.7 percent increase in video equipment sales. Audio equipment sales advanced 28.8 percent because of exceptionally strong sales of CD players in the international market, while other products sales increased 27.6 percent, showing strong growth of information-related equipment outside of Japan.

Sony is an international company with 34.0 percent of its sales occurring in Japan, 27.0 percent in the United States, 24.8 percent in Europe, and 15.2 percent in other areas. The United States posted the highest growth rate, increasing sales 46.3 percent, while Europe grew 43.7 percent and other international markets grew 32.5 percent. The Japanese market grew at a significantly lower rate of 18.9 percent.

Net income increased 41.8 percent to ¥103 billion (US$0.7 billion) from ¥73 billion (US$0.6 billion) for the year ended March 31, 1989. Sony employed approximately 95,600 people in 1990.

R&D expenditure increased 14.0 percent to ¥165 billion (US$1.2 billion) for the year ended March 1990, from ¥142 billion (US$1.1 billion) in the year ended March 31, 1989. R&D represents 5.7 percent of revenue for the year ended March 1990. Capital expenditure for the year ended March 31, 1990, increased 50.2 percent from the previous year's ¥215.6 billion (US$1.7 billion) to ¥323.8 billion (US$2.3 billion), representing 11.3 percent of total revenue. The increased expenditure primarily was used for expanding production facilities to meet rising demand for semiconductors; image-based devices, such as color picture tubes; magnetic products; and audio and video equipment. Sony intends to maintain a high level of capital investment and expects next year's expenditure to exceed this year's figure.

Sony's policy is to manufacture in the markets where its products are sold. By doing this, Sony brings its products closer to customers and avoids trade problems and exchange rate variations. Sony maintains its principal manufacturing facilities in Japan, the United States, and Europe.

Sony's products are marketed by sales subsidiaries throughout the world. There are 19 sales subsidiaries in Japan and 14 overseas.

In November 1989, Sony purchased Columbia Pictures Entertainment adding image-based software to its software business. This purchase emphasized strengthening the software operations primarily through the record and video business.

On January 5, 1988, Sony purchased CBS Records Inc. and now holds 100 percent of the shares. The US$2 billion (¥256.5 billion) acquisition was based on Sony's belief in the important relationship between the software and hardware sides of the consumer electronics business.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this backgrounder.

BUSINESS SEGMENT STRATEGIC DIRECTION

Video Equipment

The video equipment product group revenue totaled ¥743 billion (US$5.2 billion) for the year ended March 31, 1990, or 25.8 percent of sales. Products include VTRs (a videocassette recorder and player), video cameras, Betacam systems, videotapes, optical videodisc players, and high-definition video systems.

Audio Equipment

The audio equipment product group revenue totaled ¥722.8 billion (US$5.1 billion) for the year ended March 31, 1990, or 25.1 percent of total sales. Products include tape recorders, audiotapes, cassette players, car stereos, amplifiers, turners, turntables, speaker systems, CD players, digital audiotape (DAT) recorders, headphones, microphones, and compact discs.

Records

Sony's record business reported revenue of ¥455 billion (US$3.2 billion), or 15.8 percent of total revenue.

TV Equipment

Sony's television product group reported revenue of ¥446.4 billion (US$3.1 billion) for the year ended March 31, 1990, or 15.5 percent of total revenue. Key products include color TVs and monitors, projection TVs, JumboTRON, direct broadcasting satellite reception systems, and security systems.

Movies

Sony's movies reported revenue of ¥92.3 billion (US$646 million) or 3.2 percent of sales for the year ended March 31, 1990.

Other Products

The groups producing other products reported revenue of ¥420.5 billion (US$2.9 billion). Key products include the 3.5-inch microfloppy disk systems, microcomputers, workstations, CD-ROM systems, information processing systems, semiconductor devices, electronic components, dictating machines, word processors, induction cooking ranges, telephones, telecommunications systems, factory automation systems, batteries, accessories, and audio and video software.

Computer Storage

Sony was one of the leading flexible disk drive vendors in 1989. Dataquest estimates that Sony had ¥31 billion (US$242 million) in factory revenue, with 26 percent market share in 1989 in the 3.5-inch flexible disk drive market. Dataquest estimates that Sony shipped 4.3 million 3.5-inch disk drives in 1989. In the worldwide flexible disk drive (3.5-inch and 5.25-inch) market, Dataquest ranks Sony third, with 14 percent of the market.

Dataquest ranks Sony first in the optical disk drive market with ¥9.4 billion (US$73 million) in factory revenue and 33 percent market share. Sony dominates the rewritable market in optical disk drives with 76 percent of the market, 25,000 units shipped, and ¥2.1 billion (US$45.5 million) in factory revenue.

Sony ranks third in the 12-inch write-once, read-many (WORM) drives with 16 percent of the market, 2,000 units shipped, and ¥2.1 billion (US$16.3 million) in factory revenue.

Sony has entered the 3.5-inch rigid disk drive market. Dataquest expects Sony to offer a broad range of rigid drives with capacities between 40 and 200 Mbytes and access times considerably less than 20 milliseconds.

Workstations

Sony Microsystems was formed in February 1988 to market Sony's NEWS workstation, a 32-bit UNIX workstation designed primarily for software development applications. Dataquest estimates that Sony had 6.6 percent of the worldwide workstation market share for calendar 1989. Dataquest estimates that Sony ranked fourth in the workstation market with ¥4 billion (US$31 million) in factory revenue for 1989.

In May 1990, Sony introduced its Laptop NEWS workstation to the European market and later to the Japanese market. Sony had two major design goals for its new workstation:

- The same level of performance and functionality as the NEWS desktop workstation
- Compatibility with NEWS software and hardware products

The laptop workstation is priced between $10,000 and $15,000 and is targeted toward the technical user with a requirement for a transportable, fully functional technical workstation.

In 1989, Sony announced that it would develop a RISC-based workstation using MIPS R3000 processors. Sony intends to expand its NEWS line to include lower-priced models, workstations equipped with CD-ROM systems, and high-performance 32-bit CPU versions. Sony also plans to add desktop publishing applications software to the NEWS line of workstations.

Personal Computers

Dataquest estimates that Sony manufactured 65,000 personal computer units in 1989, with an if-sold value of ¥26.8 billion (US$209 million) and less than 1 percent worldwide market share. In calendar 1989, Sony's largest-selling machine was the HB-F1 XD J, which sold 60,000 units worldwide. However, Sony does not market its computers in the United States.

Semiconductors

Sony began marketing semiconductors in 1984. The Company's calendar year 1989 worldwide market share was estimated to be 1.9 percent, with ¥156.7 billion (US$1.1 billion) in revenue. Dataquest estimates that Sony ranks 19th in the total worldwide semiconductor market, while in Japan, Sony ranked 9th for the second year in row. Japan represented 81 percent of Sony's semiconductor revenue for 1989.

According to Dataquest, Sony ranked 13th in the MOS digital Japanese market, with 2.2 percent share and ¥38.5 billion (US$270 million) in revenue. In the Japanese analog market, Sony ranked 7th, with 7.2 percent of the market and ¥38 billion (US$267 million) in revenue for calendar 1989. In the total Japanese optoelectronics market, Dataquest ranked Sony 3rd, with 14.4 percent of the market and ¥35.5 billion (US$249 million) in 1989. Lastly, in the

Japanese total discrete market, Sony ranked 10th, with 2.6 percent market share and ¥12.3 billion (US$86 million) in revenue for 1989.

Computer Software

Sony Computer Science Laboratory Inc. was established by Sony Corporation to develop distributed operating systems, programming languages, system architectures, and user interfaces. Sony's goal is to penetrate the US software market.

Further Information

For further information about the Company's business segments, please contact the appropriate Dataquest industry services.

Table 1
Five-Year Corporate Highlights (Billions of US Dollars)

	1986	1987	1988	1989	1990
Five-Year Revenue	$7.6	$3.4	$10.4	$16.7	$20.2
Percent Change	-	(54.14)	205.19	41.94	20.84
Capital Expenditure	$0.5	$0.6	$1.0	$1.7	$2.3
Percent of Revenue	7.10	10.62	9.33	10.05	11.25
R&D Expenditure	$0.7	$0.8	$0.9	$1.1	$1.2
Percent of Revenue	9.16	9.27	8.91	6.62	5.74
Number of Employees	48,700	47,583	71,000	78,900	95,600
Revenue (US$K)/Employee	$0.16	$0.07	$0.15	$0.21	$0.21
Net Income	$0.2	$0.1	$0.3	$0.6	$0.7
Percent Change	(24.91)	(64.89)	223.68	86.80	27.64
Exchange Rate (US$1=¥)	¥175.09	¥159.56	¥138.03	¥128.25	¥142.47

1990 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA = Not available

Source: Sony Corporation
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1986	1987	1988	1989	1990
North America	32.00	30.00	30.00	27.00	27.00
International	68.00	70.00	70.00	73.00	73.00
Japan	30.00	32.00	34.00	34.00	34.00
Europe	21.00	24.00	22.00	24.00	24.00
All Others	17.00	14.00	14.00	15.00	15.00

Source: Sony Corporation
Annual Reports
Dataquest (1990)

1990 SALES OFFICE LOCATIONS (INCLUDES SALES SUBSIDIARIES ONLY)

Asia/Pacific—19
International—14

MANUFACTURING LOCATIONS

North America

CBS Records (United States)
  Phonograph records, tapes, CDs
Digital Audio Disc (United States)
  CDs
Sony Corporation of America (United States)
  TVs, CRTs, 32-bit workstations, 3.5-inch FDDs
Sony Magnetic Products, Inc. (United States)
  Magnetic tapes, FD
Sony Technology Center (United States)
  Video equipment
Sony USA (United States)
  Electronic equipment

Europe

DADC Austria (Austria)
  CDs
Sony (United Kingdom)
  TVs, CRTs
Sony Espana (Spain)
  TVs, VCRs
Sony France (France)
  CD players, video cameras, VHS video deck
Sony-Wega Productions (United Kingdom)
  TVs
Television Division Europe (France)
  Development, design of TVs

Asia/Pacific

Aiwa Co. (Japan)
  High-fidelity audio systems, headphone stereos
Hagiwara Electronics (Japan)
  TV/video equipment
Mac Precision Products (Japan)
  Precision parts
Miyagi Video-Tech (Japan)
  Magnetic tapes
Motomiya Denshi (Japan)
  Trinitron gun, security systems, flat display tubes, TV parts
Nakada Magnetics (Japan)
  Ferrites
Sony Akebono Denshi (Japan)
  Printed circuit boards
Sony Audio (Japan)
  Audio, video, camera, and optical systems
Sony Bonson (Japan)
  Tape recorders, flat TVs, radios
Sony Chemicals (Japan)
  Magnetic tapes, chemical products
Sony Computer Science Lab (Japan)
  R&D of computer systems/software
Sony Denshi (Japan)
  TVs and parts
Sony Electronics (Japan)
  Radiocassette tape recorders
Sony Ichinomiya (Japan)
  VCRs, color TVs
Sony Inazawa (Japan)
  Color CRTs
Sony Itakura (Japan)
  CD players, radiocassette recorders
Sony Kisarazu (Japan)
  VCRs, CD players
Sony Kohda (Japan)
  Video equipment
Sony Kokubu Semiconductor (Japan)
  Bipolar ICs, CCDs
Sony Magnescale (Japan)
  Electronic measuring instruments
Sony Magnetic Products (Japan)
  Magnetic tapes, ferrites, videotapes
Sony Minokama (Japan)
  Video equipment
Sony Mizunami (Japan)
  Color CRTs
Sony Nagasaki (Japan)
  Semiconductors
Sony Oita (Japan)
  Semiconductors
Sony Precision Engineering (Japan)
  Precision parts for audio equipment for Sony's subsidiaries worldwide
Sony Semiconductor (Japan)
  Bipolar ICs
Sony Shiroishi Semiconductor (Japan)
  Semiconductors
Sony Sound Tec (Japan)
  Microphones, PA systems, furniture, hearing aids

Sony TV-Video (Japan)
  Color TVs
Sony Tektronix (Japan)
  Electronic measurements, displays, control instruments, computer graphics products
Sony Video Taiwan (Taiwan)
  VCRs
Sound Magnetics (Japan)
  Magnetic heads
Sound System (Japan)
  VCRs, CD players
Taron Corp. (Japan)
  Audio and video products
Tohkai Electronics (Japan)
  PC boards
Toyo Radio (Japan)
  Audio products
Video Magnetics (Japan)
  Ferrites

ROW

Magneticos de Mexico (Mexico)
  Magnetic tapes, floppy disks
Sony da Amazonia (Brazil)
  VCRs
Sony de Venezuela (Venezuela)
  Color TVs
Sony Videobras (Brazil)
  Video cameras, video equipment
Videotec de Mexico (Mexico)
  Video equipment

SUBSIDIARIES

As of March 31, 1990, the Company had 576 consolidated subsidiaries. The list below gives the Company's principal subsidiaries and affiliated companies as of July 31, 1990.

North America

CBS Records Inc. (United States)
Columbia Pictures Entertainment (United States)
Digital Audio Disc Corporation (United States)
Gurber-Peters Entertainment Company (United States)
Materials Research Corporation (United States)
Sony Corporation of America (United States)
Sony of Canada Ltd. (Canada)
Sony USA Inc. (United States)
Trans Com Systems Division (United States)

Europe

DADC Austria GesmbH (Austria)
Sony Belgium N.V. (Belgium)
Sony Broadcast Limited (United Kingdom)
Sony Communication Products B.V. (Netherlands)
Sony Deutschland GmbH (Germany)
Sony Distribution Centre (Europe) B.V. (Netherlands)
Sony Espana S.A. (Spain)
Sony Europa GmbH (Germany)
Sony France S.A. (France)
Sony GesmbH (Austria)
Sony Italia S.p.A. (Italy)
Sony Nederland B.V. (Netherlands)
Sony Overseas Finance B.V. (Netherlands)
Sony Overseas S.A. (Switzerland)
Sony Portugal Lda. (Portugal)
Sony Scandinavia A/S (Denmark)
Sony (Schweiz) A.G. (Switzerland)
Sony Service Centre (Europe) N.V.
Sony (U.K.) Limited (United Kingdom)
Sony-Wega Productions GmbH (Germany)

Asia/Pacific

Aiwa Co., Ltd. (Japan)
Akebono Electronics Inc. (Japan)
CBS/Sony Group Inc. (Japan)
Hasso Electronics Corporation (Japan)
Korea Toyo Radio Co., Ltd. (South Korea)
Max Precision Products Corporation (Japan)
Motomiya Denshi Corporation (Japan)
Sony (Australia) Pty. Limited (Australia)
Sony Asco Inc. (Japan)
Sony Bonson Corporation (Japan)
Sony Broadcast Products Corporation (Japan)
Sony Chemicals Corporation (Japan)
Sony Corporation of Hong Kong Limited (Hong Kong)
Sony Creative Products Inc. (Japan)
Sony Denshi Corporation (Japan)
Sony Electronics (Malaysia) Sdn. Bhd. (Malaysia)
Sony Energytec Inc. (Japan)
Sony Engineering Corporation (Japan)
Sony Enterprise Co., Ltd. (Japan)
Sony Finance International, Inc. (Japan)
Sony Ichinomiya Corporation (Japan)
Sony Inazawa Corporation (Japan)
Sony International (Singapore) Pte. Ltd. (Singapore)
Sony Kisarazu Corporation (Japan)
Sony Kohda Corporation (Japan)
Sony Minokamo Corporation (Japan)
Sony Kokubu Semiconductor Corporation (Japan)
Sony Logistics (Singapore) Pte. Ltd. (Singapore)
Sony Logistics Corporation (Japan)

Sony Magnescale Inc. (Japan)
Sony Magnetic Products, Inc. (Japan)
Sony Magnetic Products (Thailand)
Sony Magnetic Tape Sales Corporation (Japan)
Sony Mizunami Corporation (Japan)
Sony Nagasaki Corporation (Japan)
Sony Oita Corporation (Japan)
Sony PCL Inc. (Japan)
Sony Plaza Co., Ltd. (Japan)
Sony Precision Engineering Center (Singapore) Pte. Ltd. (Singapore)
Sony Procurement Service Corporation (Japan)
Sony Pruco Life Insurance Co., Ltd. (Japan)
Sony Service Co., Ltd. (Japan)
Sony Shiroishi Semiconductor Inc. (Japan)
Sony Shoji Corporation (Japan)
Sony Singapore Pte. Ltd. (Singapore)
Sony Sound Tec Corporation (Japan)
Sony TV Video (Malaysia) Sdn. Bhd. (Malaysia)
Sony Trading Corporation (Japan)
Sony Tsukuba Corporation (Japan)
Sony Video Taiwan Co., Ltd. (Taiwan)
Sony/Tektronix Corporation (Japan)
Sound System Corporation (Japan)
Taron Corporation (Japan)
Tohkai Electronics Corporation (Japan)

ROW

Magneticos de Mexico, S.A. de C.V. (Mexico)
Sony CSA, S.A. (Panama)
Sony Chile Ltda. (Chile)
Sony Corporation of Panama S.A. (Panama)
Sony da Amazonia Ltda. (Brazil)
Sony de Venezuela S.A. (Venezuela)
Sony Saudi Arabian Company Ltd. (Saudi Arabia)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

Exabyte Corporation
Exabyte renewed a supply agreement with Sony under which Sony will supply Exabyte with 5.25-inch form factor tape drives.

Compression Labs Inc.
Sony entered into a reseller agreement with Compression Labs under which Sony will resell Compression Labs video coder/decoders. The agreement marks Sony's entry into the US videoconferencing market.

Texas Instruments
Texas Instruments will produce semiconductors in Europe for Sony on a consignment basis.

NJK Ltd.
NJK Ltd. signed as a distributor for Sony's NEWS workstations.

Fujitsu
Sony and Fujitsu jointly developed a trial common rule to develop CD-ROM XA software for their personal computers.

Oracle Corporation
Oracle Inc. will supply the Oracle relational database management systems and applications development software products to the Sony NEWS family of UNIX workstations.

Novell K.K.
Novell K.K. was formed as a joint marketing venture to sell NetWare products in Japan. Novell and six partners—Canon, Fujitsu, NEC, Softbank, Sony, and Toshiba—helped fund the project.

Advanced Micro Devices (AMD)
AMD will enter a joint manufacturing and educational pact with Sony to manufacture SRAMs.

Summus Computer Systems
Summus will sell, distribute, and service 4mm DAT drives from Sony. Summus will be an original equipment manufacturer (OEM) of Sony and will integrate hardware and software that offers turnkey storage subsystems for the Apple Computer Macintosh, Digital, and Sun Microsystems PC markets.

1989

Parallex Graphics Inc.
Sony Microsystems agreed to incorporate Parallex's color graphics and video graphics controllers in Sony's workstations.

Matsushita Philips
Sony, Matsushita, and Philips agreed to develop, manufacture, and market interactive compact disk drives.

Apple Computer
Sony signed a contract with Apple to supply 40-Mbyte rigid disk drives for the Macintosh.

Hewlett-Packard
Sony will supply 5.25-inch rewritable optical disk storage products to Hewlett-Packard for the new HP C17QA Optical Disk Library System.

Pinnacle Micro
Sony announced plans to supply $1 million (¥128.3 million) worth of 5.25-inch rewritable optical disk storage products to Pinnacle Micro.

Advanced Micro Devices (AMD)
Sony and AMD entered a joint venture agreement for an SRAM memory product.

1988

Daewoo Electronics
Sony and Daewoo agreed to jointly develop 256K SRAMs, 64K SRAMs, 8- and 16-bit MPUs, and other microchips.

Engineering Mechanics Research (EMR)
Sony and EMR agreed to a joint venture in CAE software technology and sales. EMR is marketing Sony's engineering workstations (EWSs) that employ its software in the United States while Sony supports sales agents of EMR's software in Japan by supplying its EWS.

N.V. Philips Gloeilampenfabrieken
Sony and Philips agreed to a joint development of extended architecture CD-ROMs for audio use.

Motorola Inc.
Sony Microsystems is incorporating dual Motorola 68030 MPUs in high-end models of Sony's NEWS UNIX workstation family.

Symbolics
Sony and Symbolics completed a sales agreement for Sony's workstations in the US market. Sony Microsystems began supplying its workstations to Symbolics in May 1988 for sale in the United States under the Symbolics brand name. The two companies will jointly develop a new model of workstation using Symbolics' A1 chips.

Texas Instruments (TI)
TI Japan and Sony jointly developed the CXD1144AP high-performance digital filter LSI for digital audio equipment.

Advanced Micro Devices (AMD)
Sony and AMD agreed to a sales tie-up for Sony's workstations in South Korea.

MERGERS AND ACQUISITIONS

1989

Trans Com Systems Division
Sony purchased all assets and liabilities of Trans Com Systems, a division of Sundstrand Corporation. Trans Com is engaged in designing, manufacturing, and installing in-flight AV entertainment systems in commercial aircraft worldwide.

Materials Research Corporation (MRC)
Sony acquired all of the outstanding shares of common stock of MRC and its affiliates. MRC is a manufacturer and supplier of sputtering and etching equipment, high-purity metals, and ceramics.

Columbia Pictures Entertainment
Sony acquired all of the outstanding shares of common stock of Columbia Pictures, which is primarily in the filmmaking business.

Guber-Peters Entertainment Company (GPEC)
Sony acquired GPEC, which is in the filmmaking business.

1988

CBS Records Inc.
Sony purchased CBS Records for US$2 billion (¥256.5 billion) and holds 100 percent of the shares. (The acquisition was made using US currency.)

KEY OFFICERS

Akio Morita
Chairman and chief executive officer

Norio Ohga
President and chief operating officer

Masaaki Morita
Deputy president

Masahiko Morizono
Deputy president

PRINCIPAL INVESTORS

Information is not available

FOUNDERS

Information is not available.

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Billions of US Dollars, except Per Share Data)

Balance Sheet	1986	1987*	1988	1989	1990
Total Current Assets	$5.6	$5.8	$7.8	$11.2	$15.5
Cash	0.8	1.0	1.6	2.3	3.2
Receivables	1.7	1.6	2.4	3.4	5.8
Marketable Securities	0.7	0.8	0.7	0.7	0.4
Inventory	1.8	1.9	2.4	3.8	4.9
Other Current Assets	0.5	0.5	0.7	1.0	1.2
Net Property, Plants	$1.9	$2.2	$3.1	$4.2	$6.1
Other Assets	$0.8	$0.9	$2.6	$3.0	$9.1
Total Assets	$8.3	$8.8	$13.5	$18.4	$30.7
Total Current Liabilities	$3.6	$3.7	$6.8	$8.7	$14.0
Long-Term Debt	$0.8	$0.9	$1.4	$1.7	$4.5
Other Liabilities	$0.4	$0.5	$0.6	$0.8	$2.0
Total Liabilities	$4.8	$5.0	$8.8	$11.2	$20.5
Total Shareholders' Equity	$3.5	$3.8	$4.7	$7.2	$10.2
Common Stock	0.1	0.1	0.2	0.9	2.0
Other Equity	0.4	0.4	0.4	1.5	3.3
Retained Earnings	3.0	3.4	4.1	4.8	4.9
Total Liabilities and Shareholders' Equity	$8.3	$8.8	$13.5	$18.4	$30.7
Income Statement	**1986**	**1987***	**1988**	**1989**	**1990**
Revenue	$7.6	$3.4	$10.4	$16.7	$20.2
Japanese Revenue	2.2	1.1	3.5	5.7	6.1
Non-Japanese Revenue	5.3	2.3	6.9	11.0	14.1
Cost of Sales	$5.8	$2.6	$7.7	$11.5	$13.6
R&D Expense	$0.7	$0.8	$0.9	$1.1	$1.2
SG&A Expense	$1.7	$0.8	$2.4	$4.4	$5.0
Capital Expense	$0.5	$0.6	$1.0	$1.7	$2.3
Pretax Income	$0.4	$0.1	$0.5	$1.3	$1.6
Pretax Margin (%)	5.77	4.36	5.13	7.72	7.90
Effective Tax Rate (%)	58.00	58.00	56.00	56.00	54.00
Net Income	$0.2	$0.1	$0.3	$0.6	$0.7
Shares Outstanding, Thousands	230,887	231,236	238,768	282,602	331,928
Per Share Data					
Earnings	$0.97	$0.34	$1.04	$1.88	$2.15
Dividend	$0.25	$0.12	$0.32	$0.35	$0.35
Book Value	0	0	0	0	0
Exchange Rate (US$1=¥)	¥175.09	¥159.56	¥138.03	¥128.25	¥142.47

*For the five-month period ending March 31, 1987. Effective March 31, 1987, the parent company and almost all subsidiaries and affiliates changed their fiscal year-end from October 31 to March 31. Accordingly, the fiscal period ended March 31, 1987, included only 5 months of operations, whereas other fiscal years consisted of 12 months.

Source: Sony Corporation Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of Yen, except Per Share Data)

Balance Sheet	1986	1987*	1988	1989	1990
Total Current Assets	¥973.6	¥922.2	¥1,076.9	¥1,433.8	¥2,201.6
Cash	145.5	152.9	218.0	297.9	451.7
Receivables	294.4	256.6	325.7	433.4	832.9
Marketable Securities	129.7	132.2	99.4	91.1	54.8
Inventory	313.3	302.9	334.7	483.7	693.0
Other Current Assets	90.7	77.6	99.1	127.7	169.2
Net Property, Plants	¥332.6	¥343.1	¥426.3	¥544.7	¥868.1
Other Assets	¥143.8	¥145.9	¥363.7	¥386.2	¥1,300.4
Total Assets	¥1,450.0	¥1,411.2	¥1,866.9	¥2,364.7	¥4,370.1
Total Current Liabilities	¥628.3	¥587.0	¥945.0	¥1,119.0	¥1,995.9
Long-Term Debt	¥143.9	¥143.4	¥196.0	¥220.8	¥646.0
Other Liabilities	¥71.6	¥72.1	¥76.3	¥98.2	¥281.3
Total Liabilities	¥843.8	¥802.5	¥1,217.3	¥1,438.0	¥2,923.2
Total Shareholders' Equity	¥606.2	¥608.7	¥649.6	¥926.7	¥1,446.9
Common Stock	12.0	12.0	23.7	114.6	278.0
Other Equity	62.9	56.5	60.9	195.6	473.4
Retained Earnings	531.3	540.2	565.0	616.5	695.5
Total Liabilities and Shareholders' Equity	¥1,450.0	¥1,411.2	¥1,866.9	¥2,364.7	¥4,370.1
Income Statement	**1986**	**1987***	**1988**	**1989**	**1990**
Revenue	¥1,325.1	¥547.8	¥1,431.2	¥2,145.3	¥2,879.9
Japanese Revenue	391.3	177.5	479.4	731.3	869.5
Non-Japanese Revenue	933.8	370.3	951.8	1,414.0	2,010.4
Cost of Sales	¥1,009.8	¥407.8	¥1,064.6	¥1,475.4	¥1,938.0
R&D Expense	¥121.4	¥131.2	¥127.5	¥142.1	¥165.2
SG&A Expense	¥302.5	¥131.0	¥336.3	¥565.6	¥712.0
Capital Expense	¥94.1	¥101.6	¥133.5	¥215.6	¥324.0
Pretax Income	¥76.4	¥23.6	¥73.5	¥165.5	¥227.4
Pretax Margin (%)	5.77	4.36	5.14	7.71	7.90
Effective Tax Rate (%)	58.00	58.00	56.00	56.00	54.00
Net Income	¥41.9	¥13.3	¥36.7	¥72.5	¥102.8
Shares Outstanding, Millions	230,887	231,236	238,768	282,602	331,928
Per Share Data					
Earnings	¥169.00	¥54.20	¥143.80	¥240.80	¥306.80
Dividend	¥44.00	¥18.50	¥44.60	¥44.60	¥50.00
Book Value	0	0	0	0	0

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March 31
(Millions of Yen, except Per Share Data)

Key Financial Ratios	1986	1987*	1988	1989	1990
Liquidity					
Current (Times)	1.55	1.57	1.14	1.28	1.10
Quick (Times)	1.05	1.06	0.79	0.85	0.76
Fixed Assets/Equity (%)	54.87	56.37	65.63	58.78	60.00
Current Liabilities/Equity (%)	103.65	96.44	145.47	120.75	137.94
Total Liabilities/Equity (%)	139.20	131.84	187.39	155.17	202.03
Profitability (%)					
Return on Assets	-	0.93	2.24	3.43	3.05
Return on Equity	-	2.19	5.83	9.20	8.66
Profit Margin	3.16	2.43	2.56	3.38	3.57
Other Key Ratios					
R&D Spending % of Revenue	9.16	23.95	8.91	6.62	5.74
Capital Spending % of Revenue	7.10	18.55	9.33	10.05	11.25
Employees	48,700	47,583	71,000	78,900	95,600
Revenue (¥K)/Employee	¥27.21	¥11.51	¥20.16	¥27.19	¥30.12
Capital Spending % of Assets	6.49	7.20	7.15	9.12	7.41
Exchange Rate (US$1=¥)	¥175.09	¥159.56	¥138.03	¥128.25	¥142.47

*For the five-month period ending March 31, 1987. Effective March 31, 1987, the parent company and almost all subsidiaries and affiliates changed their fiscal year-end from October 31 to March 31. Accordingly, the fiscal period ended March 31, 1987, included only 5 months of operations, whereas other fiscal years consisted of 12 months.

Source: Sony Corporation Annual Reports
Dataquest (1990)

Toshiba Corporation

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Telephone: (03) 457-4511
Fax: (03) 456-1631
Dun's Number: 06-499-3082

Date Founded: 1875

CORPORATE STRATEGIC DIRECTION

Toshiba Corporation is one of the largest electronics companies worldwide. Its main business activity is the development, manufacturing, and marketing of electrical and electronics equipment and electronic components. The business is divided into the following segments: Information/Communication Systems and Electronic Devices, which accounts for 50 percent of net sales; Heavy Electrical Apparatus, which accounts for 19 percent of net sales; and Consumer Products, which accounts for 31 percent of net sales.

Toshiba is one of two leaders of the Toshiba-IHI Group; the other is Ishikawajima-Harima Heavy Industries (IHI). These parents have close capital and business connections. Their subsidiaries are engaged in electrical and electronics products, construction, trading and finance, and shipbuilding.

Total revenue for 1991 amounted to $33.3 billion,* an increase of 12 percent over 1990 revenue of $29.7 billion. Domestic sales decreased slightly from 60.73 percent in 1990 to 54.99 percent in 1991. International sales also dropped slightly from 31.62 percent to 30.98 percent. Fierce competition in the key semiconductor and computer markets led to a decrease in net income of 7.15 percent during 1991. Net income totaled $856.2 million, compared with $922.1 in 1990.

Toshiba has developed a "Sixth Medium-Term Plan." This plan will cover the period from 1991 through 1993. The focus of this plan is group, growth, and global. Group represents Toshiba's goal to strengthen its group of companies. This will be done by building on the synergies that exist among its lines of business and by making strategic alliances. For growth, Toshiba plans to increase total sales about 60 percent by 1993. This will be done by offering value-added products that unify the collective expertise of Toshiba's numerous divisions and group companies. In addition, the contribution of overseas sales is scheduled to rise from 35 to 39 percent of total sales. In order to meet this goal, Toshiba will need to build on its commitment to developing markets worldwide. Global represents how Toshiba will build on its global presence. Toshiba plans to raise overseas sales as a percentage of total sales by increasing overseas production and strengthening marketing operations in local markets.

R&D is structured by Toshiba to incorporate both long- and short-term planning by developing projects of varying time frames. Corporate level undertakes projects with a five- to ten-year time frame, division level operates under three-year time frames, division engineering level goes by one-year time frames, and division manufacturing strives for continuous day-to-day improvement. Therefore, Toshiba can take both long- and short-term perspectives.

R&D expenditure increased 13 percent from $1.86 billion in 1990 to $2.1 billion in 1991 and represented 6.37 percent of sales in 1991. This expenditure was concentrated primarily on 16Mb and 64Mb DRAMs, large color liquid crystal displays (LCDs), new high temperature superconducting materials for future electronic devices, and various equipment for train systems. A large share of activities was also focused on information and communications systems, such as broadband ISDN (BISDN) switching equipment. Toshiba plans to raise R&D expenditure 7 percent during the 1992 fiscal year.

Capital expenditure for the same period totaled $3.1 billion, a 35 percent increase over 1990,

*All dollar amounts are in U.S. dollars.

which totaled \$2.3 billion. The rise in capital spending during fiscal 1990 and 1991 was primarily the result of development and production of 4Mb and 16Mb DRAMs. Over \$1.4 billion was invested in the semiconductor group during the fiscal year; and several new factories are either currently under construction or already completed. During fiscal 1992, capital expenditure is expected to be approximately \$3.5 billion.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channel is not available. Tables 3 through 7 at the end of this backgrounder present comprehensive financial information.

BUSINESS SEGMENT STRATEGIC DIRECTION

Information/Communication Systems and Electronic Devices

Fiscal 1991 sales in this segment were \$16.7 billion and accounted for 50 percent of company sales.

A companywide program developed by Toshiba to strengthen its capabilities in information and communications systems contributed to the sale of notebook and laptop computers, which were up 40 percent during 1991. Although semiconductor memory sales were flat, sales of ASICs grew 6 percent in that product segment. Toshiba also introduced a second generation 4Mb DRAM that features a smaller chip size and faster access time.

Semiconductors

According to Dataquest, Toshiba remained the second-largest semiconductor supplier in 1990, with 8.3 percent of the worldwide market share and revenue of \$4.8 billion. Toshiba also was the third-largest semiconductor supplier in Japan. Toshiba's diversified product portfolio emphasizes balance among analog, discrete, bipolar, MOS logic, memory devices, and ASICs.

Toshiba was also the largest worldwide supplier of discrete devices in 1988, 1989, and 1990. In 1990, Toshiba captured an 11.0 percent market share totaling \$904 million in revenue. Toshiba has stated its goal to remain No. 1 in discretes. Toshiba ranked second, with a 9.2 percent market share and \$838 million in revenue, in the MOS logic semiconductor segment and third in the MOS digital semiconductor segment with \$2.9 billion in revenue. In the analog semiconductor industry Toshiba ranked third, capturing a 5.8 percent market share, according to Dataquest.

In the DRAM market, Toshiba is committed to increasing 4Mb DRAM production and has responded to demand by developing and producing a wide range of products. In October 1991, Toshiba announced a new series of 4Mb DRAMs with a 512K×9 structure. The device has the standard data capacity of 512K×8, plus an additional 512K×1 capacity for a parity bit. Dataquest believes that this is one of what will be many announcements for this type of product.

According to Dataquest, in 1990 Toshiba remained the largest supplier of 1Mb DRAMs to worldwide markets for the second consecutive year. It was second in the 4Mb product area, having held the top spot during 1989. However, during 1990 Toshiba adjusted to a 4Mb DRAM market shift, from a 350-mil-wide-device, the 4Mb part with which it started, to the now industry-standard 300-mil part. During 1991 and 1992, the company will emphasize the 4Mb DRAM density and de-emphasize the 256K DRAMs and 1Mb DRAMs. Toshiba should remain a leader in the DRAM market for the foreseeable future and a major player in the 4Mb video RAM (VRAM) segment as that market emerges. Toshiba ranked first in the MOS memory semiconductor arena with \$1.6 billion in revenue and a 12.4 percent market share.

Dataquest ranked Toshiba third in the worldwide optoelectronic semiconductor industry, with an 11.6 percent share of the 1990 market.

During fiscal 1991, Toshiba invested approximately \$226 million in its LCD business. Preparations for expansion into this market included the construction of LCD manufacturing facilities for the joint venture with IBM Japan, Display Technologies Inc.

Personal Computers

Toshiba is developing sophisticated, high-performance PC systems to position the company at the forefront of current and emerging high-growth fields. In 1990, according to Dataquest, Toshiba ranked tenth worldwide and captured 3.6 percent of the worldwide PC market. Dataquest believes that Toshiba is now the dominant player in the world market for laptops, with a 1990 market share of 29.4 percent in the worldwide laptop/DC market and a 21.6 percent market share in the worldwide laptop/AC market.

Workstations

Toshiba markets a line of UNIX engineering workstations incorporating original hardware and Japanese-version software. This line has done well in the Japanese market.

Telecommunications Equipment

Under a development contract with NTT, Toshiba is developing an asynchronous transfer mode (ATM) switching system for BISDN, the next-generation telecommunications network. Also, in a joint effort with Kokusai Denshin Denwa (KDD), Japan's international telephone service corporation, Toshiba has developed the first satellite communications system in Japan for installation in commercial airliners to enable air-to-ground telephone communication. Demand from the growing mobile portable and cordless telephone markets is being met, and an ultralight, ultracompact portable telephone that conforms to U.S. standards has been developed. According to Dataquest, in 1990 Toshiba ranked ninth in the United States in total PBX systems with a 2.5 percent market share.

Toshiba is a major supplier of facsimile products worldwide. Much of its success stems from the effective diversification of the product line to best suit the trends in market demand. Toshiba meets the high-end demand with products that will transmit a standard document in just 13 seconds. The products feature one-touch dialing and automatic Optical Mark Recognition (OMR) dialing. Toshiba also has models that offer an additional electronic memory, which adds such valuable functions as broadcasting, mailbox, and relay transmission. In addition, Toshiba offers compact, entry-level machines with one-touch dialing. In 1990, according to Dataquest, Toshiba ranked sixth worldwide with a 5.6 percent market share.

Toshiba is one of the top 10 suppliers of key telephone systems to the U.S. market. These systems are customer-premises telephone switching systems that allow telephones to interface to the public network without dialing access codes. Competition is stiff in this market segment because the top 10 suppliers account for 85 percent of the market, and there is very little differentiation among their technologies. For 1990, according to Dataquest, Toshiba ranked fifth in the key telephone systems area in the United States with a 5.7 percent market share.

Printers

Toshiba manufactures dot matrix, laser, and thermal transfer printers, with the overwhelming majority of business in the first two product areas. According to Dataquest, for 1990 Toshiba had less than a one percent share of the North America printer market.

Copiers

Toshiba sells and manufactures plain paper copiers (PPCs) on a global scale. According to Dataquest, Toshiba is one of the top 10 PPC manufacturers in the United States, placing 51.9 thousand PPCs during 1990.

Computer Storage

Toshiba is one of the leading optical drive suppliers. According to Dataquest, for 1990 Toshiba ranked fourth in the 12-inch worldwide write-once/read-many (WORM) market with a 10.0 percent market share. In the CD-ROM market it also ranked fourth with a 9.2 percent market share. Toshiba ranked fifth in the total optical disk drive market with a market share of 3.5 percent worldwide.

Heavy Electrical Apparatus

In fiscal 1991, Toshiba's Heavy Electrical Apparatus segment accounted for 19 percent of its net sales, totaling $6.4 billion compared with $618.6 million in 1990, reflecting a 14 percent increase over 1990. Domestic sales grew due to completion of large-scale nuclear power plants and high demand for electrical equipment stimulated by brisk capital investment. However, exports were down because of decreased plant deliveries.

Toshiba will continue to emphasize the development of its energy business, focusing on three systems. In the nuclear power generation sector, Toshiba is continuing to develop advanced, simplified systems that incorporate improvements in safety, reliability, and operability. The second system is thermal power plants. Toshiba is developing and refining a system that includes a combined cycle that will achieve new levels of turbine efficiency. The third system is fuel cells. According to Toshiba, the fuel cells show great promise as a superior next-generation source of clean energy.

Consumer Products

Fiscal 1991 sales of products in this segment rose 9 percent to $10.2 billion, accounting for 31 percent of Toshiba's net sales. The high added value of products in the domestic market and smooth expansion of overseas manufacturing operations both contributed to the gain. Domestic demand centered on air conditioners, large-screen TVs incorporating broadcast satellite tuners, lighting products, and materials.

The consumer products business has been restructured to reflect the continuing development of the information society and the personal and household use of information and communications devices. The Consumer Products Group has been separated into two business units, the Video & Electronics Media Group and the Airconditioners & Appliances Group. The Video & Electronics Media Group aims to position Toshiba as a major presence in multimedia.

Further Information

For further information about the company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Millions of U.S. Dollars)

	1987	1988	1989	1990	1991
Five-Year Revenue	20,734.7	25,881.3	29,636.6	29,748.8	33,251.2
Percent Change	36.01	24.82	14.51	0.38	11.77
Capital Expenditure	1,337.1	1,359.7	2,086.5	2,263.3	3,122.3
Percent of Revenue	6.45	5.25	7.04	7.61	9.39
R&D Expenditure	1,260.7	1,575.0	1,796.5	1,860.4	2,117.4
Percent of Revenue	6.08	6.09	6.06	6.25	6.37
Number of Employees	121,000	122,000	125,000	142,000	162,000
Revenue ($K)/Employee	171.36	212.14	237.09	209.50	205.25
Net Income	214.4	439.8	9,310.0	922.1	856.2
Percent Change	(20.15)	105.13	2,016.87	(90.10)	(7.15)
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

1991 Fiscal Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA= Not available

Source: Toshiba Corporation
Annual Reports
Dataquest (January 1992)

Table 2
Revenue by Geographic Region (Percent)

Region	1987	1988	1989	1990	1991
Japan	69.14	69.03	67.93	60.73	54.99
Overseas	30.86	30.97	32.07	31.62	30.98

Source: Toshiba Corporation
Annual Reports
Dataquest (January 1992)

1991 SALES OFFICE LOCATIONS

Europe—4
Asia/Pacific—77
Japan—67
ROW—11

MANUFACTURING LOCATIONS

North America

International Fuel Cells
A joint venture with United Technologies to produce fuel cells
Microelectronics Center
Semiconductors
Toshiba America Inc.
TVs, microwave ovens, VCRs, toners, telephones, medical equipment
Toshiba International
Motors, circuit boards, control equipment
Toshiba Westinghouse Electronics
A joint venture to produce color CRTs

Europe

Compagnie Europeen Pour La Fabrication D'Enceintes A Micro-Ondes (France)
A joint venture with Thomson of France to produce microwave ovens
Toshiba Consumer Products GmbH (Germany)
VCRs, TVs
Toshiba Consumer Products Ltd. (United Kingdom)
TVs, VCRs, microwave ovens
Toshiba Consumer Products S.A. (France)
Lamps for copiers
Toshiba Semiconductor GmbH (Germany)
Semiconductors
Toshiba Systemes S.A. (France)
A joint venture with ROHM Poulanc to produce plain paper copiers

Asia/Pacific

Amori Taic (Japan)
Radio cassette recorders, record players, component stereos
Buzen Toshiba Electronics Co. Ltd. (Japan)
Semiconductors
Hankook Tungsten (South Korea)
Tungsten, molybdenum wires and parts
Harison Denki (Japan)
Electric lamps
Himeji Toshiba Electronics (Japan)
ICs, lead frames for semiconductors
Hokuto Electronics (Japan)
CRTs
Iwate Toshiba Electronics Co. Ltd. (Japan)
Semiconductors
Kaga Toshiba Electronics (Japan)
Semiconductors
Kitashiba Electric Co. Ltd. (Japan)
Transformers, electric motors
Kitsuki Toshiba Electronics (Japan)
Semiconductors
Korea Electronics (South Korea)
Semiconductors, TVs
Kumdong Lighting (South Korea)
Fluorescent lamps
Leechun Electric Mfg. (South Korea)
Generators, motors, transformers, pumps
Marcon Electronics Co. Ltd. (Japan)
Capacitors, hybrid ICs
Nishishiba Electric Co. Ltd. (Japan)
Electric marine equipment
Nougata Toshiba Electronics (Japan)
Semiconductors
Olivetti Corporation of Japan (Japan)
Data communications equipment, computers, word processing systems, typewriters
Onkyo Corporation (Japan)
Audio equipment and parts
Shibaura Engineering Works Co. Ltd. (Japan)
Motors, electric tools
Sord Computer (Japan)
Microcomputer and peripherals
Tatung Co. (Taiwan)
TVs, refrigerators, transformers
Thai Toshiba Electric Industries Co. Ltd. (Thailand)
A joint venture with Siam Cement of Thailand to produce TVs, refrigerators, electric fans, electric rice cookers, motors
Thai Toshiba Fluorescent Lamp Co. Ltd. (Thailand)
Glass tubes for fluorescent lamps
Thai Toshiba Lighting Co. Ltd. (Thailand)
Fluorescent lamps
Tohoku Semiconductor (Japan)
Semiconductors
Toki Electric Industrial (Japan)
Electric lamps, lighting equipment

Tokyo Electric Co. Ltd. (Japan)
 Business machines, lighting equipment, home appliances
Tokyo Electronic Industry Co. Ltd. (Japan)
 Industrial video equipment, control equipment
Tokyo Optical (Japan)
 Optical instruments
Toshiba Battery (Japan)
 Dry batteries, battery applied products
Toshiba Ceramics (Japan)
 Ceramics
Toshiba Chemical Corporation (Japan)
 Plastic products, insulating materials
Toshiba Cold Chain (Japan)
 Freezers, vending machines
Toshiba Components Co. Ltd. (Japan)
 Semiconductors
Toshiba Electric Equipment Co. Ltd. (Japan)
 Lighting fixtures
Toshiba Electronics Malaysia Sdn. Bhd. (Malaysia)
 IC memories
Toshiba Electronic Systems Co. Ltd. (Japan)
 A joint venture with General Electric to produce and market electronic equipment
Toshiba Engineering & Construction Co. Ltd. (Japan)
 Electric facilities
Toshiba Glass Co. Ltd. (Japan)
 Glass products
Toshiba Heating Appliances (Japan)
 Oil heating equipment
Toshiba Kiki (Japan)
 Lighting equipment, etc.
Toshiba Machine (Japan)
 Machinery, machine tools
Toshiba Medical Systems Co. Ltd. (Japan)
 Medical electronic equipment
Toshiba Seiki (Japan)
 Automatic precision apparatus
Toshiba Singapore Pte. Ltd. (Singapore)
 Color TVs, TV parts, audio equipment
Toshiba Steel Tube Co. Ltd. (Japan)
 Steel tubes, electric conduit tubes
Toshiba Tungaloy (Japan)
 Special alloy tools

ROW

Industria Mexicana Toshiba S.A. (Mexico)
 Semiconductors
Semp Toshiba Amazonas S.A. (Brazil)
 TVs, audio equipment
Toshiba Electromex S.A. de C.V. (Mexico)
 Color TV parts for Toshiba America

SUBSIDIARIES

North America

GE Toshiba Lighting Corporation (United States)
Ottawa Design Center (Canada)
Toshiba America Consumer Products Inc. (United States)
Toshiba America Electronic Components Inc. (United States)
Toshiba America, Inc. (United States)
Toshiba America Information Systems Inc. (United States)
Toshiba America Medical Systems Inc. (United States)
Toshiba Display Devices Inc. (United States)
Toshiba Hawaii Inc. (United States)
Toshiba International Corporation (United States)
Toshiba of Canada Ltd. (Canada)

Europe

Compagnie European Pour La Fabrication D'Enceintes A Micro-Ondes (France)
Toshiba AG (Switzerland)
Toshiba Consumer Products GmbH (Germany)
Toshiba Consumer Products Ltd. (United Kingdom)
Toshiba Consumer Products S.A. (France)
Toshiba Deutschland GmbH (Germany)
Toshiba Electronics Espana S.A. (Spain)
Toshiba Electronics Europe GmbH (Germany)
Toshiba Electronics Italiana S.R.L. (Italy)
Toshiba Electronics Ltd. (United Kingdom)
Toshiba Electronics Scandinavia AB (Sweden)
Toshiba Europa GmbH (Germany)
Toshiba Information Systems (Belgium)
Toshiba Information Systems Ltd. (United Kingdom)
Toshiba Information Systems S.A. (Spain)
Toshiba Information Systems S.p.A. (Italy)
Toshiba Informationssyteme GmbH (Germany)
Toshiba International (Europe) Ltd. (United Kingdom)
Toshiba International Finance B.V. (Netherlands)
Toshiba International Finance Ltd. (United Kingdom)
Toshiba Ltd. (United Kingdom)
Toshiba Medical Systems Europe B.V. (Netherlands)
Toshiba Semiconductor GmbH (Germany)
Toshiba Systemes S.A. (France)

Asia/Pacific

Iwate Toshiba Electronics Co. Ltd. (Japan)
Kitashiba Electric Co. Ltd. (Japan)

Kyodo Building Corporation (Japan)
Man On Toshiba Ltd. (Hong Kong)
Marcon Electronics Co. Ltd. (Japan)
Minato Building Co. Ltd. (Japan)
Nikko Jitsdugyo Co. Ltd. (Japan)
Nishishiba Electric Co. Ltd. (Japan)
Onkyo Corporation (Japan)
Shibaura Engineering Works Co. Ltd. (Japan)
TDH, Inc. (Japan)
Thai Toshiba Electric Industries Co. Ltd. (Thailand)
Tokyo Electric Co. Ltd. (Japan)
Toshiba Automation Co. Ltd. (Japan)
Toshiba Battery Co. Ltd. (Japan)
Toshiba Builders Appliance Co. Ltd. (Japan)
Toshiba Building Corporation (Japan)
Toshiba Ceramics Co. Ltd. (Japan)
Toshiba Chemical Corporation (Japan)
Toshiba Components Co. Ltd. (Japan)
Toshiba Consumer Products Co. Ltd. (Thailand)
Toshiba Credit Corporation (Japan)
Toshiba Display Devices Co. Ltd. (Thailand)
Toshiba Electric Appliances Co. Ltd. (Japan)
Toshiba Electric Equipment Corp. (Japan)
Toshiba Electronic Systems Co. Ltd. (Japan)
Toshiba Electronics Asia, Ltd. (Hong Kong)
Toshiba Electronics Malaysia Sdn. Bhd. (Malaysia)
Toshiba Electronics Taiwan Corporation (Taiwan)
Toshiba Elevator & Escalator Service Co. Ltd. (Japan)
Toshiba Engineering & Construction Co. Ltd. (Japan)
Toshiba Engineering Co. Ltd. (Japan)
Toshiba Glass Co. Ltd. (Japan)
Toshiba Heating Appliances Co. Ltd. (Japan)
Toshiba Higashinihon Consumer Electronics Co. Ltd. (Japan)
Toshiba Information Equipment Co. Ltd. (Japan)
Toshiba International Corporation Pty. Ltd. (Australia)
Toshiba Lightec Corporation (Japan)
Toshiba Medical Systems Co. Ltd. (Japan)
Toshiba Physical Distribution Co. Ltd. (Japan)
Toshiba Pty. Ltd. (Australia)
Toshiba Sales and Services Sdn. Bhd. (Malaysia)
Toshiba Silicone Co. Ltd. (Japan)
Toshiba Singapore Pte. Ltd. (Singapore)
Toshiba Steel Tube Co. Ltd. (Japan)
Toshiba Thailand Co. Ltd. (Thailand)

ROW

Industria Mexicana Toshiba S.A. (Mexico)
Semp Toshiba Amazonas S.A. (Brazil)
T and S Servicos Industrias S/C Ltda. (Brazil)
Toshiba de Brasil S.A. (Brazil)
Toshiba de Panama S.A. (Panama)
Toshiba Electromex S.A. de C.V. (Mexico)
Toshiba Medical de Brasil Ltda. (Brazil)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1991

Motorola Inc.

Motorola Inc.'s semiconductor products sector signed a joint-development agreement with Toshiba to design a MUSE (Multiple Sub-nyquist Encoding) decoder chip set for HDTV systems used in Japan. The chips are expected to be completed by the middle of 1992.

Sun Microsystems Inc.

Sun Microsystems Inc. and Toshiba will jointly develop the technology required to commercialize multimedia workstations, which will be compatible with the BISDN telecommunications service.

Synergy Semiconductor

Toshiba has acquired approximately a 10 percent minority stake in Synergy Semiconductor. This strategic alliance will provide for a joint-development effort to build libraries of high-speed ECL and E-BiCMOS ASIC designs. Under the agreement, Toshiba will build 6-inch submicron production lines in Japan for the to-be-designed ECL and E-BiCMOS ASICs.

Echelon Corporation

Echelon has licensed to Toshiba and Motorola the Neuron chip family, its local operating network (LON) product lines. The chip family comprises of two members: the 3210 and 3150.

TEC Electronics

Toshiba has licensed TEC Electronics, a subsidiary of its Tokyo Electric Corp. affiliate, to market its Dynabook notebook personal computers, along with the point-of-sale terminals that Toshiba manufactures.

Bull Micral of America

Toshiba entered into the PC logic chip set business with a chip set for 486-based Micro Channel systems licensed from Bull Micral of America, an affiliate of Groupe Bull.

Texas Instruments Inc.

Texas Instruments Inc. and Toshiba signed a 10-year patent cross-licensing agreement. Toshiba will pay Texas Instruments royalties for using the patented chip technology.

1990

IBM Japan Ltd.

Toshiba and IBM Japan are jointly constructing a plant that will have a production capability of 50,000 LCD panels a year.

Motorola Inc.

Toshiba and Motorola reportedly plan to sign an agreement to exchange gate array technology to allow the companies to act as mutual second sources. In the United States, Motorola will produce gate arrays designed and developed by Toshiba, which Motorola intends to market for use in workstations. In Japan, Tohoku Semiconductor Inc., a joint venture of the two companies, will produce gate arrays based on Motorola technology for supply to local companies. Toshiba and Motorola also plan to expand their technological cooperation to include discrete semiconductors.

Businessland

Businessland Japan will be formed by Businessland, Canon, Fujitsu, software distributor Softbank, Sony, and Toshiba to provide systems integration services for international firms. Businessland will have a 54 percent stake in the joint venture, Softbank will have 26 percent, and the other firms will have 5 percent each.

Spectrum Cellular Corp.

Toshiba will market Dallas-based Spectrum Cellular's new cellular/landline modem with its laptop computers as the T24D/X, and Spectrum will also develop five separate versions of its new SmartCable product for sale by Toshiba.

General Electric (GE)

GE and Toshiba have entered into a joint marketing agreement covering the sale of GE's CompuScene PT2000 in Japan. The visual simulation system and other Compu-Scene products will be distributed by Toshiba Electronics Systems, a GE/Toshiba joint venture company.

Echelon Systems Corp.

Motorola and Toshiba have become the first semiconductor makers to license the rights to a new generation of intelligent power-controller chips being developed by Echelon Systems. Under the terms of the agreement, Toshiba's Semiconductor Group will manufacture and market the Echelon-designed ICs. The agreement also permits Toshiba to design, manufacture, and market enhanced versions of the chips.

1989

EDA Systems Inc.

EDA signed a purchase agreement with Toshiba for its Powerframe product, a design management framework that integrates third-party CAD/CAE tools and speeds the overall electronic design process.

IBM Corporation

The two companies agreed to the joint development of a color flat panel display for computers that is larger and clearer than any demonstrated previously.

Digital Equipment Corporation

The companies have a technology exchange agreement that will ensure the integration of Toshiba's laptop personal computers into Digital's networking environment.

Weitek Corporation

Under a joint development agreement, Weitek will manufacture some of its semiconductors in Toshiba's plant; Toshiba will gain access to some of Weitek's floating-point product technology.

McDonnell Douglas

McDonnell Douglas has agreed to port its PRO-IV application development language to minicomputers manufactured by Toshiba.

Cummins Engine Co.

The companies have undertaken a joint venture to market silicon nitride ceramic components in North America.

Sun Microsystems Inc.

The companies signed a worldwide licensing agreement to bundle the SPARC MPU architecture, the SunOS operating system, and the Open Look Graphics interface into a series of small-footprint, low-cost computers.

Siemens

The companies extended their long-standing alliance in ASICs.

1988

Zoran
The companies agreed to a technology and manufacturing alliance.

Motorola Inc.
Under a joint venture, the companies formed Tohoku Semiconductor. Tohoku is using Toshiba's marketing channels to market Motorola's 68000 series MPUs in Japan.

Advanced Silicon Corporation
Toshiba agreed to provide Advanced Silicon Corporation with 6-inch CMOS wafers and jointly develop ASIC software.

Siemens and GE
The companies agreed to jointly develop a common cell library.

SGS-Thomson
The companies extended a six-year agreement to patent cross-licensing related to semiconductor technology.

1987

GRiD
Toshiba agreed to supply GRiD with an IBM PC AT-compatible kneetop computer.

Mitsui Petrochemical
The companies undertook the joint development of a magnetic tape emulator.

Viewlogic Systems
Viewlogic Systems is the principal worldwide supplier of CAE software for Toshiba.

Aida Corporation
Toshiba agreed to provide Aida with its TC17G gate array library models. Toshiba is gaining access to Aida's semicustom IC design equipment.

SGS-ATES
The companies made a five-year technical collaboration agreement allowing Toshiba to use SGS-ATES' semiconductor sales network in Europe and allowing SGS-ATES to receive LSI fab technology and technical training for its engineers from Toshiba.

SDA Systems
The companies undertook a five-year joint venture to cooperatively develop CAD systems for IC design.

MERGERS AND ACQUISITIONS

1991

UNIX System Laboratories
AT&T sold one-fifth of its UNIX System Laboratories to eleven computer companies, including Toshiba. The other computer companies involved are Motorola Inc., Novell Inc., Sun Microsystems Inc., NEC America Inc., England's ICL, Ing. C. Olivetti & Co. of Italy, the Institute for Information Industry of Taiwan, Fujitsu Ltd., and Oki Electric Industries Co. Ltd.

Vertex Semiconductor Corporation
Toshiba America Electronic Components Inc. acquired Vertex Semiconductor Corporation for approximately $20 million. Vertex is a designer and manufacturer of high-performance, multichip ASICs for high gate count, performance-driven electronic systems. Toshiba had already owned a 14 percent equity stake under a three-year agreement signed in 1989.

1990

Toshiba Display Devices Inc. and Toshiba America Electronic Components Inc.
These two Toshiba subsidiaries have been merged to complete the consolidation of all of Toshiba's North American components marketing, sales, and manufacturing operations.

Power and Design
Toshiba has acquired Power and Design, a Belgian distributor for Toshiba. The new subsidiary will be renamed Toshiba Information Systems and will deal with marketing and sales for Toshiba-made printers, photocopiers, personal computers, and fax machines. The subsidiary is the seventh sales outlet for Toshiba communications and information equipment in Europe.

Integrated CMOS Systems Inc. (ICS)
Toshiba has acquired equity stake in ICS. The acquisition will enable Toshiba to use the U.S. firm's design tools with existing customers, and, under its own name, Toshiba will market a new array family that will be developed using submicron CMOS technology. (Note: ICS subsequently changed its name to Vertex Semiconductor Corporation.)

KEY OFFICERS

Joichi Aoi
President and chief executive officer

Tsuyoshi Kawanishi
Senior executive vice president

Keiichi Komiya
Senior executive vice president

Kinichi Kadono
Senior executive vice president

Fumio Sato
Senior executive vice president

PRINCIPAL INVESTORS

The Dai-ichi Mutual Life Insurance Company—4.3 percent
Nippon Life Insurance Company—3.6 percent
The Mitsubishi Trust & Banking Corporation—3.1 percent
The Mitsui Bank Limited—3.1 percent

FOUNDERS

Information is not publicly available.

Table 3
Consolidated Balance Sheet
Fiscal Year Ending in March
(Millions of U.S. Dollars)

Balance Sheet	1987	1988	1989	1990	1991
Cash	1,279.5	3,681.8	4,964.5	7,127.3	5,998.9
Receivables	4212.6	5,223.5	6,885.8	7,131.5	8,288.4
Marketable Securities	1,284.5	1,409.8	1,334.1	1,323.7	1,373.8
Inventory	3,363.8	5,308.7	6,434.3	6,716.6	7,808.2
Other Current Assets	1,153.5	1,333.8	1,613.3	1,784.8	1,882.3
Total Current Assets	12,347.7	17,030.4	21,232.0	24,083.8	25,351.6
Net Property, Plants	4,666.5	5,346.6	6,158.3	6,336.0	7,915.2
Other Assets	3,573.2	4,399.8	5,402.7	5,830.8	5,896.9
Total Assets	20,587.4	26,776.8	32,793.0	36,250.6	39,163.7
Total Current Liabilities	11,500.1	15,018.5	19,002.7	19,287.1	20,713.1
Long-Term Debt	4,570.0	5,642.3	6,007.0	8,429.3	9,112.7
Other Liabilities	800.5	915.0	918.6	937.5	991.4
Total Liabilities	16,870.6	21,575.8	25,928.3	28,653.9	30,817.2
Common Stock	951.6	1,424.3	1,791.0	1,831.0	1,924.8
Other Equity	935.3	1,489.5	1,894.0	2,359.2	2,475.7
Retained Earnings	1,829.7	2,287.2	3,180.0	3,406.6	3,945.9
Total Shareholders' Equity	3,716.8	5,201.0	6,864.7	7,596.7	8,346.4
Total Liabilities and Shareholders' Equity	20,587.4	26,776.8	32,793.0	36,250.6	39,163.7
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Toshiba Corporation
Annual Reports
Dataquest (January 1992)

Table 4
Consolidated Income Statement
Fiscal Year Ending in March
(Millions of U.S. Dollars, except Per Share Data)

Consolidated Income Statement	1987	1988	1989	1990	1991
Revenue	20,734.7	25,881.3	29,636.6	29,748.8	33,251.2
Japanese Revenue	14,336.8	17,865.7	20,133.3	18,065.5	18,285.5
Non-Japanese Revenue	6,397.9	8,015.6	9,503.3	9,405.3	10,302.4
Cost of Sales	15,223.8	18,640.2	20,150.0	20,037.8	22,509.0
R&D Expense	1,260.7	1,575.0	1,796.5	1,860.4	2,117.4
SG&A Expense	5,187.4	6,443.5	7,553.2	7,500.9	8,886.1
Capital Expense	1,337.1	1,359.7	2,086.5	2,263.3	3,122.3
Pretax Income	489.0	909.2	1,830.8	1,886.9	1,833.4
Pretax Margin (%)	2.36	3.51	6.18	6.3	5.5
Effective Tax Rate (%)	58.00	56.00	56.00	54.0	51.0
Net Income	214.4	439.8	922.1	922.1	856.2
Shares Outstanding, Millions	2,732.5	2,939.4	3,074.6	3,172.5	3,206.1
Per Share Data					
Earnings	0.07	0.15	0.29	0.28	0.25
Dividend	0.05	0.06	0.06	0.07	0.07
Book Value	1.36	1.77	2.23	1.68	1.82
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Toshiba Corporation
Annual Reports
Dataquest (January 1992)

Table 5
Consolidated Balance Sheet
Fiscal Year Ending in March
(Billions of Yen)

Balance Sheet	1987	1988	1989	1990	1991
Cash	204.1	508.2	636.7	1,018.7	847.1
Receivables	671.9	721.0	883.1	1,019.3	1,170.4
Marketable Securities	204.9	194.6	171.1	189.2	194.0
Inventory	536.6	742.7	825.2	960.0	1,102.6
Other Current Assets	184.0	184.1	206.9	255.1	265.8
Total Current Assets	1,969.7	2,350.7	2,723.0	3,442.3	3,579.9
Net Property, Plants	744.5	737.9	789.8	905.6	1,117.7
Other Assets	569.9	607.4	692.9	833.4	832.7
Total Assets	3,284.1	3,696.0	4,205.7	5,181.3	5,530.3
Total Current Liabilities	1,834.5	2,073.0	2,437.1	2,756.7	2,924.9
Long-Term Debt	729.0	778.8	770.4	1,204.8	1,286.8
Other Liabilities	127.7	126.3	117.8	134.0	140.0
Total Liabilities	2,691.2	2,978.1	3,325.3	4,095.5	4,351.7
Converted Preferred Stock	0	0	0	0	0
Common Stock	151.8	196.6	229.7	261.7	271.8
Other Equity	149.2	205.6	242.9	337.2	349.6
Retained Earnings	291.9	315.7	407.8	486.9	557.2
Total Shareholders' Equity	592.9	717.9	880.4	1,085.8	1,178.6
Total Liabilities and Shareholders' Equity	3,284.1	3,696.0	4,205.7	5,181.3	5,530.3
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Toshiba Corporation
Annual Reports
Dataquest (January 1992)

Table 6
Consolidated Income Statement
Fiscal Year Ending in March
(Billions of Yen, except Per Share Data)

Consolidated Income Statement	1987	1988	1989	1990	1991
Revenue	3,307.6	3,572.4	3,800.9	4,252.0	4,695.4
Japanese Revenue	2,287.0	2,466.0	2,582.1	2,582.1	2,582.1
Non-Japanese Revenue	1,020.6	1,106.4	1,218.8	1,344.3	1,454.8
Cost of Sales	2,428.5	2,572.9	2,584.2	2,864.0	3,178.5
R&D Expense	201.1	217.4	230.4	265.9	299.0
SG&A Expense	827.5	889.4	968.7	1,072.1	1,254.8
Capital Expense	213.3	187.7	267.6	323.5	440.9
Pretax Income	78.0	125.5	234.8	269.7	258.9
Pretax Margin (%)	2.4	3.5	6.2	6.3	5.5
Effective Tax Rate (%)	58.0	56.0	56.0	54.0	51.0
Net Income	34.2	60.7	119.4	131.8	120.9
Shares Outstanding, Millions	2,732.5	2,939.4	3,074.6	3,172.5	3,206.1
Per Share Data					
Earnings	11.86	20.37	37.27	40.11	35.72
Dividend	8.00	8.00	8.00	10.00	10.00
Book Value	216.98	244.23	286.35	342.3	367.6
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Toshiba Corporation
Annual Reports
Dataquest (January 1992)

Table 7
Key Financial Ratios
Fiscal Year Ending in March

Key Financial Ratios	1987	1988	1989	1990	1991
Liquidity					
Current (Times)	1.07	1.13	1.12	1.25	1.22
Total Assets/Equity (%)	553.90	514.83	477.70	477.19	469.23
Current Liabilities/Equity (%)	309.41	288.76	276.82	253.89	248.17
Total Liabilities/Equity (%)	453.90	414.83	377.70	377.19	369.23
Profitability (%)					
Return on Assets	1.04	1.64	2.84	2.54	2.19
Return on Equity	5.77	8.46	13.56	12.14	10.26
Profit Margin	1.03	1.70	3.14	3.10	2.57
Other Key Ratios					
R&D Spending % of Revenue	6.08	6.09	6.06	6.25	6.37
Capital Spending % of Revenue	6.45	5.25	7.04	7.61	9.39
Employees	121,000	122,000	125,000	142,000	162,000
Revenue (¥M)/Employee	27.34	29.28	30.41	29.94	28.98
Capital Spending % of Assets	6.49	5.08	6.36	6.24	7.97
Exchange Rate (U.S.$1=¥)	159.56	138.03	128.25	142.93	141.21

Source: Toshiba Corporation
Annual Reports
Dataquest (January 1992)

Toshiba Corporation

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Dun's Number: 06-499-3082

Date Founded: 1875

CORPORATE STRATEGIC DIRECTION

Toshiba Corporation is one of the largest electronics companies in Japan and throughout the world. Its main business activity is the development, manufacturing, and marketing of industrial electronics and electronic components, including personal computers and printers, which account for 48 percent of its total sales. The Company's second most important business segment is consumer products, which contribute 32 percent of its net sales, followed closely by heavy electrical apparatus, which contribute 19 percent of its net sales. The Company's remaining business is realized from machinery and materials.

Toshiba is one of two leaders of the Toshiba-IHI Group; the other is Ishikawajima-Harima Heavy Industries (IHI). These parents have close capital and business connections. Their subsidiaries are engaged in electrical and electronics products, construction, trading and finance, and shipbuilding.

Total revenue for 1989 amounted to ¥3.8 trillion (US$29.6 billion), an increase of 6 percent over 1988 revenue of ¥3.57 trillion (US$25.9 billion). (Percentage changes refer only to ¥ amounts; US$ percentage changes will differ because of fluctuations in Dataquest exchange rates.) Domestic sales increased 5 percent over the past year, while international sales advanced 10 percent. Net income rose dramatically, increasing 97.0 percent from ¥60.7 billion ($440 million) in 1988 to ¥119.4 billion ($931 million) in 1989.

Sales of information systems and electronic devices jumped 22 percent, to ¥1.87 trillion (US$13.5 billion). Toshiba attributes the significant increase to brisk demand and stable prices, which led to higher domestic and international sales of semiconductors, primarily memories. In Japan, sales of industrial systems and computers were firm, reflecting heightened demand from public agencies and growing demand in the distribution and financial services industries. International sales were strong because of increased demand for personal computers.

R&D expenditure increased 6 percent to ¥230.4 billion (US$1.80 billion), and represented 6.1 percent of sales in 1989. This expenditure was concentrated primarily on such information equipment fields as digital communications equipment and artificial intelligence (AI), as well as on semiconductor-related areas, mainly 16M memories. Capital expenditure for the same period amounted to ¥267.6 billion (US$2.09 billion), a 26 percent increase over the previous year. These investments were mainly for strengthening Toshiba's mass production system in response to the appreciation of the yen, facilities for manufacturing new products, and R&D-related equipment.

In July 1990, Toshiba set up the LCD Business Division, which will manage the development and production of liquid crystal displays (LCDs). The Company is attempting to increase production of large LCDs substantially and to increase its presence in the LCD market. In order to begin these activities, Toshiba will invest a total of about ¥40 billion (US$312 million) during fiscal 1990, including the cost of constructing a new plant in Japan. The plant is a joint venture with IBM Japan, and will be called Display Technologies.

More detailed information is available in Tables 1 and 2, which appear after "Business Segment Strategic Direction" and present corporate highlights and revenue by region. Information on revenue by distribution channels is not available. Tables 3 and 4, comprehensive financial statements, are at the end of this profile.

BUSINESS SEGMENT STRATEGIC DIRECTION

Information/Communications Systems and Electronic Devices

Semiconductors

Dataquest believes that Toshiba remained the second-largest semiconductor supplier in 1989, with 8.6 percent of the worldwide market share and revenue of ¥628.4 billion (US$4.9 billion). Toshiba also remained the second-largest semiconductor supplier in Japan. As a world leader in semiconductors, Toshiba's diversified product portfolio emphasizes balance among analog, discrete, bipolar, MOS logic, memory devices, and ASICs. Toshiba uses approximately 15 percent of its semiconductor products internally.

Analog, Discrete, Logic

Dataquest ranked Toshiba as the largest worldwide supplier of discrete devices in both 1988 and 1989. Toshiba has stated its goal to remain number one. In 1989, Toshiba captured 11.2 percent of the market. In the analog semiconductor industry, Toshiba maintained first place, capturing 6.1 percent market share, according to Dataquest estimates. Toshiba ranked second, with 9.4 percent of the market share, in the MOS digital semiconductor segment.

Memory

In the DRAM market, Toshiba may accomplish what has never been done in the semiconductor industry: being the market leader for two consecutive DRAM product generations. The race between Toshiba and Hitachi should be a close one. Toshiba remained the largest supplier of 1Mb DRAMs to worldwide markets in 1989. Toshiba supplied approximately 30 percent of the world's 1Mb DRAMs. It also developed a 4Mb DRAM and began shipping it in spring 1989. In May 1990, Toshiba introduced the industry's first 1Mb DRAM with a 16-word width. Toshiba believes that graphics will become a standard feature on new personal computers, and the new device is designed for such applications as VGA, super-VGA, and 8514/A. The Company introduced four new high-speed 256K CMOS SRAMs in early 1989. Toshiba ranked first in the MOS memory semiconductor arena with ¥243.7 billion (US$1.9 billion) in revenue and 12.3 percent of the market share.

Optoelectronics

Dataquest believes that Toshiba ranked fourth in the worldwide optoelectronic semiconductor industry, with 9.2 percent of the 1989 market share. Toshiba announced that it has manufactured, on an experimental basis, a charge-coupled device (CCD) with 2 million picture elements. The Company plans to use the CCD in high-definition television (HDTV).

Personal Computers

Toshiba is using its technological edge in a drive to develop sophisticated, high-performance PC systems and to position the Company at the forefront of current and emerging high-growth fields. In 1989, Toshiba ranked tenth worldwide and captured 2.7 percent of the market share. Dataquest believes that Toshiba is now the dominant player in the world market for laptops, having carved out a world market share of 26 percent, based on unit shipments of 505,000.

Toshiba is by far the most successful Japanese PC vendor in Europe. The Company initially entered the PC market with a range of desktops. However, it finally specialized in laptops and is currently the laptop leader in Europe with a 38.2 percent market share. Toshiba owes much of its success to its early and well-timed entry into the IBM dealer network, where it practically has established itself as a standard for laptops.

Workstations

Toshiba was the first company to offer a Japanese version of the UNIX operating system developed by AT&T and based on a Sun Microsystems machine. Toshiba's line of UNIX engineering workstations incorporating original hardware and Japanese-version software has been highly evaluated in the Japanese market.

Telecommunications Equipment

Toshiba is a major supplier of facsimile products worldwide. Much of its success stems from the effective diversification of the product line to best suit the trends in market demand. Toshiba meets the high-end demand with products that will transmit a standard document in just 13 seconds. The products feature one-touch dialing and automatic OMR dialing. It also has models that offer an additional electronic memory, which adds such valuable functions as broadcasting, mailbox, and relay transmission. In addition, Toshiba offers compact, entry-level machines with one-touch dialing and a low price tag. Dataquest estimates that Toshiba ranked sixth worldwide in 1989 with a 5.6 percent market share.

Toshiba is one of the top ten suppliers of key telephone systems. These systems are customer-premises telephone switching systems that allow telephones to interface to the public network without dialing access codes. Competition is stiff in this market segment because the top ten suppliers account for 85 percent of the market, and there is very little differentiation among their technologies. Dataquest estimates that Toshiba is ranked fifth in this area in the United States with a 7.5 percent market share.

In the PBX market segment, Toshiba is a major player in Japan but not worldwide.

Printers

Toshiba manufactures dot matrix, laser, and thermal transfer printers, with the overwhelming majority of business in the first two product areas.

Copiers

Toshiba has advanced and convenient plain paper copiers (PPCs) that are sold and manufactured on a global scale. Dataquest estimates that Toshiba is one of the top ten PPC manufacturers in the United States.

Computer Storage

In 1989, Toshiba ranked fifth in the flexible disk drive market with 7 percent of the worldwide market, based on factory revenue of ¥15.4 billion (US$120 million). Toshiba is one of the leading optical drive suppliers, supplying drives to both Wang and Dun & Bradstreet. Toshiba is also ranked fourth in the CD-ROM market with a 10 percent market share. In the 12- and 5.25-inch WORM drive industry segments, Toshiba commands less than a 1 percent worldwide market share.

Heavy Electrical Apparatus

Toshiba's heavy electrical apparatus field, which accounted for 19 percent of its net sales, recorded sales of ¥705.4 billion (US$5.5 billion) in fiscal 1989, a decline of 17 percent from 1988. This drop reflected the adverse effect of cyclical swings in large orders for power-generation facilities, offsetting healthy sales of industrial apparatus, elevators, escalators, and transportation equipment.

Consumer Products

Fiscal 1989 sales of products in this category rose 3 percent to ¥1.2 trillion (US$9.1 billion), accounting for 32 percent of Toshiba's net sales. Sales in the latter half of the fiscal period were hampered by restrained consumer spending in anticipation of major changes in the Japanese tax system, but were counterbalanced by expanding worldwide sales of color televisions and brisk domestic sales of air conditioners and lighting products. Sales of materials continued their upward trend.

Further Information

For further information about the Company's business segments, please contact the appropriate Dataquest industry service.

Table 1
Five-Year Corporate Highlights (Millions of US Dollars)

	1985	1986	1987	1988	1989
Five-Year Revenue	$13,339.2	$15,244.5	$20,734.7	$25,881.3	$29,636.6
Percent Change	-	14.28	36.01	24.82	14.51
Capital Expenditure	$115.0	$1,147.1	$1,337.1	$1,359.7	$2,086.5
Percent of Revenue	0.86	7.52	6.45	5.25	7.04
R&D Expenditure	$676.0	$857.4	$1,260.7	$1,575.0	$1,796.5
Percent of Revenue	5.07	5.62	6.08	6.09	6.06
Number of Employees	114,000	120,000	121,000	122,000	125,000
Revenue ($K)/Employee	$117.01	$127.04	$171.36	$212.14	$237.09
Net Income	$343.6	$268.5	$214.4	$439.8	$9,310.0
Percent Change	-	(21.86)	(20.15)	105.13	2,016.87
Exchange Rate (US$1=¥)	¥250.60	¥221.26	¥159.52	¥138.03	¥128.25

1989 Calendar Year	Q1	Q2	Q3	Q4
Quarterly Revenue	NA	NA	NA	NA
Quarterly Profit	NA	NA	NA	NA

NA= Not available

Source: Toshiba Corporation
Annual Reports
Dataquest (1990)

Table 2
Revenue by Geographic Region (Percent)

Region	1985	1986	1987	1988	1989
Asia/Pacific	0	68.75	69.14	69.03	67.93
Japan	0	68.75	69.14	69.03	67.93
International	0	31.25	30.86	30.97	32.07

Source: Toshiba Corporation
Annual Reports
Dataquest (1990)

1989 SALES OFFICE LOCATIONS

Europe—4
Asia/Pacific—77
Japan—67
ROW—11

MANUFACTURING LOCATIONS

North America

International Fuel Cells
A joint venture with United Technologies to produce fuel cells
Microelectronics Center
256K DRAMs, 1Mb DRAMs, etc.
Toshiba America, Inc.
TVs, microwave ovens, VCRs, toners, telephones, medical equipment
Toshiba International
Motors, circuit boards, control equipment
Toshiba Westinghouse Electronics
A joint venture to produce color CRTs

Europe

Compagnie European Pour La Fabrication D'Enceintes A Micro-Ondes (France)
A joint venture with Thomson of France to produce microwave ovens
Toshiba Consumer Products GmbH (Germany)
VCRs, TVs
Toshiba Consumer Products Ltd. (United Kingdom)
TVs, VCRs, microwave ovens
Toshiba Consumer Products S.A. (France)
Lamps for copiers
Toshiba Semiconductor GmbH (Germany)
256K DRAMs, 64K SRAMs, CMOS, 1Mb DRAMs
Toshiba Systemes S.A. (France)
Joint venture with ROHM Poulanc to produce plain paper copiers

Asia/Pacific

Amori Taic (Japan)
Radio cassette recorders, record players, component stereos
Buzen Toshiba Electronics Co., Ltd. (Japan)
Semiconductors
Hankook Tungsten (South Korea)
Tungsten, molybdenum wires and parts
Harison Denki (Japan)
Electric lamps
Himeji Toshiba Electronics (Japan)
ICs, lead frames for semiconductors
Hokuto Electronics (Japan)
CRTs
Iwate Toshiba Electronics Co., Ltd. (Japan)
Semiconductors
Kaga Toshiba Electronics (Japan)
Semiconductors
Kitashiba Electric Co., Ltd. (Japan)
Transformers, electric motors
Kitsuki Toshiba Electronics (Japan)
Semiconductors
Korea Electronics (South Korea)
Semiconductors, TVs
Kumdong Lighting (South Korea)
Fluorescent lamps
Leechun Electric Mfg. (South Korea)
Generators, motors, transformers, pumps
Marcon Electronics Co., Ltd. (Japan)
Capacitors, hybrid ICs
Nishishiba Electric Co., Ltd. (Japan)
Electric marine equipment
Nougata Toshiba Electronics (Japan)
Semiconductors
Olivetti Corporation of Japan (Japan)
Data communications equipment, computers, word processing systems, typewriters
Onkyo Corporation (Japan)
Audio equipment and parts
Shibaura Engineering Works Co., Ltd. (Japan)
Motors, electric tools
Sord Computer (Japan)
Microcomputer and peripherals
Tatung Co. (Taiwan)
TVs, refrigerators, transformers
Thai Toshiba Electric Industries Co., Ltd. (Thailand)
A joint venture with Siam Cement of Thailand to produce TVs, refrigerators, electric fans, electric rice cookers, motors
Thai Toshiba Fluorescent Lamp Co., Ltd. (Thailand)
Glass tubes for fluorescent lamps

Thai Toshiba Lighting Co., Ltd. (Thailand)
Fluorescent lamps
Tohoku Semiconductor (Japan)
1Mb DRAMs, SRAMs, HPUs
Toki Electric Industrial (Japan)
Electric lamps, lighting equipment
Tokyo Electric Co., Ltd. (Japan)
Business machines, lighting equipment, home appliances
Tokyo Electronic Ind. (Japan)
Industrial video equipment, control equipment
Tokyo Optical (Japan)
Optical instruments
Toshiba Battery (Japan)
Dry batteries, battery applied products
Toshiba Ceramics (Japan)
Ceramics
Toshiba Chemical Corporation (Japan)
Plastic products, insulating materials
Toshiba Cold Chain (Japan)
Freezers, vending machines
Toshiba Components Co., Ltd. (Japan)
Semiconductors
Toshiba Electric Equipment Co., Ltd. (Japan)
Lighting fixtures
Toshiba Electronic Systems Co., Ltd. (Japan)
A joint venture with General Electric to produce and market electronic equipment
Toshiba Electronics Malaysia Snd. Bhd. (Malaysia)
IC memories
Toshiba Engineering & Construction Co., Ltd. (Japan)
Electric facilities
Toshiba Glass Co., Ltd. (Japan)
Glass products
Toshiba Heating Appliances (Japan)
Oil heating equipment
Toshiba Kiki (Japan)
Lighting equipment, etc.
Toshiba Machine (Japan)
Machinery, machine tools
Toshiba Medical Systems Co., Ltd. (Japan)
Medical electronic equipment
Toshiba Seiki (Japan)
Automatic precision apparatus
Toshiba Singapore Pte., Ltd. (Singapore)
Color TVs, TV parts, audio equipment
Toshiba Steel Tube Co., Ltd. (Japan)
Steel tubes, electric conduit tubes
Toshiba Tungaloy (Japan)
Special alloy tools

ROW

Industria Mexicana Toshiba, S.A. (Mexico)
Semiconductors
Semp Toshiba Amazonas S.A. (Brazil)
TVs, audio equipment
Toshiba Electromex S.A. de C.V. (Mexico)
Color TV parts for Toshiba America

SUBSIDIARIES

North America

GE Toshiba Lighting Corporation (United States)
Ottawa Design Center (Canada)
Toshiba America Consumer Products, Inc. (United States)
Toshiba America Electronic Components, Inc. (United States)
Toshiba America, Inc. (United States)
Toshiba America Information Systems, Inc. (United States)
Toshiba America Medical Systems, Inc. (United States)
Toshiba Display Devices Inc. (United States)
Toshiba Hawaii, Inc. (United States)
Toshiba International Corporation (United States)
Toshiba of Canada, Ltd. (Canada)

Europe

Compagnie European Pour La Fabrication D'Enceintes A Micro-Ondes (France)
Toshiba AG (Switzerland)
Toshiba Consumer Products GmbH (Germany)
Toshiba Consumer Products Ltd. (United Kingdom)
Toshiba Consumer Products S.A. (France)
Toshiba Deutschland GmbH (Germany)
Toshiba Electronics Espana S.A. (Spain)
Toshiba Electronics Europe GmbH (Germany)
Toshiba Electronics Italiana S.R.L. (Italy)
Toshiba Electronics Ltd. (United Kingdom)
Toshiba Electronics Scandinavia AB (Sweden)
Toshiba Europa GmbH (Germany)
Toshiba Information Systems (Belgium)
Toshiba Information Systems Ltd. (United Kingdom)
Toshiba Information Systems S.A. (Spain)
Toshiba Information Systems S.p.A. (Italy)
Toshiba Informationssyteme GmbH (Germany)

Toshiba International (Europe) Ltd. (United Kingdom)
Toshiba International Finance Ltd. (United Kingdom)
Toshiba International Finance B.V. (Netherlands)
Toshiba Ltd. (United Kingdom)
Toshiba Medical Systems Europe B.V. (Netherlands)
Toshiba Semiconductor GmbH (Germany)
Toshiba Systemes S.A. (France)

Asia/Pacific

Iwate Toshiba Electronics Co., Ltd. (Japan)
Kitashiba Electric Co., Ltd. (Japan)
Kyodo Building Corporation (Japan)
Man On Toshiba, Ltd. (Hong Kong)
Marcon Electronics Co., Ltd. (Japan)
Minato Building Co., Ltd. (Japan)
Nikko Jitsdugyo Co., Ltd. (Japan)
Nishishiba Electric Co., Ltd. (Japan)
Onkyo Corporation (Japan)
Shibaura Engineering Works Co., Ltd. (Japan)
TDH, Inc. (Japan)
Thai Toshiba Electric Industries Co., Ltd. (Thailand)
Tokyo Electric Co., Ltd. (Japan)
Toshiba Automation Co., Ltd. (Japan)
Toshiba Battery Co., Ltd. (Japan)
Toshiba Builders Appliance Co., Ltd. (Japan)
Toshiba Building Corporation (Japan)
Toshiba Ceramics Co., Ltd. (Japan)
Toshiba Chemical Corporation (Japan)
Toshiba Components Co., Ltd. (Japan)
Toshiba Consumer Products Co., Ltd. (Thailand)
Toshiba Credit Corporation (Japan)
Toshiba Display Devices Co., Ltd. (Thailand)
Toshiba Electric Appliances Co., Ltd. (Japan)
Toshiba Electric Equipment Corp. (Japan)
Toshiba Electronic Systems Co., Ltd. (Japan)
Toshiba Electronics Asia, Ltd. (Hong Kong)
Toshiba Electronics Malaysia Sdn. Bhd. (Malaysia)
Toshiba Electronics Taiwan Corporation (Taiwan)
Toshiba Elevator & Escalator Service Co., Ltd. (Japan)
Toshiba Engineering & Construction Co., Ltd. (Japan)
Toshiba Engineering Co., Ltd. (Japan)
Toshiba Glass Co., Ltd. (Japan)
Toshiba Heating Appliances Co., Ltd. (Japan)
Toshiba Higashinihon Consumer Electronics Co., Ltd. (Japan)
Toshiba Information Equipment Co., Ltd. (Japan)
Toshiba International Corporation Pty. Ltd. (Australia)
Toshiba Lightec Corporation (Japan)
Toshiba Medical Systems Co., Ltd. (Japan)
Toshiba Physical Distribution Co., Ltd. (Japan)
Toshiba Pty. Ltd. (Australia)
Toshiba Sales and Services Sdn. Bhd. (Malaysia)
Toshiba Silicone Co., Ltd. (Japan)
Toshiba Singapore Pte., Ltd. (Singapore)
Toshiba Steel Tube Co., Ltd. (Japan)
Toshiba Thailand Co., Ltd. (Thailand)

ROW

Industria Mexicana Toshiba S.A. (Mexico)
Semp Toshiba Amazonas S.A. (Brazil)
T and S Servicos Industrias S/C Ltda. (Brazil)
Toshiba de Panama S.A. (Panama)
Toshiba de Brasil S.A. (Brazil)
Toshiba Electromex S.A. de C.V. (Mexico)
Toshiba Medical de Brasil Ltda. (Brazil)

ALLIANCES, JOINT VENTURES, AND LICENSING AGREEMENTS

1990

IBM Japan, Ltd.

Toshiba and IBM Japan are jointly constructing a plant that will have a production capability of 50,000 LCD panels a year.

Motorola, Inc.

Toshiba and Motorola reportedly plan to sign an agreement to exchange gate array technology to allow the companies to act as mutual second sources. In the United States, Motorola will produce gate arrays designed and developed by Toshiba, which Motorola intends to market for use in workstations. In Japan, Tohoku Semiconductor Inc., a joint venture of the two companies, will produce gate arrays based on Motorola technology for supply to local companies. Toshiba and Motorola also plan to expand their technological cooperation to include discrete semiconductors.

Businessland

Businessland Japan will be formed by Businessland, Canon, Fujitsu, software distributor Softbank, Sony, and Toshiba to provide systems integration services for international firms. Businessland will have a 54 percent stake in the joint venture, Softbank will have 26 percent, and the other firms will have 5 percent each.

Spectrum Cellular Corp.
Toshiba will market Dallas-based Spectrum Cellular's new cellular/landline modem with its laptop computers as the T24D/X, and Spectrum will also develop five separate versions of its new SmartCable product for sale by Toshiba.

General Electric (GE)
GE and Toshiba have entered into a joint marketing agreement covering the sale of GE's CompuScene PT2000 in Japan. The visual simulation system and other Compu-Scene products will be distributed by Toshiba Electronics Systems, a GE/Toshiba joint venture company.

Echelon Systems Corp.
Motorola and Toshiba have become the first semiconductor makers to license the rights to a new generation of intelligent power-controller chips being developed by Echelon Systems. Under the terms of the agreement, Toshiba's Semiconductor Group will manufacture and market the Echelon-designed ICs. The agreement also permits Toshiba to design, manufacture, and market enhanced versions of the chips.

1989

Integrated CMOS Systems, Inc. (ICS)
Toshiba signed a technological collaboration agreement, including an equity investment, with ICS of Sunnyvale, California. ICS specializes in advanced ASIC technology and its applications in high-performance design. The two companies will codevelop a design and test system for large-scale gate arrays.

EDA Systems Inc.
EDA signed a purchase agreement with Toshiba for its Powerframe product, a design management framework that integrates third-party CAD/CAE tools and speeds the overall electronic design process.

IBM
The two companies agreed to the joint development of a color flat-panel display for computers that is larger and clearer than any demonstrated previously.

Digital Equipment Corporation
The companies have a technology exchange agreement that will ensure the integration of Toshiba's laptop personal computers into Digital's networking environment.

Weitek Corporation
Under a joint development agreement, Weitek will manufacture some of its semiconductors in Toshiba's plant; Toshiba will gain access to some of Weitek's floating-point product technology.

McDonnell Douglas
McDonnell Douglas has agreed to port its PRO-IV application development language to minicomputers manufactured by Toshiba.

Cummins Engine Co.
The companies have undertaken a joint venture to market silicon nitride ceramic components in North America.

Sun Microsystems
The companies signed a worldwide licensing agreement to bundle the SPARC MPU architecture, the SunOS operating system, and the Open Look Graphics interface into a series of small-footprint, low-cost computers.

Siemens
The companies extended their longstanding alliance in ASICs.

Sun Microsystems
Toshiba announced plans to develop a new high-performance computer, based on Sun's SPARC technology, that could be as small as a laptop.

1988

Zoran
The companies agreed to a technology and manufacturing alliance.

Motorola
Under a joint venture, the companies formed Tohoku Semiconductor. Tohoku is using Toshiba's marketing channels to market Motorola's 68000 series MPUs in Japan.

Advanced Silicon Corporation
Toshiba agreed to provide Advanced Silicon Corporation with 6-inch CMOS wafers and jointly develop ASIC software.

Siemens and GE
The companies agreed to jointly develop a common cell library.

SGS-Thomson
The companies extended a six-year agreement to patent cross-licensing related to semiconductor technology.

1987

GRiD
Toshiba agreed to supply GRiD with an IBM PC AT-compatible kneetop computer.

Mitsui Petrochemical
The companies undertook the joint development of a magnetic tape emulator.

Viewlogic Systems
Viewlogic Systems is the principal worldwide supplier of CAE software for Toshiba.

Aida Corporation
Toshiba agreed to provide Aida with its TC17G gate array library models. Toshiba is gaining access to Aida's semicustom IC design equipment.

SGS-ATES
The companies made a five-year technical collaboration agreement allowing Toshiba to use SGS-ATES' semiconductor sales network in Europe and allowing SGS-ATES to receive LSI fab technology and technical training for its engineers from Toshiba.

SDA Systems
The companies undertook a five-year joint venture to cooperatively develop CAD systems for IC design.

MERGERS AND ACQUISITIONS

1990

Toshiba Display Devices, Inc., and Toshiba America Electronic Components, Inc.
These two Toshiba subsidiaries have been merged to complete the consolidation of all of Toshiba's North American components marketing, sales, and manufacturing operations.

Power and Design
Toshiba has acquired Power and Design, a Belgian distributor for Toshiba. The new subsidiary will be renamed Toshiba Information Systems and will deal with marketing and sales for Toshiba-made printers, photocopiers, personal computers, and fax machines. The subsidiary is the seventh sales outlet for Toshiba communications and information equipment in Europe.

Integrated CMOS Systems, Inc.(ICS)
Toshiba has acquired equity stake in ICS. The acquisition will enable Toshiba to use the US firm's design tools with existing customers, and, under its own name, Toshiba will market a new array family that will be developed using submicron CMOS technology.

KEY OFFICERS

Joichi Aoi
President and chief executive officer

Sakakae Shimizu
Senior executive vice president

Fumio Ohta
Senior executive vice president

Kinichi Kadono
Senior executive vice president

Fumio Sato
Senior executive vice president

PRINCIPAL INVESTORS

The Dai-ichi Mutual Life Insurance Company—4.3 percent
Nippon Life Insurance Company—3.6 percent
The Mitsubishi Trust & Banking Corporation—3.1 percent
The Mitsui Bank, Limited—3.1 percent

FOUNDERS

Information is not available.

Table 3
Comprehensive Financial Statement
Fiscal Year Ending March
(Millions of US Dollars, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	$7,735.8	$8,686.2	$12,347.7	$17,030.4	$21,232.0
Cash	1,200.3	761.5	1,279.5	3,681.8	4,964.5
Receivables	2,626.1	3,108.6	4212.6	5,223.5	6,885.8
Marketable Securities	1,030.7	1,177.8	1,284.5	1,409.8	1,334.1
Inventory	2,048.7	2,317.6	3,363.8	5,308.7	6,434.3
Other Current Assets	830.0	782.3	1,153.5	1,333.8	1,613.3
Net Property, Plants	$2,431.8	$3,325.0	$4,666.5	$5,346.6	$6,158.3
Other Assets	$1,849.2	$2,305.0	$3,573.2	$4,399.8	$5,402.7
Total Assets	$14,027.5	$14,316.2	$20,587.4	$26,776.8	$32,793.0
Total Current Liabilities	$7,019.2	$8,227.4	$11,500.1	$15,018.5	$19,002.7
Long-Term Debt	$1,765.4	$2,985.6	$4,570.0	$5,642.3	$6,007.0
Other Liabilities	$689.9	$542.2	$800.5	$915.0	$918.6
Total Liabilities	$9,474.9	$11,755.2	$16,870.6	$21,575.8	$25,928.3
Total Shareholders' Equity	$2,186.4	$2,561.0	$3,716.8	$5,201.0	$6,864.7
Common Stock	537.1	632.3	951.6	1,424.3	1,791.0
Other Equity	626.9	654.9	935.3	1,489.5	1,894.0
Retained Earnings	950.5	1,273.8	1,829.7	2,287.2	3,180.0
Total Liabilities and Shareholders' Equity	$14,027.5	$14,316.2	$20,587.4	$26,776.8	$32,793.0
Income Statement	**1985**	**1986**	**1987**	**1988**	**1989**
Revenue	$13,339.2	$15,244.5	$20,734.7	$25,881.3	$29,636.6
Japanese Revenue	NA	10,481.3	14,336.8	17,865.7	20,133.3
Non-Japanese Revenue	NA	4,763.2	6,397.9	8,015.6	9,503.3
Cost of Sales	$9,533.5	$11,046.7	$15,223.8	$18,640.2	$20,150.0
R&D Expense	$676.0	$857.4	$1,260.7	$1,575.0	$1,796.5
SG&A Expense	$3,073.0	$3,648.6	$5,187.4	$6,443.5	$7,553.2
Capital Expense	$115.0	$1,147.1	$1,337.1	$1,359.7	$2,086.5
Pretax Income	$741.0	$589.8	$489.0	$909.2	$1,830.8
Pretax Margin (%)	5.56	3.87	2.36	3.51	6.18
Effective Tax Rate (%)	58.00	58.00	58.00	56.00	56.00
Net Income	$343.6	$268.5	$214.4	$439.8	$9,310.0
Shares Outstanding, Millions	2,672.1	2,675.7	2,732.5	2,939.4	3,074.6
Per Share Data					
Earnings	$0.11	$0.09	$0.07	$0.15	$0.29
Dividend	$0.03	$0.04	$0.05	$0.06	$0.06
Book Value	$0.82	$0.96	$1.36	$1.77	$2.23
Exchange Rate (US$1=¥)	¥250.60	¥221.26	¥159.52	¥138.03	¥128.25

Source: Toshiba Corporation
Annual Reports
Dataquest (1990)

Table 4
Comprehensive Financial Statement
Fiscal Year Ending March
(Billions of Yen, except Per Share Data)

Balance Sheet	1985	1986	1987	1988	1989
Total Current Assets	¥1,938.6	¥1,921.9	¥1,969.7	¥2,350.7	¥2,723.0
Cash	300.8	168.5	204.1	508.2	636.7
Receivables	658.1	687.8	671.9	721.0	883.1
Marketable Securities	258.3	260.6	204.9	194.6	171.1
Inventory	513.4	512.8	536.6	742.7	825.2
Other Current Assets	208.0	173.1	184.0	184.1	206.9
Net Property, Plants	¥609.4	¥735.7	¥744.5	¥737.9	¥789.8
Other Assets	¥967.3	¥510.0	¥569.9	¥607.4	¥692.9
Total Assets	¥3,515.3	¥3,167.6	¥3,284.1	¥3,696.0	¥4,205.7
Total Current Liabilities	¥1,759.0	¥1,820.4	¥1,834.5	¥2,073.0	¥2,437.1
Long-Term Debt	¥442.5	¥660.6	¥729.0	¥778.8	¥770.4
Other Liabilities	¥172.9	¥120.0	¥127.7	¥126.3	¥117.8
Total Liabilities	¥2,967.4	¥2,601.0	¥2,691.2	¥2,978.1	¥3,325.3
Total Shareholders' Equity	¥547.9	¥566.6	¥592.9	¥717.9	¥880.4
Converted Preferred Stock	0	0	0	0	0
Common Stock	134.6	139.9	151.8	196.6	229.7
Other Equity	157.1	144.9	149.2	205.6	242.9
Retained Earnings	238.2	281.8	291.9	315.7	407.8
Total Liabilities and Shareholders' Equity	¥3,515.3	¥3,167.6	¥3,284.1	¥3,696.0	¥4,205.7

Income Statement	1985	1986	1987	1988	1989
Revenue	¥3,342.8	¥3,373.0	¥3,307.6	¥3,572.4	¥3,800.9
Japanese Revenue	NA	2,319.1	2,287.0	2,466.0	2,582.1
Non-Japanese Revenue	NA	1,053.9	1,020.6	1,106.4	1,218.8
Cost of Sales	¥2,389.1	¥2,444.2	¥2,428.5	¥2,572.9	¥2,584.2
R&D Expense	¥169.4	¥189.7	¥201.1	¥217.4	¥230.4
SG&A Expense	¥770.1	¥807.3	¥827.5	¥889.4	¥968.7
Capital Expense	¥288.2	¥253.8	¥213.3	¥187.7	¥267.6
Pretax Income	¥185.7	¥130.5	¥78.0	¥125.5	¥234.8
Pretax Margin (%)	5.56	3.87	2.36	3.51	6.18
Effective Tax Rate (%)	58.00	58.00	58.00	56.00	56.00
Net Income	¥86.1	¥59.4	¥34.2	¥60.7	¥119.4
Shares Outstanding, Millions	2,672.1	2,675.7	2,732.5	2,939.4	3,074.6
Per Share Data					
Earnings	¥29.63	¥19.24	¥11.86	¥20.37	¥37.27
Dividend	¥8.00	¥8.00	¥8.00	¥8.00	¥8.00
Book Value	¥205.04	¥211.76	¥216.98	¥244.23	¥286.35

Table 4 (Continued)
Comprehensive Financial Statement
Fiscal Year Ending March
(Billions of Yen, except Per Share Data)

Key Financial Ratios	1985	1986	1987	1988	1989
Liquidity					
Current (Times)	1.10	1.06	1.07	1.13	1.12
Quick (Times)	0.81	0.77	0.78	0.78	0.78
Fixed Assets/Equity (%)	111.22	129.84	125.57	102.79	89.71
Current Liabilities/Equity (%)	321.04	321.28	309.41	288.76	276.82
Total Liabilities/Equity (%)	541.60	459.05	453.90	414.83	377.70
Profitability (%)					
Return on Assets	-	1.78	1.06	1.74	3.02
Return on Equity	-	10.66	5.90	9.26	14.94
Profit Margin	12.58	1.76	1.03	1.70	3.14
Other Key Ratios					
R&D Spending % of Revenue	5.07	5.62	6.08	6.09	6.06
Capital Spending % of Revenue	8.62	7.52	6.45	5.25	7.04
Employees	114,000	120,000	121,000	122,000	125,000
Revenue (¥K)/Employee	¥29.32	¥28.11	¥27.34	¥29.28	¥30.41
Capital Spending % of Assets	8.20	8.01	6.49	5.08	6.36
Exchange Rate (US$1=¥)	¥250.60	¥221.26	¥159.52	¥138.03	¥128.25

NA = Not available

Source: Toshiba Corporation
Annual Reports
Dataquest (1990)