Semiconductor Application Markets Newsletters 1985–1986

Dataquest

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters, January 1986-1

WHEN WILL THE INTEGRATED VOICE/DATA TERMINAL MARKET TAKE OFF?

INTRODUCTION

There seems to be no doubt that vendors of information display devices are now facing off to do battle for the desktops of knowledge workers worldwide. There are also strong indications that integrated voice/data terminals (IVDTs) will be strong contenders for those desktops.

However, actual shipments of IVDTs have remained relatively low through 1984, and the needs of the market have been hard to define. In addition, the market has been dominated by telecommunications-oriented companies. Thus, traditional alphanumeric display terminal manufacturers face a considerable challenge if they wish to participate in the IVDT market.

The purpose of this newsletter is to discuss the IVDT in terms of:

- Products and market
- Users' requirements
- Product requirements
- Distribution channels

The newsletter concludes with an analysis that presents our observations on how display terminal manufacturers can best participate in the IVDT market.

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PRODUCTS AND MARKET

Products

DATAQUEST categorizes four types of products competing in the integrated voice/data workstation market. They are:

- Asynchronous voice/data terminals
- Synchronous voice/data terminals
- Voice/data personal computers
- Voice/data add-on products for personal computers

This newsletter focuses only on the asynchronous and synchronous voice/data terminal section of the larger integrated voice/data workstation market.

Integrated voice/data terminals combine the functions of a telephone and a terminal in a single unit. IVDTs do not have mass storage capability and they communicate with a host in order to perform their primary task. This differentiates them from PC-based voice/data products. Integrated voice/data terminals typically consist of the following elements:

- Display screen--commonly a CRT
- Keyboard--alphanumeric cluster, function keys, cursor control keys, editing keys, numeric pad
- Optional dashboard--special function keys, phone support
- Telephone handset--either integrated or detached

A listing of some of the companies and products competing in the integrated voice/data terminal market are shown in Table 1.

Table 1

SELECTED IVDT MARKET PARTICIPANTS AND PRODUCTS

Asynchronous

Synchronous

DAVOX Corp.--811, 821 Intelligent Workstation

AMBI Corp. -- AmbiTerminal, Ambiset AT&T-IS--510A, 510D, 515 BCT Basic Telecommunications--Datavoice 10, 20 Data General--Dasher D555 InteCom, Inc.--Keystone ITT--InfoStation Lee Data--2510, 2520 Liberty Electronics--Freedom 212, 222 Matra Communications--Scanset XL, XLHS Northern Telecom--Displayphone Plus, Displayphone, Meridian 4010, 4020 ROLM Corp. -- Cypress Sydis, Inc.--VoiceStation TeleVideo--Personal Terminal Thomson CSF--XT300, XT300E Zaisan--ES.1

> Source: DATAQUEST January 1986

The current crop of IVDTs indicates a wide range of approaches to the design and integration of the basic elements of the product. Their screen sizes range from 7 to 14 inches diagonally. Their keyboards have from 55 to more than 100 keys. Some IVDTs do not have a dashboard, while others have elaborate dashboards containing up to 42 keys. The terminals also provide a variety of methods of integrating the handset and speakerphone. Table 2 compares the features and prices of selected IVDTs.

Table 2

Hanufacturer/Hodel	Screen Size	Number of Keys	Integrated Modem	Integrated Handset	Speaker- Phone	Dashboard	List Price*
AMBI/AmbiTerminal	- <u>9</u> "	84	Yes	Yes	Yes	No	\$1,195**
A161/510A	9"	72#	Yes	Yes	Yes	Phone pad, speaker control	\$1,645
DAVOX/821 Intelligent Workstation	12"	101	No	Yes	Yes	No	\$1,995
Themson CSF/XT300E	9"	81	No	Yes	Yes	No	\$1,645
Liberty/Freedom 222	144	106	Yes	No	No	No	\$ 945
Matra/Scanset XLHS	9"	99	Yes	Yes	No	No	\$1,395
Northern Telecom/ Displayphone Plus	7 "	55	Yes	Yes	Yes	No	\$1,395
Heridian 4020##	12"	109	No	Yes	Yes	No	\$1,395
ROLM/Cypress	9 "	68	Ko	Yes	Yes	Yes—42 Keys	\$1,950
TeleVideo/Personal Terminal	g"	75	Yes	Yes -	No	No	\$1,127
Zaisan/ES.1	9*	70	Yes	Yes	Yes	Yes27 Keys	\$ 995

FEATURE COMPARISON--SELECTED IVDTs

List price based on maximum configuration
**With 300 bps modem
#Keyboard is an option
##Can be upgraded to a PC

Source: DATAQUEST

In addition to the variety of feature sets shown in Table 2, the voice/data terminals available today differ in a number of other aspects. Some IVDTs, such as those from InteCom, Northern Telecom, and ROLM, are designed to work only on those companies' PBX systems. Other IVDTs are more generic in this respect. Today's IVDTs have varying amounts of ROM and RAM memory. They display characters in matrices ranging from 5 by 7 pixels to 8 by 10 pixels. More importantly, there is a dizzying array of telephone and personal support functions available. These include dozens of phone features, clocks, alarms, calendars, directories of varying size, calculators, touch screens, password or security features, electronic mail, and on-screen help and tutorial features.

Products like Sydis' VoiceStation and DAVOX's Professional Deskset communicate specifically with certain computer systems. Sydis' IVDT is designed to work with the company's VoiceStation system. DAVOX's products are designed to work with the DavoxNet local area network. Most IVDTs designed to operate independently of a system provide popular terminal emulations; the most common is the VT100 emulation.

Market

Market Size

DATAQUEST estimates that 55,900 integrated voice/data products of all types were shipped in the United States in 1984. Fewer than 47,000 of these were asynchronous and synchronous IVDTs. Their value was approximately \$58 million.

Table 3 shows the projected shipments and compound growth rate for the various types of integrated voice/data products for 1985 through 1989.

Table 3

ESTIMATED UNIT SHIPMENTS---1985 TO 1989 (Thousands of Units Shipped)

Segment	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	1985-1989
Asynchronous	77.5	116.2	162.7	219.7	296.6	39.98
Synchronous	14.8	31.0	62.0	125.0	200.0	91.7%
Personal Computer	28.0	42.0	82.0	164.0	228.0	68.9%
Add-Ons	17.0	13.0	46.0	92.0	<u>174.0</u>	78.9%
Total Market	137.3	212.2	352.7	600.7	898.6	59.9%

Source: DATAQUEST January 1986

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The if-sold value of the voice/data workstation segment for the 1985 to 1989 forecast period is expected to increase from approximately \$127 million in 1985 to more than \$526 million in 1989. The value of asynchronous IVDTs is expected to increase from \$82.4 million to more than \$252 million during the forecast period. The value of synchronous IVDTs is expected to grow from \$45 million in 1985 to \$274 million in 1989.

The healthy revenue growth for integrated voice/data terminals is expected to occur despite expected price erosion. Prices for asynchronous voice/data terminals are expected to erode 5.4 percent per year during the forecast period. Prices for synchronous IVDTs are expected to erode 18.1 percent per year over the same period.

Market Characteristics

Much more important than the size and projected growth of the IVDT market are its characteristics. So far, its characteristics have proven to be elusive. So elusive that the market until now has consisted of many unsuccessful attempts to link the right product with the right customer. The telecommunications-oriented companies have had the most, albeit limited, success by selling their IVDTs to their existing customer bases. Major systems and terminal manufacturers have heretofore shied away from IVDTs. And independent display terminal manufacturers who offer IVDTs have been seriously disappointed with their sales results. Independent IVDT-maker Zaisan, one of the most heavily financed start-ups in history, has recently filed for Chapter 11 bankruptcy protection and is liquidating its assets.

The market for IVDTs was initially thought to consist of professional workers who needed to combine terminal and telephone capability in one, compact, desktop device. Recent definitions of the market have become more specific. In our opinion, the primary target market for IVDTs is composed of executives and professionals in the fields of brokerage, customer service, financial planning, market research, purchasing, real estate, and telemarketing. We also consider knowledge workers in the legal and health care fields to be a target market. Workers in these fields have the common need to be able to access and transmit data, often while simultaneously using the telephone.

In attacking this market, IVDT vendors are faced with a number of challenges. Those challenges include defining users' needs, demonstrating that the product enhances productivity, providing the right mix of features for the user, educating the potential customer in the benefits of IVDTs, reducing the current relatively high price of IVDTs, competition from alternative devices, resistance to change, and, for many, lack of adequate distribution channels.

USERS' REQUIREMENTS

User Types

The majority of IVDT users are expected to be knowledge workers. DATAQUEST defines knowledge workers as professional, managerial, and technical people engaged in the creation, manipulation, analysis, and dissemination of information. It is important for IVDT vendors to recognize that knowledge workers have a variety of needs and that their needs are different from the traditional hard core of display terminal users--the data entry and data retrieval workers. While IVDT users will use their terminals to access internal and external data bases, they will also need to communicate with each other. There are many user types with data and communication needs and it is unlikely that a single IVDT will satisfy them all.

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The amount of functionality that an IVDT provides will be based upon the intended user's requirements for data access, manipulation, and phone support. DATAQUEST's estimates of the percentages of time spent in terminal and telephone usage is presented in Table 4.

Table 4

ESTIMATED PORTION OF WORKDAY SPENT USING DISPLAY TERMINALS AND TELEPHONES

<u>User Type</u>	<u>Display Terminal</u>	Telephone
Clerical	608	10%
Secretary/ Administrative	20\$	40-60%
Professional	408	30%
Manager	15%	358
Executive	5%	25%

Source: DATAQUEST January 1986

IVDT manufacturers should recognize that the needs of the user are not as simply stated. It has been difficult so far for both manufacturers and users to identify those needs. DATAQUEST considers the process of need identification to be crucial to the development of a successful IVDT.

<u>User Characteristics</u>

The various types of users have differing characteristics. At the executive level, the user needs information but is uncomfortable working with computers. Most often, he communicates verbally and others usually compile and format written reports for him. He expects attractive, up-to-date equipment that provides a number of desktop functions.

Managers and professionals often access information data bases, create and modify data, and generate reports. They have a need to transmit information to others in their work groups using a variety of means--verbal, electronic, and written. There is a high degree of communications among workers at this level. Time is almost evenly split between telephone usage and information-oriented work.

Secretaries, administrators, and clerical workers have infrequent need for either telephone use or data access and manipulation.

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It is probable that three types of IVDTs will emerge to provide three levels of functionality--high, medium, and low--to meet users' varying needs. At the low end, we expect IVDTs to provide for frequent keyboard use and limited telephone use. The emphasis will be on the IVDTs' terminal elements. The midrange IVDTs will combine a moderate amount of telephone management functions with good terminal design. The high-end IVDTs will provide more, but not overwhelming, telephone functions with an attractive terminal, providing alternate input capability in addition to its keyboard. In all cases, the IVDTs must be very easy to use.

PRODUCT REQUIREMENTS

Reyboard

The keyboard remains the primary input device for display terminals, despite the emergence of alternate input methods such as touch screens, voice, and mice. DATAQUEST believes that a full-size, full-travel keyboard similar to those found on most alphanumeric terminals today is desirable for most IVDTs. Such keyboards include a typewriter section, a cursor control section, function keys, and a numeric pad as a minimum complement. In addition, the keyboards have adequate keyspacing and touch and feedback to accommodate more than casual use. Most users are familiar with the common display terminal keyboard layouts.

Function keys are needed to provide single keystroke implementation of complex functions. Automatic one-key log-on is the prime example of this.

Screen

If an IVDT is to be used productively, we would expect it to have a 12- or 14-inch screen. These screen sizes are common in most terminals. They allow characters to be displayed in a reasonable matrix (7 by 9) distinctly and legibly. They also allow more than 80 columns of data to be displayed on the screen while maintaining good legibility. We believe that the IVDT's screen should display a minimum of 24 lines of data and that a function key label line is desirable. DATAQUEST believes that a smaller-than-12-inch screen will relegate the IVDT to the more casual users and to those who want to save desk space.

We expect CRT display screens to be used for IVDTs for the next few years. As flat panel displays come down in price, we believe that they will be used extensively in IVDTs, probably in a horizontal desktop or fold-up configuration.

Telephone Support

Though they are now designed into many IVDTs, DATAQUEST does not believe that an extensive number of telephone functions need to be present in an IVDT. Making the telephone any more complex than it already is does not seem to be a winning strategy. A minimum amount of phone support would include:

- One-key dialing
- Connect, hold, forward, conference, and transfer
- Last number redial
- Personal directory
- Speaker control--on, off, volume

An argument can be made for letting an existing telephone perform these functions, if it does so, and providing only a few telephone functions in the IVDT, such as a directory and one-key dialing. We see this as a viable approach.

Communications

The communications requirements are the most complex issues that IVDTs face in their battle for success in the marketplace. Two divergent paths are available: PBX proprietary and system based. A PBXproprietary IVDT will exclude, by its nature, a large portion of the potential market. System-based IVDTs will face the same limitation. Until communications standards emerge to erase some of the confusion that exists, we expect that a generic product that provides compatibility with most PBXs and systems will be the most logical approach. Compatibility with PBXs is needed because we expect most IVDTs to ultimately be associated with PBXs. Though generic products might not be able to access all PBX applications, they would probably be useful for most purposes.

Popular emulations such as Digital Equipment Corporation's VT100 and IBM's 3270 Information Display System should satisfy most needs.

DISTRIBUTION CHANNELS

For the display terminal manufacturer, distribution is probably the thorniest issue surrounding the IVDT market. We believe that only the most sophisticated distributors currently used by terminal manufacturers are able to sell IVDTs to users. A direct sales force, if a terminal manufacturer has one, will also be limited in its ability to reach and sell to IVDT purchasers in most organizations. Direct sales are most useful for selling high-end IVDTs into vertical applications. For the near term, therefore, we believe that the greatest success will be achieved through telecommunications-oriented channels of distribution. These include:

- PBX vendors
- Interconnects
- Regional Bell operating companies
- VARs, system integrators, and OEMs
- Manufacturers' representatives

It is not surprising that PBX vendors such as Northern Telecom and ROLM have been relatively successful selling IVDTs. Their IVDTs are designed to work with their switches, and their sales forces are able to demonstrate the products to the customers. The Regional Bell operating companies have set up operations to sell a wide variety of computer and telephone equipment to their service areas. Often they provide PBX systems and they are able to promote and sell the IVDT. Interconnects are the value-added resellers of the telecommunications industry. They, also, have the expertise and contacts to sell IVDTs. The VARs, system integrators, and OEMs that display terminal manufacturers have traditionally used can provide their customers with IVDTs and support the product. However, many of them do not have the expertise or customer base to achieve widespread success selling IVDTs. Manufacturers' representatives are a possible channel for IVDT distribution. However, their small territories and customer bases will limit their abilities to sell the product in large volume.

In the next few years, IVDT distribution channels will evolve and become more clearly defined. In order to succeed, terminal companies offering IVDTs will have to ally themselves with PBX vendors (who will probably compete in the market with their own products), regional telephone companies, or telecom-oriented OEMs. Direct sales, the retail channel, and most traditional display terminal distributors will not prove fruitful for volume IVDT sales.

Alliances and OEM agreements also provide terminal manufacturers with a way to participate in the IVDT market. A number of alliances have already taken place, most notably between IBM and its ROLM subsidiary, Wang and InteCom, and TeleVideo and AMBI. We expect to see more alliances announced in the near future. IVDT OEM agreements have abounded. Beleaguered Zaisan has signed OEM agreements with ITT and Lee Data. Matra supplies its IVDTs to Tymshare, and Thomson CSF sells its IVDTs to GTE.

DATAQUEST ANALYSIS

The IVDT has been called an "executive toy" and a product looking for a market. It faces stiff competition from personal computers and PC voice/data add-on products. Does this mean that display terminal manufacturers should ignore the integrated voice/data terminal market? We think not.

It is DATAQUEST's opinion that display terminal manufacturers can be winners in the emerging integrated voice/data terminal market. Terminal manufacturers can win because they have traditionally shown expertise in keyboard and display quality. We believe that all display terminals--not just IVDTs--must provide a good user interface through their keyboards (or other input device) and their display screens. Terminal manufacturers can bring their expertise in these areas to the IVDT market.

However, the IVDT market is not without its pitfalls for terminal manufacturers. One of the pitfalls is the telecommunications aspect of these devices. It is in this complex area that display terminal manufacturers need to rely on telecommunications-oriented companies for help. They can get the help they need through alliances and partnerships. There are many recent examples of such partnerships that support the wisdom of such an approach.

Another pitfall facing the traditional terminal manufacturer is distribution. For the short term, the distribution channels of all but the largest terminal manufacturers are not adequate for getting IVDTs to end users. Therefore, we believe that terminal manufacturers must move outside of their normal distribution channels in order to achieve success with IVDTs. Terminal manufacturers can also participate in the IVDT market by forming strategic alliances. They can design and develop products for PBX makers and OEMs who can then market the products.

DATAQUEST believes that any company competing in the IVDT market must carefully assess the users' needs and then design products to meet those needs. The needs are varied and must be carefully defined. It is likely that in the foreseeable future, no single IVDT will meet the wide range of needs that exist. However, we suggest that terminal manufacturers may wish to study how Northern Telecom has approached this challenge with its Meridian 4020 terminal, and how AMBI and DAVOX have developed vertical market applications. A family of products, based upon modular, flexible design, will be needed. Great attention must be paid to ease of use. Those terminal manufacturers that also offer personal computers should look to those systems as another way of competing in the integrated voice/data market.

For the integrated voice/data terminal market to take off, four things must occur:

- IVDT manufacturers must be able to demonstrate that their products enhance productivity and that their products can be firmly cost justified.
- IVDT prices must drop.

- IVDTs must provide all the elements of a quality terminal.
- Digital voice and data pathways must be established.

DATAQUEST believes that in the past, IVDT manufacturers have not done a good job of demonstrating how their product enhances productivity or how the purchase of an IVDT may be cost justified. For example, it is one thing to tell a stock brokerage firm that the purchase of an IVDT will increase productivity. It is something else to show how that purchase would result in a 20 percent increase in the number of transactions the firm will realize and to provide statistics and references to back that up. Similarly, it is one thing to tell a client that he or she will save money by purchasing an IVDT, but it is something else again to develop cost justifications that can be tested. IVDT manufacturers who can accomplish the two tasks enumerated above will have taken a major step toward closing sales.

DATAQUEST expects IVDT prices to drop due to pressures from competitive devices like personal computers and "smart" telephones. Competition in the already crowded IVDT market will also fuel its own price erosion. IVDT vendors must realize that users will not pay premium prices for what they consider to be a sophisticated telephone.

We believe that a successful IVDT must have all the elements of today's quality terminals. The current proliferation of design approaches has only served to confuse the potential user. The spectrum of products ranges from compact, executive terminals with small screens and "chiclet" keyboards to products with an overwhelming array of telephone and personal productivity features. DATAQUEST believes that small screens and limited-use keyboards equate to a small potential market. We do not believe that an overwhelming amount of telephone support functions are needed.

A flexible, modularly designed IVDT will allow for a variety of users to be targeted. This, combined with the elements of a quality display terminal will provide the right IVDT for much of the market. To escape from the limitations of PBX-specific products, a generic approach to PBX interfaces is needed.

The necessary digital voice and data pathways for widespread IVDT use are not yet established. In 1986 and 1987, the testing of integrated services digital network (ISDN) implementation will begin in the United States. Similar testing is taking place in Europe. ISDN provides simultaneous digital voice, data, and image transmission over one cable. DATAQUEST expects ISDN to open the world to integrated voice/data terminals.

Perhaps one more event must occur before the IVDT market takes off--the entry of both IBM (with a product of its own design) and Digital Equipment Corporation. These two industry leaders have cautiously avoided this market thus far. We expect them to enter it within the next year as they attempt to integrate the office. When they do, they will most likely legitimize and standardize the IVDT market. DATAQUEST believes that the IVDT market will then acquire a focused direction. With the major display terminal, computer, and office automation companies all converging upon a central point--integrated office systems--it is apparent to us that IVDTs will emerge from their obscurity into the limelight of the office desk. Just as very few users question their need for a telephone, the IVDT market will take off when very few users question their need for IVDTs.

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John Brew Greg Blatnik



RESEARCH NEWSLETTER

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ELECTRONIC EQUIPMENT MARKET UPDATE: STABLE GROWTH TO CONTINUE

INTRODUCTION

Despite the worst semiconductor slump in history, North American electronic equipment continued its resilient growth in 1985 by increasing 11.7 percent over 1984. While this output is lower than 1984's 16.6 percent improvement over 1983, it indicates that the instability in the semiconductor marketplace has been more a factor of inventory and pricing fluctuations than depressed electronic equipment production. DATAQUEST forecasts a somewhat slower growth of 11.0 percent for North American electronic equipment in 1986, with a compound annual growth rate (CAGR) of 10.7 percent from 1986 through 1990.

Figure 1 shows the historical relationship (1974 through 1985) between semiconductor consumption and electronic equipment production, including our forecast for 1986.

OUTLOOK FOR APPLICATION SEGMENTS

This market update will briefly recap the performance of each segment and note important developments that may affect future semiconductor market growth. Table 1 contains the updated revenue forecast for North American electronic equipment by application market.

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Figure 1

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HISTORICAL COMPARISON OF U.S. SEMICONDUCTOR CONSUMPTION AND ELECTRONIC EQUIPMENT PRODUCTION (1974-1986)



Source: DATAQUEST February 1986

Table 1

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SEGMENT OVERVIEW NORTH AMERICAN ELECTRONIC EQUIPMENT FORECAST (Millions of Dollars)

Segment	1983	1 784	1985	1986	1987	1 988	1989	CA G r 84-85	CA6R 84-89
DATA PROCESSING						*-			
Computers	\$29.779	\$40.589	\$45.794	\$50,337	\$55.985	\$64.736	\$69,990	12.87	11.5%
Data Storage Subsystems	13.989	14.914	16.403	18,654	20.655	21,192	21,758	10.5%	7.9%
Terminals	4,305	4,872	5,277	5,685	5,956	6,391	6,858	8.32	7.17
Input/Output	7,778	8,260	9,850	9,838	11,199	11,905	12,252	7.1%	8.2%
Dedicated Systems	7,855	8,610	8,909	9,136	9,824	10,707	12,084	3.52	7.01
Subtotal	\$63,706	\$77,245	\$85, 313	\$93,650	\$103,619	\$114,932	\$122,942	10.41	9.7%
COMMUNICATIONS									
Customer Premises	\$10,112	\$12,017	\$13,607	\$15,025	\$16,761	\$19,043	\$21,366	13.2%	12.21
Public Telecommunications	ó,245	7,223	8,098	9,087	10,048	10,748	12,106	12.17	10.9%
Radio	3,429	4,207	4,954	5,748	6,568	7,556	8,830	17.7%	16.0%
Broadcast and Studio	1,464	1,449	l,666	2,055	2,423	2,830	3,461	15.02	19.01
Other	2,322	2,558	2,720	3,156	3,647	4,259	4,928	6.32	14.02
Subtotal	\$23,573	\$27,454	\$31,046	\$35,070	\$39,447	\$44,443	\$50,691	13.17	13.01
INDUSTRIAL									
Security/Energy Mget.	\$2,065	\$2,191	\$2,320	\$2,497	\$2,707	\$2,966	\$3,228	5.9%	8.1%
Manu. Sys./Instrumentation	14,899	16,889	19,193	21,798	24,830	28,334	32,389	13.6%	13.9%
Robot Systems	343	488	769	1,007	1,259	1,678	2,276	57.71	36.17
Medical Equipment	5,312	5,822	6,463	7,030	7,699	8,535	9,520	11.0%	10.32
Commercial Aviation	1,832	2,108	2,426	2,792	5,213	3,698	4,256	15.1%	15.1%
Other	4,677	4,966	5,627	6,311	7,346	8,207	9,266	13.31	13,37
Subtotal	\$29,128	\$32,463	\$36,798	\$41,435	\$47,053	\$53,418	\$60,934	13.41	£3.4%
CONSUMER									
Audzo	\$23B	\$255	\$261	\$273	\$288	\$304	\$319	2.21	4.6%
¥1deo	3,757	4,292	4,348	4,638	5,021	5,376	5,745	1.37	6.0%
Personal Electronics	959	423	505	543	592	647	685	19.52	10.1%
Other	7,279	8,172	8,866	9,208	9,541	9,861	10,172	6.51	4.52
Subtotal	\$12,232	\$13,142	\$13,979	\$14,662	\$15,442	\$16,188	\$15,920	6.42	5.2%
MILITARY	\$38,500	\$43,595	\$49,246	\$55,233	\$61,645	\$67,575	\$73,280	13.02	10.92
TRANSPORTATION	\$5,547	\$7,441	\$8,4 8 0	\$9,580	\$10,410	\$11,799	\$13,812	14.02	13.2%
TOTAL EQUIPMENT	\$172,686	\$201,340	\$224,862	\$249,630	\$277,615	\$308,355	\$330,579	11.7%	11.01

Source: DATAQUEST February 1986

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Data Processing

The well-publicized slowdown of personal computer sales deceptively portrayed this segment as stagnant in 1985. While growth was well below the double-digit rates that have come to be expected of this industry, sales slowed primarily because of the following:

- Confusion in the PC marketplace
- Anticipation of new product introductions (causing postponement of purchases) -- from small systems to mainframes
- A very strong U.S. dollar against most non-U.S. currencies

DATAQUEST is forecasting a 9.9 percent revenue gain in computer sales (for North American-based manufacturers) in 1986. We believe that high-end systems should fare best, with strong performances by Digital Equipment's MicroVAX II and IBM's Sierra line. DATAQUEST believes that PC sales will remain sluggish as price cutting continues and more products are delivered by Far Eastern manufacturers.

Growth in data storage subsystems has eased somewhat, as would be expected with a slowdown in computer sales. Nevertheless, spectacular expansion is expected for smaller (3- to 4-inch) disks in both fixed and removable drive systems.

While moderate growth characterized the terminal industry, there was a great deal of activity in product development, especially for the graphics segment. For 1986, two trends are evident. We believe that continued price erosion will permeate the industry as the display terminal market remains healthy and active. Also, the emergence of dual-protocol terminals that combine ANSI, ASCII, or 3270 capability (thus providing easier access to a wealth of applications software and data resources) will mark a significant development for the coming year.

The printer market is in the midst of a transition, spurred by the technological developments of non-impact printers. Although dot matrix and fully formed (both impact) printers still dominate the market, their growth has diminished and they are slowly being replaced by the non-impact thermal transfer and ink jet products.

Other key markets to watch in data processing include smart cards, an area where the Japanese are pushing ahead at an alarming pace; and add-on boards--products that provide key functions such as memory expansion, networking, printer interface, emulation, and video display.

Communications

The communications arena is expected to maintain healthy growth, as the surge of activity since the divestiture of AT&T continues. The entire segment is expected to see a 13.0 percent revenue growth in 1986, slightly less than the 13.1 percent increase of 1985. The coming year will find the telecommunications industry facing two major challenges. One is the integration of voice and data in the network, on the desktop, and in the building. The other challenge is connectivity with regard to terminals, workstations, computers, and networks. Innovative telecommunications managers are trying to understand how these challenges can be overcome with minimal economic impact and operational effort.

DATAQUEST believes that the Integrated Services Digital Network (ISDN), which provides simultaneous digital voice, data, and image transmission over one cable, will become more visible in the future as the network transport that will carry voice and data from the customer location into the network. Despite the push by semiconductor manufacturers (who are eager to capitalize on the ISDN opportunity to mass-produce digital and analog-to-digital telecommunications chips) and others, many standards still need to be agreed upon. The large installed base of analog switching equipment, as well as proprietary designs by numerous premise communications vendors, will prevent widespread implementation of a standard digital format in the United States for many years.

Equipment areas that are poised for growth in 1986 include:

Integrated voice/data workstations

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- T-1 multiplexers
- Local area networks (bolstered by IBM's Token-Ring announcement in October)
- Cellular radio/telephones

<u>Industrial</u>

Perhaps more than any other segment, the industrial sector represents a cross-section of the entire economy. The 13.4 percent growth of 1985 should be down slightly to 12.6 percent in 1986, mirroring the entire electronic equipment index. The prospects for the industrial segment from 1986 through 1989 appear strong, with a stable 13.7 percent CAGR.

Robotics will hold the greatest potential for expansion; DATAQUEST expects to see a 30.9 percent growth in robot systems revenues for 1986, with similar expansion seen through the decade.

Consumer

While exciting consumer products deluged the market in 1985 (and will continue to do so in 1986), the vast majority of introductions came from Japanese manufacturers.

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The past year saw astounding activity in products such as compact disk players, VCRs, satellite dishes, and digital television, along with the incorporation of stereo into television units. Sales should continue to be strong for these products during 1986, although the record amount of debt incurred this past year may slow consumer spending slightly.

North American production of consumer electronics will progress slowly at a growth rate hovering around 5.0 percent. Recent moves by some Japanese firms to manufacture in the United States (such as Hitachi producing VCRs in California), as well as the continued strength of certain home appliances (such as microwave ovens) will keep the market moderately healthy.

For semiconductor manufacturers, the consumer market still represents an opportunity. While growth of consumer equipment is not spectacular, the penetration of electronics into many of these products has been rather limited, and the potential for further integration is great.

Military

While future reductions in the military budget are a virtual certainty given the passage of the Gramm-Rudman Act, there still remain enough defense programs under contract to keep the military market strong. The strong revenue growth in 1985 (13.0 percent) will slow in the upcoming years, although the pervasiveness of electronics in military equipment will continue to increase.

We believe that reliability, maintenance, and cost cutting will continue to be emphasized by a more scrupulous Congress, as it selects the defense contractors that will be awarded the major grants in the budget-tightening years ahead.

Transportation

The proliferation of semiconductors in automobiles continues to make the transportation segment a promising application area. DATAQUEST estimates a 13.0 percent growth in this market for 1986, which should continue to expand at a CAGR of 12.9 percent through 1989.

We estimate that the present value of electronics per new car is \$625, increasing to \$1,350 by 1992. By comparison, new European models have far less electronic content, due primarily to the lack of emission control standards such as those found in the United States. With recent activity toward establishing such standards, the European automobile market for semiconductors is expected to grow at nearly 20 percent for the remainder of this decade.

The potential for new developments in navigational systems, driver convenience instruments, and body control applications all point to a continued strong market.

DATAQUEST CONCLUSIONS

With a sound economy forecast for 1986 and recent analysis of Department of Commerce (DOC) data that indicate that inventory is coming on-line with shipments (in data processing and communications products), DATAQUEST expects another year of stable growth for North American electronic equipment. As indicated in Figure 1, the historical relationship between semiconductor consumption and equipment production has been skewed (1983 through 1985), and only after going through the drastic corrections of last year are we now able to see a modest rebound in the battered semiconductor industry.

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While growth should be moderate for the first quarter of 1986, we believe that strong improvements will be seen in the semiconductor industry in the remainder of the year, following the stable expansion of the end equipment markets. An updated electronic equipment forecast will be published at the end of the first quarter of 1986. That document will review the status of the application markets and note any changes in their impact on the semiconductor industry.

John Brew

RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: February 1986-3

1986 WINTER CONSUMER ELECTRONICS SHOW

INTRODUCTION

Dataquest

FR a company of The Dun & Bradstreet Corporation

> While the future dollar growth of the U.S. consumer electronics market continues to appear modest at best, the Winter Consumer Electronics Show (CES) clearly exhibited the healthy state of the industry in terms of product innovation and technological achievements. More than 100,000 people passed through a variety of exhibits at the show, which was held in Las Vegas, Nevada, January 9 through 12.

> As for market growth, as indicated in Table 1, DATAQUEST estimates that North American production of consumer electronic goods rose 6.4 percent in 1985, to just under \$14 billion. Projected growth for 1986 is 4.9 percent, with a compound annual growth (CAGR) of 4.8 percent for 1986-1989.

> This newsletter will summarize some of the data presented by the Electronic Industries Association (EIA) at CES, as well as highlight key markets that stood out during the four days of exhibits. While the focus of the show is on the audio and video segments, which are dominated by the Japanese, it is important to remember that these products constitute less than 40 percent of the total U.S. consumer electronics market.

Table 1

NORTH AMERICAN CONSUMER EQUIPMENT FORECAST (Millions of Dollars)

Consumer Equipment	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	1988	<u>1989</u>	CAGR 84-85	CAGR 84-89
Audio	\$ 238	\$ 255	\$ 261	\$ 273	\$ 288	\$ 304	\$ 319	2.28	4.68
Video	3,757	4,292	4,348	4,638	5,021	5,376	5,745	1.38	6.08
Personal Electronics	959	423	505	543	592	647	685	19.58	10.18
Other	7,279	8,172	8,866	9,208	9,541	9,861	10,172	8.5%	4.58
Total	\$12,233	\$13,142	\$13,980	\$14,662	\$15,442	\$16,188	\$16,921	6.48	5.28

Source: DATAQUEST February 1986

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ECONOMIC DATA

With moderate economic growth forecast for 1986, the EIA projects that consumption of consumer electronics in the United States will rise 5 percent in 1986, to \$25.7 billion. This is slightly below the 6.1 percent increase of 1985. Ron Nessen, former White House official currently with the Mutual Radio Network, speaking on the American economy, cited two factors that could slow consumer electronic purchasing in 1986: ÷.

- The unprecedented rise in consumer debt and drop in savings rate that occurred in 1985
- The dollar's gradual decline against the Japanese yen, which will raise the cost of imported goods

William Boss, former EIA director and president of RCA Consumer Electronics, made the following observations:

- Expect more 'audio/video technology mergers. The upcoming year could be remembered as the "year of the stereo television."
- VCRs, after a record-breaking 1985, should experience relatively flat sales in 1986.
- Video products as a whole will experience little or no dollar growth in sales this year.

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POPULAR MARKETS AT CES

Television Products

Despite the lackluster consumption forecast presented by the EIA, the emergence of the following new markets should lay the foundation for future growth:

- Pocket-size television sets with LCD screens
- Digital television sets
- Stereo broadcast sets
- High-definition television (HDTV)

LCD-based television sets from Casio, Citizen, Panasonic, and Seiko drew widespread attention as attendees marveled at the size of these battery-operated, portable units. Ranging in price from \$100 to \$300, many of these color and monochrome products still lack outstanding resolution. Flat-screen technology (using LCDs) is being developed by many Japanese manufacturers, including Casio, who is expected to announce 6" and 12" versions within the next year. Flat panels in larger sets (20") are not anticipated until late 1987.

Digital television products were abundant at CES. Besides the ability to achieve high resolution, digital sets have many of the following special effect capabilities:

- Two or more color pictures on one screen
- Combining still pictures with moving images
- Instant replay of images just seen

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• Image processing of computer graphics

The opportunity for semiconductor houses to develop digital conversion and dedicated video chips is starting to draw the attention of many manufacturers. Panasonic and Toshiba use an ITT chip set, and Zenith's new digital television receiver is also expected to use similar circuitry. Multivision Products, a start-up located in Fremont, California, exhibited a one-chip semicustom CMOS IC that is aimed at grabbing a share of this lucrative market. Surrounded by converter (analog-to-digital, digital-to-analog) chips, with a small amount of RAM, the Multivision product is being licensed for sale to OEMs in the cable, satellite, VCR, and television industries.

The sales of "stereo-capable" television units (sets with built-in stereo or adaptability for it) are expected to flourish this year. Stereo broadcast is capable of reaching 75 percent of the U.S. population, and projections by the EIA set sales figures near \$2 billion in 1986 for color television receivers with built-in stereo capability.

One final television product that drew rave reviews was the highdefinition television (HDTV) displayed by NEC. HDTV was developed by the Japan Broadcast Association, better known as the NHK. NEC, in cooperation with the NHK (which is planning to broadcast HDTV via satellite in 1989), developed an HDTV monitor capable of reproducing the highdefinition video signal. The astounding resolution is intended to resemble 35mm film. Hitachi and Toshiba have also developed HDTV projection screens.

Video Cassette Recorders (VCRs)

While consumption of VCRs is expected to slow from its 35.8 percent growth in 1985, product introductions (generally with more and more features) will continue to flourish. Presently, more than 200 different models of VCRs are available in at least seven different formats. Development activity in the Beta format has slowed considerably, due in part to the emergence of 8mm, which is expected to dominate the market within 10 years. Manufacturing of VCRs in the United States is expected to increase dramatically as Hitachi Consumer Products of America has announced plans to set up production in Anaheim, California. Matsushita and Toshiba have also indicated that they may launch U.S. manufacturing plants. Sony presently makes professional-use VCRs in the United States.

Cancorders

Camcorders, a combination of video cameras and recorders, are being touted as the fastest-selling item of 1986, spurred in part by recent product introductions from Canon, Goldstar, JVC, Kodak, Kyocera, Mitsubishi, NEC, Sanyo, Sharp, and Zenith, among others. Despite the excitement surrounding this market, the variety of formats leaves consumers with the same confusing choice that has troubled the VCR industry.

Satellite Earth Stations

Being tracked by the EIA for the first time, sales of satellite units are expected to reach 600,000 units in 1986, which will push the industry above the \$1 billion plateau. A typical system includes a satellite receiver, an 8-bit MPU (such as the 280), and a dish. An upcoming newsletter will detail the semiconductor content of these systems.

Resolution of the issue concerning the scrambling of pay-TV signals could be the most important factor in determining sales in the upcoming years.

Compact Disk (CD) Players

The rapid development of the CD market has astounded everyone and left the market with an abundance of available models. New product introductions are moving in two directions: added features and diversified applications. An example of added functionality is a CD player exhibited by Pioneer that can hold up to six disks at one time. Portable and car CD players are seeing the majority of new product announcements. It is estimated that portable models will make up more than one-third of all new CD players sold, while car CD players are seeing a dramatic drop in price as more manufacturers offer models.

Home CD players still constitute the largest share of this market, and with its glut of participants, prices could dip near \$100 on very basic units by the beginning of 1987. Home CD players are also producing a resurgence in sales of related stereo components (speakers, amplifiers), which are being upgraded by consumers to maximize the quality of sound available from digital music.

Digital Audio Tape (DAT)

The popularity of CD players (as well as their inability to record music) has spurred the development of digital audio tape players. Onkyo USA Corporation displayed its prototype player at CES, getting the jump on many other manufacturers who plan to announce products by the end of this year.

DATs' impact on CD sales are uncertain, although their expected price (around \$1,000) will certainly tumble before mass consumer acceptance. Drastically reducing the number of integrated circuits used in the present model was mentioned by Onkyo as one way of cutting costs.

DATAQUEST CONCLUSIONS

It would be inaccurate to interpret the moderate dollar growth projections (5 to 6 percent) for the consumer electronics market as signaling a static industry. As technological marvels are introduced into the mass markets, prices have generally plummeted due to fierce competition. The potential for American semiconductor manufacturers is still present, although the Japanese tend to have captive sources for many of their consumer products. From the microcontrollers used in CD players, to the vast amounts of memory found in the new digital television sets, DATAQUEST believes that the opportunities are plentiful for greater integration and penetration into this rapidly changing market.

John Brew



RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters, January-March 1986-4

VIDEO-7'S VEGA: WILL THE FIRST IBM/HERCULES CLONE SUCCEED?

EXECUTIVE SUMMARY

Video-7 Incorporated manufactures a unique and inexpensive PC graphics board called the VEGA. This is the first board on the market that is fully compatible with the PC graphics standards that are emerging from volume sales of graphics boards from IBM and Hercules. These boards include IBM's Enhanced Graphics Adapter (EGA) and Hercules' Graphics Card (HGC). Video-7 appears well poised to succeed in the low-end, IBM EGA and HGC segment of the graphics board market.

This newsletter:

- Reviews the Video-7 VEGA and how it is engineered and marketed
- Presents the domestic and Rest of World (ROW) market potential for low-end graphics boards
- Analyzes the VEGA's impact on the graphics add-on board market and on Video-7, and presents a glimpse of the future competition

THE VEGA

Video-7's VEGA features 100 percent compatibility with IBM's EGA, Color Graphics Adapter (CGA), and Monochrome Display Adapter (MDA), as well as with Hercules' monochrome HGC. The VEGA's price is \$599 for either the short- or long-slot version. The short-slot VEGA will fit any slot of the IBM PC, XT, AT (including slot 8 of the PC/XT), and most PC-compatibles, leaving room for adding other functions that the long-slot IBM EGA cannot offer. The long-slot version of the VEGA, the VEGA-LS, is designed for retailers and OEMs.

The short-slot VEGA offers 256 Kbytes of display RAM as the result of using four custom chips, surface-mount technology (allowing high reliability as well as high component density), and a reduced chip count that

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The content of this report represents our interpretation and analyses of information generally available to the public or released by responsible individuals in the subject companies, but is not guaranteed as to accuracy or completeness. It does not contain material provided to us in confidence by our clients. Individual companies reported on and analyzed by DATAQUEST, may be clients of this and/or other DATAQUEST services. This information is not furnished in connection with a sale or offer to self securities or in connection with the solicitation plan offer to buy securities. This limit and its parent and/or their officers, stockholders or members of their families may from time to time, have a long or short position in the securities mentioned and may set or buy such securities. totals 28 integrated circuits. In comparison, the IBM EGA is a long-slot board that uses 86 integrated circuits and provides 64 Kbytes of RAM for \$524; with a daughter board that provides 256 Kbytes of RAM, the EGA lists for \$982.

The VEGA features 12 graphics/text display modes and supports 640 x 350 resolution in both monochrome and color modes. In the color mode, 16 colors from a palette of 64 are supported. Support is also provided for a light-pen interface and a RAM-loadable character generator.

Compatibility with the IBM/Hercules video modes allows the VEGA to run any business graphics software on the market, including the newest EGA software: Drawing Assistant, Topview, and VDI from IBM; Windows, Word and Chart from Microsoft; Lotus 1-2-3 and Symphony from Lotus; Framework from Ashton-Tate; and GEM from Digital Research. All earlier software runs without special software drivers or modifications.

An external switch selector is provided to VEGA users, which allows them to choose color, enhanced color, or monochrome displays without removing the PC cover.

Figure 1 illustrates the short-slot VEGA.

Figure 1



THE VIDEO-7 VEGA

Source: Video-7 Incorporated

Engineering

Video-7 began business in 1983 as a designer, manufacturer, and marketer of high-resolution video and graphics adapters for personal computers. In October 1985, Video-7 announced an agreement with Chips and Technologies, Incorporated (Chips), of Milpitas, California. Chips is a one-year-old designer and manufacturer of microcomputer system components. The agreement allows Video-7 to purchase volume amounts of Chips' new Enhanced Graphics CHIPSet over a 12-month period. The CHIPSet is packaged into Video-7's VEGA graphics board and is the key to providing the VEGA with its IBM/Hercules compatibility. In addition, Video-7 has added Hercules compatibility, as well as full CGA and MDA emulation and 256 Kbytes of display RAM on a half-slot card.

The Key: Chips and Technologies' Enhanced Graphics CHIPSet

Chips' Enhanced Graphics CHIPSet is the first hardware alternative that provides 100 percent IBM EGA compatibility. It is also the first to integrate emerging standards resulting from the market's acceptance of IBM and Hercules video controllers. This CHIPSet is offered as an integrated solution for engineering workstations, graphics terminals, and other applications requiring an Enhanced Graphics interface capability and/or the BIOS level of emulation for the IBM CGA or MDA products.

The Enhanced Graphics CHIPSet replaces 19 devices with 4 full-custom VLSI integrated circuit components--which reduces the number of components needed for a fully configured EGA implementation from 76 to 32. By combining the CHIPSet with eight 256K DRAMs to replace the thirty-two 64K DRAMs currently used in the IBM implementation, a vendor can create a system design that eliminates the need to use a daughter board for the additional required display memory. Furthermore, half of the slot space required for the long-slot IBM EGA is saved for other use. For example, this space can be used for input/output interfaces, more memory, or another Chips board, the PC/AT CHIPSet. (The PC/AT CHIPSet is aimed directly at PC AT-compatible, 80286-based microcomputer system implementation.)

Marketing

Video-7 has added significant value to the CHIPSet with the full Hercules, CGA, and MDA emulation modes of the VEGA and plans to market it through various channels. An example of this is Video-7's November 1985 joint marketing agreement with Quadram Corporation. Quadram is a Norcross, Georgia-based subsidiary of Intelligent Systems Corporation and a leading designer and manufacturer of microcomputer enhancements products. Quadram has named its board the QuadEGA+ and is offering it for \$595. The QuadEGA+ will be marketed through Quadram's established channels in the retail market, where it currently has more than 3,000 retail outlets.

In addition, Video-7 intends to market the VEGA to OEMs and retailers and can customize and industrialize the product. Deliveries of the VEGA began in November 1985.

MARKET POTENTIAL

The PC Graphics Add-On Board Market

There are more than 50 PC graphics board manufacturers currently moving into the high-end tier and the low-end tier of the PC market. This new market segment opens up the base of PC and PC AT-compatible software and add-on boards to applications in process control, industrial automation, engineering and scientific systems, and office systems. The worldwide graphics board market is expected to grow to more than 5.5 million units by 1989--but the total available market (TAM) could be as high as 78 million graphics-compatible PC units. We believe that boards penetrated only 4 percent of the TAM that was available worldwide in 1984. Our current estimates indicate that by 1989, board penetration will be little more than 7 percent, even with between 75 and 100 percent growth compounded annually.

The TAM for graphics add-on boards is in the newer portion of the installed base of PCs that range in price from \$1,000 to \$10,000 and have been shipped since 1984. These newer units are designed with slots for add-on boards, making them graphics compatible. The very low-end (less than \$1,000) and older units in the installed base do not lend themselves to graphics enhancement. Based on information from DATAQUEST's Personal Computer Industry Service (PCIS), the total 1984 worldwide installed base of PCs exceeded 34 million units. Of these units, nearly 16 million units, almost 7.8 million graphics-compatible units were shipped in 1984, representing the worldwide TAM for add-on boards. Table 1 presents the estimated worldwide installed base of graphics-compatible PCs for 1984 through 1989.

Table l

ESTIMATED GRAPHICS-COMPATIBLE PC INSTALLED BASE \$1,000 TO \$10,000 SEGMENT (Thousands of Units)

	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>
Worldwide	7,762.3	17,480.8	29,081.4	42,274.4	58,813.4	77,972.4
U.S.	4,650.0	10,246.7	16,555.7	23,558.7	32,050.7	41,638.7
ROW	3,112.3	7,234.1	12,525.7	18,715.7	26,762.7	36,333.7

Source: DATAQUEST February 1986

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The Domestic TAM

DATAQUEST estimates that in 1984 the domestic installed base for PCs in the \$1,000 to \$10,000 range was more than 9 million units. Of these units, approximately 4.7 million units are graphics compatible. The add-on board penetration of these newly installed units was estimated to be only about 250,000 units in 1984, or about 5 percent. This leaves approximately 95 percent, or 4.4 million, of the newer PC units available as the domestic TAM for board penetration. As new PC unit shipments increase, the potential for adding graphics boards will also rise, creating a lucrative market for boards. We estimate that the domestic board market will increase between 75 and 100 percent for the period from 1984 to 1989 (see Table 2).

Table 2

ESTIMATED UNIT SHIPMENTS PC GRAPHICS ADD-ON BOARDS (Thousands of Units)

	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>
Worldwide	325.0	663.0	1,160.3	1,972.1	3,352.7	5,531.5
U.S.	250.0	510.0	892.5	1,517.0	2,579.0	4,255.0
ROW	75.0	153.0	267.8	455.1	773.7	1,276.5

Source: DATAQUEST February 1986

The Rest of World (ROW) TAM

The 1984 ROW installed base of PCs in the \$1,000 to \$10,000 price range totaled approximately 6.7 million units. About 3.1 million of these units are graphics compatible, having been shipped and installed in 1984. Preliminary estimates indicate that board shipments to the ROW market will represent an additional 30 percent. Thus, we estimate that the 1984 ROW board penetration was approximately 75,000 units, or only about 2 percent of the newer PC units. This leaves 98 percent, or almost the entire 3 million units, available as the ROW TAM for boards.

DATAQUEST ANALYSIS

In the November 8, 1985, Graphics Industry Service (GIS) Research Newsletter, "Graphics Goes Retail: PC Add-On Market Explodes," we stated that the PC graphics board aftermarket is booming, that it will probably maintain a growth rate of 75 to 100 percent for 1985 from 1984, and that it will maintain this growth through 1989. Furthermore, we postulated that this market, which is now segmenting into high- and low-end products, represents major opportunities as well as risks to vendors, and that a shakeout among the more than 50 vendors is likely in the future. Video-7's VEGA is the industry's first graphics board that embraces both of the PC standards that are emerging as a result of volume shipments by IBM and Hercules--and is offered at a lower price and with higher performance than IBM's EGA. Although the VEGA is higher priced than the Hercules HGC, it is backward-compatible to these standards and does not require that the user choose one standard PC software package over another. Personal computer users who opt for the VEGA will, therefore, retain any investments they have already made in standard PC software, some of which they would lose with the purchase of any other board that is currently on the market.

However, several recent announcements indicate that this EGAcompatible market will be very competitive. At COMDEX '85, Paradise Systems and STB announced products that will rival the VEGA. And announcements from AST, Atronix, Genoa, and other companies that are incorporating the Chips and Technologies Enhanced Graphics CHIPSet into their boards indicate the direction of low-end suppliers. The Paradise offering emulates the MDA, CGA, EGA, Hercules, and Plantronics ColorPlus products. Paradise could have a price advantage over Video-7 since its chip was designed in-house rather than acquired externally. The Paradise board-level product is scheduled for shipment in the first quarter of 1986, and the company has indicated that its chip will be sold separately for approximately \$25 each, quantity 10,000. The STB EGA Plus product uses Chips' components and has only MDA emulation, but it offers additional functionality, such as a parallel printer port and an optional This product began shipping in November 1985, and clock/calendar. carries a list price of \$595 in a configuration similar to the VEGA product.

As the competition builds, being first to market is unquestionably an advantage. DATAQUEST believes that the EGA will emerge as the next standard in the low end of PC graphics as more leading software companies support it. As lower-cost suppliers of EGA emulators realize early market positions, they will clearly benefit--and Video-7 has a good lead. Video-7's foresight and ability to be the first to market with IBM-, Hercules-, and full CGA/MDA-compatibility on a single, smaller, less-expensive board could give the VEGA real marketing clout and could create a leading position for Video-7 in the low end.

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John Brew Karen Davis Lewis Brentano


SAM Code: 1985-1986 Newsletters, January-March 1986-5

DRAWING CONCLUSIONS -- ALPHANUMERIC TERMINAL VENDORS DABBLING IN THE GRAPHICS TERMINAL MARKETPLACE

EXECUTIVE OVERVIEW

Dataquest

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Entering the graphics terminal marketplace turned out to be a bigger challenge than many alphanumeric terminal vendors had expected. In many cases, the increased profitability that vendors anticipated with highermargin graphics products was not realized.

DATAQUEST includes graphics terminals in the overall graphics market, as well as PC board products for personal computers. Graphics terminals are in turn subdivided into three segments: low-end graphics terminals and retrofitted graphics terminals (for data conversion usage), graphics terminals used in concept design, and graphics terminals used in imaging applications.

To date, most alphanumeric terminal vendors entering the graphics market have done so in the low-end, data conversion segment of the market (Segment 1G). A total of 103,472 Segment 1G graphics terminals are expected to be shipped in 1985, with an if-sold value of \$406 million. Our 1986 estimates are for 140,037 terminals to be shipped, with an if-sold dollar value of \$517 million.

Although the Segment 1G graphics terminal market is not very large compared to the alphanumeric terminal market, it is growing much faster. Segment 1G is expected to have a compound annual growth rate (CAGR) of 32.5 percent, between 1985 and 1989. Furthermore, it is an entry point into the larger, overall graphics market, which includes higher-end graphics terminals as well as graphics add-on boards for PCs.

The leaders in the graphics market segment are Digital, Hewlett-Packard, Tektronix, and IBM, with its new 3179G. Other independent graphics companies also compete in this market, such as GraphOn, Modgraph, and Selanar.

More than 15 independent ASCII terminal vendors have introduced products into this segment of the market, but so far, most have not been successful. We believe that they have not succeeded because they have not offered either leading-edge graphics products and peripherals, or used effective distribution channels.

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The content of this report represents our interpretation and analysis of information generally available to the public or released by responsible individuals in the subject companies but is not guaranteed as to accuracy or completeness. It does not contain material provided to us in confidence by our clients individual companies reported on and analyzed by DATAQUEST, may be clients of this and/or other DATAQUEST services. This information is not furnished in continection with a sale or offer to self security or in connection with the solicitation of an offer to buy securities. This firm and is parent and/or their officers, stockholders, or members of their families may, from time to time, have a long or short position in the securities mentioned and may sail or buy such securities. This DATAQUEST newsletter discusses the alphanumeric terminal vendors' entry into the low-end graphics market, evaluates their past performance, and projects their future.

This newsletter is divided into the following sections:

- Background
- Products and prices in the low-end graphics market
- Alphanumeric terminal vendors in the graphics arena
- Product distribution
- DATAQUEST analysis

BACKGROUND

Historical Perspective

The 1950s saw increasing applications for computers in the scientific and defense industries, as graphics displays became indispensable to greater productivity. However, such displays were very expensive, and it was not until Tektronix introduced the 4010 interactive graphics terminal (using storage tube technology), that they became economical and commonplace.

Graphics terminals have used many technologies since then, and have finally settled on raster scan as the preferred technology for generalpurpose graphics displays.

In the past, graphics software was written to output to specific terminals (like the Tektronix 4010/4014). In recent years, software has been written to be "device independent," i.e., not written for any one output device. Terminal driver programs are then used to display graphics on many different types of graphics terminals. Devices from Tektronix and other vendors can be used with a large variety of computer systems and software packages. The "device driver" takes care of translating commands for the specific terminal.

The following types of companies have been competing in the low-end graphics marketplace (DATAQUEST's Segment 1G):

- Independent graphics terminal companies, such as Tektronix and GraphOn that make graphics products, but not computer systems
- Computer systems vendors, such as Digital, Hewlett-Packard, and IBM that sell complete computer systems
- Independent alphanumeric terminal companies, such as Visual, Qume, and CIE

PRODUCTS AND PRICES IN THE LOW-END GRAPHICS MARKET

The types of products sold in the low-end graphics market by alphanumeric terminal vendors and their competition, are as follows:

- Alphanumeric terminals retrofitted with add-on graphics boards that are low- to medium-resolution bit-mapped devices, Tektronix 4010/4014-compatible. These devices have usually had major limitations, and the market has moved away from them, preferring integrated (single-board) graphics terminals. Most alphanumeric terminal vendors have used retrofitted terminals to enter the market. They are cheaper to produce because the vendors can use their existing alphanumeric terminal. Prices for such products are approaching the \$1,000 mark.
- Low-, medium-, or high-resolution graphics terminals, Tektronix 4010/4014-compatible, as well as Digital VT100-compatible. Some of these terminals are also VT220- and ReGIS-compatible, so they can emulate the Digital VT240/241. Most of these terminals are list priced between \$1,500 and \$2,500. However, the "street price," or the price paid by the user, is approaching \$1,500 for high resolution, and \$1,000 for medium- or low-resolution devices.
- Low- to medium-resolution, Tektronix 41XX-compatible, color graphics terminals. So far, Qume is the only alphanumeric vendor that has announced such a product. Qume's product is called the QVT-511GX, and lists for \$2,995.
- Low-, medium-, and high-resolution add-on boards for personal computers. Such boards are usually compatible with one of IBM's graphics boards. So far, Wyse Technology is the only alphanumeric terminal vendor that has announced such a product. Wyse's product is called the WY-700, and its price is \$1,595, including monitor. However, other alphanumeric vendors that sell PCs are expected to enter this market. The competition in this area has become quite intense, with more than 40 vendors currently offering such products. This is today's fastest growing graphics market.

ALPHANUMERIC TERMINAL VENDORS IN THE GRAPHICS ARENA

Looking for additional sales, and in the face of fierce competition in the alphanumeric terminal market, many alphanumeric terminal vendors entered this market.

Alphanumeric Terminal Companies as Part of the Total Market

Table 1 shows the companies that participate in DATAQUEST's Graphics Industry Service (GIS) Segments 1G, 2G, and 3G. Among alphanumeric terminal vendors, only CIE, Intecolor, Qume, and Visual are represented in our data base. According to our 1984 estimates, these were the only companies that had any significant levels of graphics terminal shipments.

Table 1

GRAPHICS TERMINALS 1984 U.S. SHIPMENTS BY MANUFACTURER MONOCHROME AND COLOR UNITS

	S	egments			
	1G:	2G :			
	Data	Concept	3G :	A11	Market
Company	<u>Conversion</u>	<u>Design</u>	<u>Imaging</u>	Segments	<u>Share</u>
Adage	0	1,000	300	1,300	1.3%
Advanced Electronics Design	200	285	15	500	0.5
Aydin Controls	225	160	25	410	0.4
California Computer Products	60	1,400	0	1,460	1.5
Chromatics	250	250	0	500	0.5
CIE Terminals	800	0	0	800	0.8
Convergent Technologies	700	0	0	700	0.7
Colorgraphic Communications	490	0	0	490	0.5
Data General	500	1,300	0	1,800	1.8
Digital Equipment	38,600	0	0	38,600	38.4
Envision	600	100	0	700	0.7
Genisco	363	403	108	874	0.9
GraphOn	1,250	1,250	0	2,500	2.5
Hewlett-Packard	11,400	0	0	11,400	11.3
International Business Machines	0	3,200	0	3,200	3.2
ID Systems	600	0	0	600	0.6
Industrial Data Terminals	300	300	0	600	0.6
Intecolor	1,350	200	0	1,550	1.5
Lexidata	110	1,775	40	1,925	1.9
Megatek	60	940	0	1,000	1.0
Modgraph	250	2,200	0	2,450	2.4
Psitech	525	0	0	525	0.5
Qume	1,050	0	0	1,050	1.0
Rantek	250	450	75	775	0.8
Raster Technologies	300	350	150	800	0.8
Seiko Instruments U.S.A.	400	600	0	1,000	1.0
Selanar	800	800	0	1,600	1.6
Tektronix	6,700	6,900	0	13,600	13.5
Visual Technology	3,000	100	0	3,100	3.1
Others*	2,105	2,440	<u>135</u>	4,680	4.7
Total	73,238	26,403	848	100,489	100.0%

*Others include Ann Arbor Terminals, CGX, Evans and Sutherland, Florida Computer Graphics, Jupiter Systems, Lundy Electronics and Systems, Spectragraphics, Terak, Transiac, Vector Automation, and VG Systems.

> Source: DATAQUEST February 1986

Breakdown by Type of Manufacturer

The participants shown in Table 1 for Segment 1G (the low-end segment), can be broken down into the following categories: Graphics Terminal Companies, Computer Systems Vendors, Independent Alphanumeric Terminal Vendors, and an Other category, which includes small shipments from miscellaneous vendors. This breakdown is shown in Table 2, which also shows the percentage of 1984 shipments by type of vendor.

Table 2

GRAPHICS TERMINALS 1984 U.S SHIPMENTS BY TYPE OF MANUFACTURER

<u>Shipments</u>	<u>Units</u>	Share of Total:
Graphics Terminal Companies	13,733	18.7%
Computer Systems Vendors	51,200	69.9
Independent Alphanumeric Terminal Vendors (CIE, Intecolor,	6 000	
Qume, and visual)	6,200	8.5
Others -	2,105	9
Total Graphics Terminals Shipped	73,238	100.0%

Source: DATAQUEST February 1986

Independent Alphanumeric Terminal Vendors and Their Products

Table 3 shows all independent alphanumeric terminal vendors with graphics terminals, irrespective of their 1984 shipment levels. The table also includes some important features of their products, such as: screen resolution, compatibility, availability of color, and whether it is retrofitted with an add-on graphics board, or whether it is a single-board design.

We attribute the bleak performance of most vendors shown in Table 3 to: inadequate product performance, and unsuitable distribution channels. We will examine these and other issues in this section.

Table 3

INDEPENDENT ALPHANUMERIC TERMINAL VENDORS IN THE LOW-END GRAPHICS TERMINAL MARKET

			Comp	atib	<u>ility</u>				
			Tektro	<u>nix</u>	Digital			esolutio	n* _
Vendor	<u>Retrofit</u>	Integrated	<u>40XX 4</u>	1XX	Regis	<u>Color</u>	Low	Medium	<u>High</u>
ADDS/Datatype	x		х				x		
Beehive	x		X				х		
Ann Arbor	х	X	X				x	х	
CIE Terminals	X		Х			X	X	х	
ESPRIT	X		Х				х		
Lanpar	x		X				X		
Liberty	X		х				X		
Lear Siegler		x	х			X	х	x	
Microterm	х		X		x		х		
Qume	x	x	Х	X	x		х	х	
TAB	х		х				х		
Telerey	х		Х				x		
TeleVideo	x		X				X		
Visual	X	x	Х			X	x	х	

*Resolution: Low = Below 640 by 480 pixels Medium = Below 1,024 by 780 pixels High = At or above 1,024 by 780 pixels

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Source: DATAQUEST February 1986

Product Performance

Most vendors started out by adding graphics boards to their alphanumeric terminals (retrofitting). While this is acceptable in some cases (e.g., Digital's VT100 was designed to accommodate add-on boards), the performance of most terminals is badly hampered. Their installation is problematic and the overall quality of emulation and resolution is very limited. Market preference has quickly shifted from such add-on products to single-board, higher speed, performance, and reliability graphics terminals.

Distribution Channels

In many cases, the distribution channels were not experienced in selling graphics. Most alphanumeric terminals distributors are not good at selling graphics terminals. Direct selling by the vendor is costly and more appropriate for vendors selling highly complex products, or computer systems, directly.

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Other Pactors

There are other factors to be considered, which vary from vendor to vendor. TeleVideo, for example, has not been very aggressive with its graphics products because of the relatively small size of Segment 1G, compared to the alphanumeric terminal market.

Other companies such as Visual, Beehive, and Liberty could have done far better, but they were distracted by other concerns in their overall business and, at least temporarily, lost focus in graphics.

Lear Siegler has only recently entered the market with its color graphics products. Thus, it is still too early to measure its success.

We believe that to a certain extent, both Tab Products and CIE Terminals have been held back somewhat by not offering leading-edge, high-resolution products earlier. (Most such vendors have had to acquire products elsewhere, as opposed to developing them in-house. Good graphics technology is a specialty that is difficult to obtain.) In our opinion, Qume has had difficulty in fully establishing its graphics distribution channels and may also have faced unforeseen delays in releasing product to market.

Computer Systems Vendors See Better Results

Digital, which shipped an estimated 2,000 retrofit graphics terminals in 1983, was able to ship more than 38,000 integrated graphics terminals in the United States, just one year later. Digital was able to do this, in our opinion, because it had the advantage of a large customer base already using graphics software running on its own CPUs. The company provided its graphics customers (many of whom were using Tektronix terminals) with a Tektronix-compatible product, at a much lower price than the competition offered. Digital was able to reach these customers with an effective technical sales force.

Hewlett-Packard has also been successful at selling Tektronixcompatible graphics products to its own CPU customer base.

DISTRIBUTION

Graphics devices are shipped through several channels in the United States, including traditional distributors, VARs, OEMs, and vendor direct. Many independent alphanumeric terminal vendors have been badly hampered by using unsuitable distribution channels for their graphics products. The distribution company's past experience in selling graphics products is the key to its future potential. The more popular channels are discussed in the following sections.

Computer Peripherals Distributors

Many types of distributors and VARs sell alphanumeric terminal products in the United States. But most such distributors, especially large industrial types, are not suitable for selling graphics equipment. However, a number of distributors and VARs specialize, to varying degrees, in selling graphics products. Such graphics-oriented distributors tend to be medium to small regional distributors, which usually sell other, perhaps competitive, graphics products.

Such distributors and VARs are very conscious of product features and performance, because better performance terminals help them maintain profit margins. They are also attracted to vendors that have a family of products that fulfill a variety of the users' broad graphics needs; for example, they like to offer hardcopy and input devices in addition to display products.

The OEM Channel

Because they are technology intensive, graphics products are well suited for OEM channels. These products should be adaptable to multiple types of systems without major redesign. Though the OEM customer is usually quite knowledgable in graphics, other members of the decisionmaking group often are not. Thus, vendors should be prepared to educate the OEM in the use of graphics.

Direct Selling

Since direct selling is costly compared to other channels, highly complex or higher-priced products are a better fit for such sales. This channel is more cost-effective for computer system vendors, since they also sell their systems products directly.

Dealers

Dealers, which buy from other distributors, usually are not a major channel for graphics terminal products. The storefront type of dealer, however, has been very successful at selling add-on personal computer graphics boards, such as the Hercules product. For such PC graphics products, the dealer channel (especially for low-end products) should continue to be suitable. Dealers have also started selling highperformance IBM-compatible graphics boards.

The development of effective distribution channels traditionally has served as a barrier to entry in this market. The success of any new graphics product is not probable, unless this important part of the equation is worked out first.

DATAQUEST ANALYSIS

Alphanumeric terminal vendors have had limited success in the graphics terminal market. DATAQUEST believes that this is because of one or more of the following reasons:

- A lack of adequate strategy for this market, resulting in a lack of competitive products and appropriate distribution channels
- Distraction from focus in graphics, due to other priorities
- Stiff competition from both systems vendors and independent graphics terminal companies

We believe that for most alphanumeric terminal vendors, entering the graphics business simply meant making a graphics board "option" available for their alphanumeric terminal. Consequently, many of them did not employ enough expertise in graphics product planning and positioning. This often resulted in a mediocre or inferior product, targeted at the alphanumeric terminal market, rather than the graphics user.

Without superior products and with little visibility in the graphics market, most terminal companies were unable to develop distributors experienced in selling graphics (most such vendors do not sell direct). Graphics terminals (as opposed to alphanumeric terminals, which respond better to pull-through advertising) require an agressive personal sales effort. This includes demonstrations, and user evaluations of the device on their own graphics software.

Marketing graphics products also requires an in-house sales and technical support staff that is well-trained in graphics. This was lacking in many cases. In the past, users looking for inexpensive graphics terminals had few options. Alphanumeric terminals retrofitted with graphics boards had a significant price advantage. But most such products have major performance limitations and are not competitive with the newer graphics terminals. The new graphics terminals are designed from the ground up, to provide good alphanumeric <u>and</u> graphics functionality, at a low price.

Most alphanumeric terminal companies that had little success in retrofitted graphics terminals were unable to make the transition into integrated (single-board) graphics terminals. Such graphics terminals require a bigger investment than add-on boards. Having made a false start with retrofit products, these companies were unwilling to make the move into integrated graphics terminals.

At the low end of the graphics terminal market, Tektronix has not had very significant competition from independent (non-computer systems) vendors. This is why we believe that there is room for vendors that can provide low-priced products. The overall graphics market (which includes graphics products for PCs, as well as terminals beyond Segment 1G) is very large, and still taking shape. Low-end graphics terminals are one entry point into this market. Another is to provide graphics systems or subsystems for PCs. Providing graphics systems solutions--complete with software and peripherals--to vertical applications is another approach.

If alphanumeric terminal vendors wish to be committed to this market, they must provide products that either solve a problem (e.g., low-cost, fast hard copy output), or have a very significant price/performance advantage. In this market, there is still much room for higherperformance graphics products. And, since this continues to be a technology-intensive market, vendors can compete by improving performance, as opposed to just cutting prices.

For alphanumeric terminal vendors, success in the graphics market can only come with the right combination of a technically superior product and the proper distribution channels.

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John Brew Sohail (Sahl) Malik



SAM Code: 1985-1986 Newsletters: January-March 1986-6

ANNUAL SEMICONDUCTOR PROCUREMENT SURVEY: PRELIMINARY RESULTS

INTRODUCT ION

Dataquest

FR a company of The Dun & Bradstreet Corporation

> During last October's Semiconductor Industry Service Conference, the SAM service announced the undertaking of our first annual procurement survey--a major project to gather data and industry trends from the largest electronic manufacturers in the United States.

> The primary purpose of the survey is twofold: to provide important data and trend information to semiconductor manufacturers about their clients and markets; and to provide an opportunity for users to understand where they stand compared to their peers in both their own and other electronic industries.

> At present the survey is still under way; preliminary results, however, were discussed by semiconductor users and manufacturers attending a SAM-sponsored workshop held during DATAQUEST's recent Semiconductor User Information Service conference. This newsletter recaps those results.

THE AUDIENCE

The survey's target audience is manufacturers that comprise the <u>Electronic Business</u> 200, a comprehensive annual listing of the top 200 electronic equipment manufacturers in the United States.

The original list of 200 companies was pared to eliminate semiconductor, PCB, and other types of component manufacturers that do not represent electronic equipment manufacturers that buy semiconductors for use in their systems and subassemblies. After the eliminations, approximately 178 companies remained to be surveyed, with more than 350 purchasing sites having been identified by DATAQUEST as semiconductor

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procurement locations within these companies--divisions and subsidiaries are included and tracked under the parent corporation's name; each location is individually surveyed.

To date, the survey is approximately one-third complete and is running at about a 75 to 80 percent response rate. DATAQUEST is surveying each location directly by telephone and is interviewing individuals who are buyers or purchasing directors, or who are in material or corporate contract management. Figure 1 shows the geographic locations of the respondents.

RESULTS

Technology

On an aggregate basis, users are still cautious about their procurement expectations and expect only mild growth in their 1986 purchases compared to their 1985 purchases. The average estimate was up 5.6 percent. Semiconductor procurement in 1985 had its own characteristics, which we have analyzed by the manufacturers and their respective lines of business. Tables 1, 2, and 3 reflect the average use of semiconductors and ICs, by both technology and product category.

We noted the high use of discrete devices among domestic buyers in the industrial, consumer, and transportation businesses. This is in keeping with our belief that use of VLSI has concentrated in the larger and more traditional sectors, such as data processing, communications, and military markets. OMOS technology, clamored for by the military and transportation markets, has low penetration in these markets with much room for growth. It is interesting to note that in the military sector, bipolar will give way to CMOS, while in transportation, the transition may occur largely from other MOS. Among IC products, we were particularly interested in the relatively low penetration of ASICs and the still heavy use of standard logic. From this view, all of the application markets appear to represent a fairly large replacement market.

DATAQUEST further analyzed the respondents who used ASIC devices compared to those who did not and found that ASIC users were largely data processing, industrial, and military equipment manufacturers. The nonusers were heavily concentrated in the industrial area followed by data processing and communications.

Distribution

The size of these companies and the amount of their procurement was reinforced when we inquired about distribution purchases. As seen in Table 4, the average purchases from distribution was 13 percent. This is somewhat lower than industry averages, which are frequently mentioned as being in the 20 to 25 percent range. Data processing and industrial manufacturers fell in the extremes--data processing is lower than average because of the large companies participating in the market and the size of their contract purchases. The industrial client base tends to be more fragmented--this segment contains many more companies that purchase smaller amounts, so their purchases are often from distribution.

Regional Supplier Base

Survey results indicate that U.S.-based semiconductor manufacturers have 79.9 percent of the purchases made by the purchasing community we surveyed. Japan-based suppliers came in at 18.6 percent while Europe had only 1.5 percent. These results came in answer to the question, "What percentage of your 1985 semiconductor procurement was acquired from a) U.S.-based suppliers, b) Japan-based suppliers, c) European-based suppliers, or d) other. We defined the regional base as the company's country of origin. For example, we defined purchases from TI Japan as U.S., and those from NEC America as Japanese.

We also asked about offshore semiconductor purchases for U.S.-based equipment production (regardless of regional supplier base). The consumer, data processing, and transportation manufacturers did the most procurement offshore for domestic production, using either their own offshore procurement offices, their domestic offices, or agents. Consumer manufacturers made the most use of agents, while DP manufacturers were more likely to have their own offshore offices.

OUTLOOK

ASICs

It is interesting to note the procurement community's knowledge of their individual company's use of ASICs. DATAQUEST inquired about this, knowing that these individuals may not always be the ones who are most knowledgeable about the technology's future use. However, their responses indicate how far ASICs have come in a given company, since procurement in an organization is farther down the pike than is system design.

Overall, 65 percent of the respondents said that there was system design activity contemplating the adoption of ASICs; 35 percent said there was not. Data processing manufacturers were the most active, with 70 percent considering ASICs. Across all lines of business, gate arrays were most frequently mentioned as the design methodology solution.

We also tried to quantify ranges in the number of designs that respondents said their company would do in 1986. Here again, regardless of the number of designs, gate arrays were the most frequently mentioned design methodology, followed by standard cells and full custom. PLDs were selected least.

Key Procurement Issues

We also asked what major procurement issues the respondents were facing in 1986 other than the usual issues like price and availability. Listed below are the ten most frequently mentioned issues and the strategic imperatives that we believe will typify future business relationships between buyers and sellers:

- 1. Quality/reliability
- 2. On-time delivery
- 3. Supply/availability/shortages
- 4. Service/vendor relationships
- 5. JIT/dock-to-stock/inventory control
- 6. Lead times
- 7. Reducing supplier base
- 8. Product obsolescence
- 9. Second sourcing
- 10. Forecasting

DATAQUEST_CONCLUSIONS

Completion of the survey is slated for the end of March, after which we will publish an update of final results. We believe that this survey, which will be conducted annually, will provide more insight into the changing dynamics and evolving trends in this industry. The SAM service is particularly eager to understand these purchasing issues and changes since they complement DATAQUEST'S traditional perspective on the semiconductor manufacturing community. We look forward to the survey's next iteration and invite further questions and comments from our clients regarding information that they would like us to gather.

Anthea C. Stratigos

Figure 1

PROCUREMENT SURVEY AUDIENCE



Source: DATAQUEST March 1986

Table 1

1985 PROCUREMENT SEMICONDUCTOR MIX (Percent of Total)

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Application				
Market	<u>1C</u>	Opto	Discrete	Total
Data Processing	87%	48	98	100%
Communications	848	38	13%	100%
Industrial	698	6%	25%	100%
Consumer	76%	28	22%	100%
Military	86%	28	12%	100%
Transportation	728	78	21%	100%

Source: DATAQUEST March 1986

Table 2

1985 PROCUREMENT IC TECHNOLOGY MIX (Percent of Total)

Application				
Market	<u>Bipolar</u>	MOS	CMOS	<u>Total</u>
Data Processing	48%	36%	16%	100%
Communications	39%	378	248	100%
Industrial	38%	328	30%	100%
Consumer	28	338	65 %	100%
Military	52%	398	98	100%
Fransportation	29%	68%	38	100%

Table 3

1985 PROCUREMENT IC PRODUCT MIX (Percent of Total)

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Application						
Market	Memory	Micro	Logic	ASIC	<u>Linear</u>	<u>Total</u>
Data Processing	32%	198	288	11%	10%	100%
Communications	18%	10%	538 -	38	16%	100%
Industrial	31%	128	33%	88	16%	100%
Consumer	348	88	398	13%	68	100%
Military	22%	248	45%	28	-78	100%
Transportation*				_		

*Sample too limited; detail available after completion of survey.

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Source: DATAQUEST March 1986

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Table 4

1985 PROCUREMENT DISTRIBUTION PURCHASES

Total Distribution Purchases	13%
Distribution Purchases by Application Market	
Data Processing	114
Communications	138
Industrial	324
Consumer	234
Military	15%
Transportation	0%

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Source: DATAQUEST March 1986

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: March 1986-7

SUN MICROSYSTEMS INTRODUCES LOW-END TECHNICAL WORKSTATION PUSHING SYSTEM AND MEMORY PRICES TO NEW LOW

EXECUTIVE SUMMARY

Sandwiched between the Digital Equipment VAXstation II/GPX and the IBM PC RT announcements, Sun Microsystems (Mountain View, California) recently introduced two low-end 68020-based technical workstations--the Sun 3/50M and Sun 3/52M priced at \$7,900 and \$13,900, respectively. The 3/50M is a diskless node, whereas the 3/52M is a full standalone system. Sun also announced new memory prices that push memory prices to the lowest levels in the industry.

This newsletter examines the products, compares and contrasts them with other recently announced products, and examines their impact on technical applications.

THE NEW SYSTEMS

System Features

The Sun 3/50M and Sun 3/52M offer the following features:

- Run at 1.5 MIPS, 32-bit M68020 microprocessor runs at 15 MHz
- Run Sun Operating System (derived from Berkeley 4.2 version)
- Support for Fortran and Pascal compilers
- Support for up to 4 Mbytes of 270ns RAM memory
- Use built-in VLSI thin Ethernet transceiver
- Support for 19-inch monitor with 1152 x 900, 66HZ, noninterlaced, monochrome graphics display
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- Have optional M68881 floating-point coprocessor
- Support for two RS-423 serial ports
- Have built-in SCSI mass storage host adapter
- Are fully compatible with Sun 3/75, 3/160M, 3/160C, 3/160C workstations; 3/160S and 3/180S file servers; and other members of the Sun 2 family

Significant software enhancements include:

- A multiwindow display manager called SunWindows
- An NFS network file system
- The SunView and SunPro software development tools

Sun_3/50M and Sun 3/52M Differences

Both systems have fundamentally the same architecture, but the Sun 3/50M is designed as a diskless workstation node used on a distributed network such as NFS. This allows users to offload all system filing to a large network-based file server.

The Sun 3/52M is designed as a standalone computer system with support for a 71-Mbyte formatted Winchester disk drive (25 msec. access time at 5-Mbits-per-second transfer rate) and a 60-Mbyte 1/4-inch streaming cartridge tape drive.

At present, Sun's 3/52M products offer the best price/performance in the industry. However, we expect other vendors to announce similar products in the near future.

The Competition

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Table 1 outlines the key features of the Sun 3/52M compared to similar products from its nearest competitors.

Sun 3/52M versus IBM RT

Clearly, the Sun 3/52M is in a different product space than the IBM RT. The 3/52M offers the same CPU performance (1.5 MIPS), four times the memory, nearly twice the storage (71 Mbytes versus 40 Mbytes), and significantly faster graphics performance for \$4,650 less (\$18,550 versus \$13,900). And, while the IBM RT runs at 10,000 vectors per second, the 3/52M runs about 25,000 vectors per second. Furthermore, the Sun 3/52M has a built-in Ethernet network transceiver with distributed file system software, which is included in the price and is fully integrated into the operating system.

Table 1

FEATURE COMPARISON OF SELECTED TECHNICAL WORKSTATIONS

<u>Feature</u>	Apollo DN330	<u>Digital GPX</u>	<u>Sun 3/52M</u>	IBM RT 6151
CPU (MIPS)	1.0	0.9	1.5	1.5
floating Point	Standard	Standard	Optional	Optional
Floating Point Chip	M68881	Proprietary	M68881	Proprietary
Memory (Standard) (Mbytes)	2	3	4	1
(Maximum) (Mbytes)	3	9	4	4
Fixed Disks (Standard	63	71	71	40
(Maximum)	70	213	71	40
flexible Disks (Mbytes)	1.2	None	None	1.2
Streamer Tape (Mbytes)	None	Standard, 95	Standard, 60	None
Networking	Domain Ethernet	Bthernet	Ethernet	PC Net
Support of Network File System	Yes	Yes	Yes	No
Graphics Monitor Format Resolution Type	17 inch 1024 x 800 Monochrome	19 incn 1024 x 864 Monochrome	l9 inch 1152 x 900 Monochrome	1024 x 768 Monochrome
Operating System	AEGIS UNIX	ULTRIX VAX/VMS	UNIX	AIX (UNIX) PC-DOS
Price	\$15,900	\$33,000	\$13,900	\$18,550

Source: DATAQUEST February 1986

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On the other hand, the RT supports a flexible disk, PC-DOS, and can be upgraded to a color system, whereas the 3/52M cannot. The new IBM RT is expected to trigger a large number of applications to be ported to the UNIX operating system, which will be to Sun's advantage.

Sun 3/52M versus IBM PC AT

The Sun 3/50M and Sun 3/52M offer significant performance for a relatively low price. The Sun 3/52M costs only about \$1,500 more than a similarly configured IBM PC AT that has only one-third the performance and capability.

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The one thing that the Sun systems need to support is IBM PC-DOS. Both the IBM RT and PC AT have an advantage over Sun in applications where PC-DOS environments are important. This is especially important at the low end of the market where many applications currently run on the PC AT. IBM will be the system of choice in applications where PC-DOS is important.

Sun 3/52M versus Digital VAXstation II/GPX

Digital's GPX offering is priced \$21,100 higher than the 3/52M (\$35,000 versus \$13,900). However, the GPX can be expanded upwards more than the Sun 3/52M. It can support up to 9 Mbytes of memory, 213 Mbytes of fixed disk, a 95-Mbyte tape drive, and can be expanded to support color. The Sun 3/52M runs almost 40 percent faster in CPU performance (1.5 MIPS for the 3/52M versus 0.9 MIPS for the GPX).

The GPX systems' standard features include floating point, a 95-Mbyte tape drive, and a four-plane graphics grey-scale coprocessor.

The one thing Digital does have is a large number of application software packages running on the VAX/VMS operating system. With the UNIX operating system, there is significantly less application software available.

Sun 3/52M versus Apollo DN330

The DN330 supports the 16-bit M68000 whereas the Sun 3/5XM supports the faster 32-bit 68020 microprocessor. We expect Apollo to upgrade this processor to the 16-MHz 68020 soon, now that these chips are available. This would match the CPU performance of the DN330 with the Sun 3/5XM.

Sun 3/50M versus Apollo DN330 Diskless Node Configurations

The Apollo DN330 diskless node configuration currently runs at 1 MIPS, supports 2 Mbytes of memory, and is priced at \$15,900. The Sun 3/50M runs at 1.5 MIPS (50 percent faster than the DN330), supports 4 Mbytes of memory (twice as much as the DN330), and is priced at \$7,900 (less than half the price of a DN330).

To remain competitive at price levels less than \$20,000, Apollo will have to respond to Sun's announcement with a similar configuration.

Applications Impact

Technical workstations are used in relatively few technical applications--primarily design automation, CAP, CASE, laboratory, and AI. We expect this announcement to trigger the migration of more applications to Sun workstations, especially in the areas of biotechnology and molecular modeling, artificial intelligence, and CAP. Except for 3D solids modeling, most of the traditional technical workstation applications that run under UNIX will benefit from the high performance and low cost of these systems.

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Memory Prices Reach New Low

Technical workstations use a great deal of memory, especially in graphically intense applications. Until now, high memory prices have significantly limited the technical workstation industry. Sun is now offering memory at \$833 per megabyte, which is a 33 to 45 percent drop in its memory prices from the \$1,500 set in November. In November, Sun reduced its memory prices to \$1,500, which was a 50 percent cut from the original \$3,000 price. Only a few years ago, the memory price on Prime Computer's superminicomputer line was \$45,000 per megabyte. The drop in memory prices is one of the major factors of the drop in system prices and the increased use of graphics.

Summary

Sun is clearly pushing the lower limits of the technical workstation price curve seeking higher volumes at low prices. In 1985, Sun shipped slightly more systems (8,200 units) than the market leader, Apollo (7,600 units). However, Apollo's average selling price was approximately twice that of Sun's (\$40,000 versus Sun's \$19,000). Consequently, Apollo's revenues were twice Sun's revenues (\$290 million versus Sun's \$147 million).

Sun was the number two market leader by revenue, and number one leader by unit shipments in 1985. We expect that these new low-end products will keep Sun on the fast track.

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John Brew Brad Smith

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SAM Code: 1985-1986 Newsletters, March 1986-8

TELECOMMUNICATIONS PLANNING--PAYING ATTENTION TO MARKET FORCES IS VITAL FOR SURVIVAL

SUMMARY

Dataquest

B a company of The Dun & Bradstreet Corporation

> A recent analysis of current quarterly earnings reports for telecommunications companies indicates that more companies are experiencing flat or declining revenues than are enjoying significant revenue increases. The most visible indicator of a company's performance is a comparison of its profits reported in this period with profits reported in last year's comparable reporting period. Many companies' profit reports are alarming; corporate profits for many companies have fallen significantly since the same period last year. Several companies experienced swings of more than \$5 million from previous profits to current losses. One company reported an \$11 million shift on a comparative basis. We believe that this trend of falling profits will continue for many companies before an upswing to increased profits occurs.

> Our quarterly corporate scorecard analyses indicate that companies must establish growth and profit targets that can work to their advantage. We strongly recommend that telecommunications companies continue to monitor the current market forces (prices, profits, costs, competitors, markets, etc.) while devising a business strategy that includes contingency plans for the possibility that revenues and profits don't improve in the short term. We are entering a new period in which each user segment is developing different product and price requirements. A single vendor may no longer be able to meet the expanding and diverging needs of all users. Companies must be positioned to meet their current objectives without panicking under pressure and making short-term decisions at the expense of long-term success.

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UNCONTROLLABLE FACTORS

The year 1985 will long be remembered as the second year after deregulation and a critical year for business growth as a result of the "high-technology slowdown." Deregulation has brought positive and negative results for many companies and individuals as the RBOCs and AT&T have introduced new services, products, and prices based on their own financial objectives. The dust has yet to settle.

The U.S. corporate structure has also taken on a new look as companies trim their overhead expenses to improve profits. We expect further corporate trimming as companies defend themselves from takeovers, close unproductive plants, or write off other assets while reducing management expense.

In spite of the softness, we continue to see unparalleled new product introductions from U.S. and non-U.S. suppliers as technology continues to outdistance the user's ability to digest new products and the functions they provide. The public and private business sectors have held capital equipment expenditures to a low level in 1985. While capital equipment expenditures are tightly controlled, corporate user requirements continue to escalate as new acquisitions of hardware and software are deferred. We expect the spending slowdown to roll over into 1986 as corporate managers continue to watch their own corporate profit situations.

Telecommunications vendors must realize that the industry is passing through turbulent times and that there are market factors that they cannot control, factors that affect their near- and long-term objectives. These factors include:

- Sluggish U.S. economy
- User confusion
- Capital spending reductions
- Excessive trade deficits
- Shortened product life cycles
- Flat or slow primary market segment growth
- Increased competition
- Improved microprocessor designs at lower costs
- Worldwide alliances
- Falling prices
- Supply-driven markets
- Telephone carrier network service offerings and rate changes

In the midst of these negative factors there are some promising indicators that will have some effect on the softness of the hightechnology industry. These positive factors include:

- Improving, although sluggish U.S. economy
- Low interest rates
- Accelerating stock market activity
- Stable dollar abroad
- Low inflation

Vendors should consider all these factors in their planning activities. We believe that the one factor having the greatest impact at this time, other than buyer demand, is falling prices. This phenomenon has the potential to lead many companies into pricing problems that will result in poor profits.

FALLING PRICES

We believe that prices will continue to fall in 1986. Companies must realize that price competition will become more pervasive in some segments and that it will affect both revenues and profits. We believe that companies must design plans to control their costs while setting realistic revenue and profit goals. The telecommunications industry has seen unprecedented layoffs and workweek reductions as a result of the forces influencing change throughout the high-technology industries. The forces leading to falling prices will continue to be major influences in the telecommunications industry.

The combination of deregulation and increased import competition in 1984 is affecting U.S. companies today. U.S. vendors are now adjusting to the effects of these pricing influences. The major international markets such as Great Britain, Italy, and Holland are now beginning to see price decreases as international competitors enter these newly deregulated markets with a host of telecommunications products. Lower prices will be an offensive weapon competitors use to gain market share.

Numerous factors are influencing falling prices, including:

- Competitive pressure
- Overcapacity
- Low price strategy
- Global competition
- Deflation
- New technology introductions

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Competitive Pressure

As new entrants enter established markets, they use lower prices to attract customers and build market share. In response, some established suppliers have decided to fight it out, dollar for dollar, to protect their market positions. These leading companies have determined that they want to compete and have developed strategies to reduce their product costs. These strategies include offshore manufacturing, reduced direct and indirect costs, and contracting out manufacturing activities.

In other cases, we are seeing the leading companies reduce prices before the competitors do, thereby forcing them to follow suit. Offensive and defensive price strategies are being designed to maintain growth goals and market positions. Vendors must be fully aware of their cost and profit goals before implementing offensive or defensive strategies.

To broaden their revenue bases, vendors are seeking new distribution channels. Most sales channels now realize that they themselves need higher margins to compete, so they are demanding 40 and 50 percent discount levels from manufacturers. This is a significant increase from the 30 percent levels being offered less than 18 months ago by some manufacturers. The RBOCs have demanded these same 40 and 50 percent discount levels for their CPE products in order to compete in their markets. DATAQUEST was told by one modem distribution company that it was getting a 60 percent discount from its manufacturer and a five-year product warranty, and it didn't have to stock inventory. These unprecedented discounts affect margins and require that manufacturers fully understand their pretax profit margin objectives.

Some data communications managers have realized that by shopping around for prices, they can obtain bigger discounts. They are playing supplier against supplier to get a better price. This competitive shopping is occurring for PBXs, central office switches, modems, multiplexers, PADs, and PCs. Some users know that a manufacturer's published list price really doesn't mean much in these changing times. DATAQUEST is aware of vendors that are giving their field sales managers limited price discount authority to use in competitive situations. This new practice will become more common as some companies seek customer orders in competitive segments. The old sales adage "I want to be the last one in the door" is truer than ever.

Overcapacity

Substantial manufacturing capacity is available due in part to presoftness manufacturing investments and reduced operations as a result of the softness. Outside the United States, this overcapacity is due to the lack of short-term checks and balances as manufacturers produced high volumes of products with the desire to gain market position. This overcapacity has created excessive inventories for some companies, who have decided to reduce inventory by cutting prices. Many telecommunications companies use global manufacturing operations to support their business objectives. Since excess capacity exists in some plant locations, some companies are taking short-term gains by adding incremental manufacturing activities for certain products that can be sold at significantly lower prices with minimal profit. These vendors are using purchasing economies of scale to generate profit contribution by keeping their manufacturing lines operating. This has created lower prices that established companies have had to meet in order to protect themselves.

Overcapacity can play an important role for companies as the softness disappears and orders increase. Higher profit levels can be achieved when production increases, since direct and indirect manufacturing costs will have been previously reduced to meet company objectives. This streamlined activity will help the companies who made tough decisions early on to reduce their costs.

Low Price Strategy

Some vendors have designed a strategy that calls for selling below cost on certain comparable products with selected high-volume users. This price strategy forces the established company to match prices in order to maintain its relationship with its customers. Once the market hears that customers have received lower prices, others will demand or expect the same treatment. Once this occurs, prices will eventually drop for all companies and profit margins will erode quickly.

Some companies are using this strategy to take market share. No matter what the new price level, a company whose business strategy is to be the lowest-price supplier will always make profits. It will take market share by eroding price and will force other companies to follow suit.

Global Competition

A single supplier can no longer excel in satisfying the expanding and diverging needs of all user segments. The demands of corporate users for integrated telecommunications systems has created joint ventures, technology agreements, alliances, R&D partnerships, and equity positions among the telecommunications companies.

Telecommunications is a worldwide business serving the needs of worldwide users and markets. User demands for products and services are forcing telcommunications carriers (U.S. and foreign) to keep pace with these market demands. Global suppliers are expanding to serve their customers and the telecommunications carriers' product requirements. Companies use joint ventures in combination with other alternatives to achieve their objectives. IBM, which does have alliances, announced in October that it plans to double its European telecommunications products revenues in five years. NEC has been increasing its presence in the United States as a full-service supplier of equipment ranging from data processing computers to CPE products to central office systems. Siemens offers a broad product line from computers to fiber cable to packet switching systems. Siemens just restructured its U.S. operations to better serve its systems and communications activities in the United States. Sperry and Hitachi just announced a development relationship. Global vendors are using top-flight technology, substantial marketing investments, and in-country expertise to expand their international influence and market opportunities.

Major alliances continue to be formed for both offensive and defensive reasons. These strategic alliances are weighted in favor of the larger companies that have joined forces to serve the need for a broad product line and expansive technology base. Alliances include:

- IBM--ROLM, MCI, Bytex, DCA, partnerships in Sweden, Germany, Japan, and Italy
- AT&T--Olivetti, Convergent Technologies, Philips, Amdahl, Tellabs
- Northern Telecom--Digital Equipment Corporation, Sperry
- CIT Alcatel--Philips, Siemens, Olivetti
- Philips--Concord Data, Kyocera, AT&T
- BBN--Racal-Milgo, Olivetti

This list could be expanded many times over to include numerous other vendor alliances. We reiterate our view that strategic alliances will continue to affect markets and prices as these partners analyze attractive market segments and customer requirements.

Deflation

A term we are becoming more familiar with as a result of strong political and economic efforts to control and reduce inflation, <u>deflation</u> refers to an abnormal decline in price levels without an accompanying and equal reduction in operation costs. Prices for many telecommunications products are lower today than they were 12 months ago. Since inflation has been reduced to a low, single-digit percentage (4 percent), manufacturers have not been able to raise product prices to cover increased costs. Significant price increases occurred during the early 1980s because inflation was running over 14 percent annually. Inflation is no longer a problem and prices are holding the line.

The telecommunications industry, like many other high-technology industries, was caught by the market forces that created the current softness. The industry as a whole had been growing more than 13 percent for the past several years. In 1985, however, we estimate that growth was less than 9 percent. Companies were used to higher-than-average growth, which exceeded 30 percent in many instances, before 1985. Vendors developed their business strategies on this anticipated strong growth. Business plans were prepared to meet or exceed industry segment growth and a large portion of budgeted expenses for 1985 included increased wages, expanded organizations, improved distribution channels, and expanded inventories. As the softness expanded and segment growth slowed significantly, many vendors were caught short and unprepared for sales downturn and profit shortfalls that are occurring today.

Deflation means that costs can no longer be passed on to the customer at accelerated rates. Vendors are being forced to cut costs at every level and seek ways to improve their costs. We don't expect this to change and recommend that companies realize that deflation will affect prices.

New Technology Introductions

We have previously stated that users are living through a technology glut. We read and hear about and see numerous new alternatives coming on the market every week. Users are having a difficult time utilizing the capacity of all the equipment they have installed or warehoused. This overcapacity has been created by the lack of applications software or network capacity to provide communications and data base access.

The pace of microtechnology introductions is driving product prices lower while giving the user more operating capacity. Codex's new 2600 modem family offers not only the modem function but also a built-in statistical multiplexer or protocol converter as well as Codex's network management functions. We were recently told about a new statistical multiplexer that will have a 64-Kbps link speed and will interface 16 input channels capable of running at 19.2 Kbps at a price of less than \$2,500. Apple's Macintosh has only \$45 worth of semiconductors in it now versus \$160 worth less than a year ago. Motorola's 68000 processor costs \$6 today versus \$15 a year ago. Memory prices have tumbled to the present level of 25 cents each per thousand RAMs.

We are seeing a new product generation every 18 months. Software is becoming more complex and the critical factor for a product's success or failure. The migration to higher bandwidth and the use of fiber optics is offering new product opportunities for handling voice, data, and a host of data base services through terminals, computers, and television sets.

Users are benefiting from this improved functionality at a lower (or even a higher) price. Since technology changes so quickly, companies are not going to be able to spread themselves too thin trying to cover every market segment. If current products are not profitable, companies must analyze their situations and make business decisions that can maximize their technology expertise with a focus on products backed by excellent support, service, and training.

CONCLUSION

We do not expect any reversal in the trend of falling prices. We believe that vendors must begin to address several key issues in order to maintain their respective market shares or increase their positions. We believe that these key issues are:

- Product differentiation in a crowded market
- Marketing and promotional investments to sustain market visibility in competitive segments
- Service and support resources to convince unsophisticated users that the vendor understands their requirements and can meet them better than anyone else
- Extensive technology base, where applicable, for innovative solutions
- Niche market strategy that takes into consideration all possible competitive entrants and product alternatives
- Realistic revenue forecasts and cost control plans
- Pricing decisions based on the company's best interests not the competitor's
- Training sales personnel to accurately describe a product's functions and benefits

The semiconductor and telecommunications industries have been going through a lot of belt tightening. Tough decisions are being made but they are necessary during these soft times. We understand full well the need to monitor expenses and revenue objectives.

We recommend that management pay close attention to revenue forecasts and order entry bookings into the first quarter. These forecasts must be realistic. Costs must be managed accordingly so that margins will not be severely affected. It currently looks as if business may not get any worse for some companies, but it may not get much better.

We recommend that companies not slash prices to compete if at all possible. Slashing will only cost profits and even a company's existence. Management needs to keep a tight reign on prices and costs with an eye on market forces.

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John Brew William C. Kanupke

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: April-June 1986-**4**

APOLLO INTRODUCES NEW TECHNICAL WORKSTATION PRODUCTS

SUMMARY

Apollo introduced three new technical workstation products and a compute server processor line in response to the flurry of January activities by competitors Digital, IBM, and Sun.

The new workstations and their prices are as follows:

- DN3000--\$9,900 to \$21,400
- DN570--\$29,900 to \$32,900
- DN580--\$43,900

These new Apollo products position the company very well and are expected to be serious competition for all participants in the technical workstation industry. Figure 1 is a photograph of the new systems.

This newsletter examines the products, compares them with newly introduced competitive products, and assesses their impact on technical applications.

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Left (top to bottom): DSP9000, DN580, DN570 Right (top to bottom): DN570, DN3000 with 19-inch monitor, DN3000 with 15-inch monitor

Source: Apollo Computers

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NEW PRODUCTS

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The features of Apollo's new products are listed in Table 1.

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Table 1

APOLLO'S NEW PRODUCT LINE

Features	DN3000	<u>DN570</u>	<u>DN580</u>
Processor Chip	68020	68020	68020
Clock Speed (MHz)	12	16	16
Speed (MIPS)	1.2	1.5	1.5
Operating System	AEGIS MS-DOS DOMAIN/IX*	AEGIS MS-DOS DOMAIN/IX*	AEGIS MS-DOS DOMAIN/IX*
Floating-Point Unit	68881	68881	68881
Floating-Point Accelerator (Option)	No	Yes	Yes
3DGA Graphics Accelerator (Option)	No	No	Yes
Memory (Mbytes)			
Standard Mariana	2	2.	2
	•	10	10
Flexible Disks (Mbytes)	1.2	N/A	N/A
Hard Disks (Mbytes)			
Standard	86	86 or 190	86 or 190
Maximum	172	2,000	2,000
Cartridge Tape (Mbytes)	60	60	60
Network	DOMAIN	DOMAIN	DOMAIN
	Ethernet	Ethernet	Bthernet
I/O Bus .	PC AT 8-slot	Multibus 4-slot	Multibus 4-slot
Graphics			
Dedicated Processor	No	Yes, 3DGA	Yes, 3DGA
Graphics Assist Hardware	Yes	No	No
Resolution & Screen			
1,024 x 800,15", Color	Yes, 60Hz	Yes, 60Hz	No
1,280 x 800, 19", Color	No	Yes, 40Hz	NO No CONO
1,280 x 1,024, 19", COLOF	Yes, 64Hz	No	No.
Color Planes	4	8	8
Colors	16	256	256
Writing Speed (Vectors/Sec.)	6,500	40,000	100,000
Price			
Monochrome	\$9,900-\$16,400		
Color	\$14,900-\$21,400	\$29,900-\$32,900	\$43,900
N/A = Not Available			

*Apollo's UNIX operating system

Source: Apollo Computers

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DN3000

Apollo says that the DN3000 is "the machine to end the personal power shortage" by offering 1.2-million-instructions-per-second (MIPS) processing power, which is significantly above that of the PC AT. This system redefines the low-end color workstation business by breaking the \$20,000 price barrier--a sensitive pricing area for engineer buyers. A monochrome version is priced starting at \$9,900, which is directly competitive with the price of the Sun 3/52M.

A Personal Computer/Technical Workstation Bridge

Apollo calls the DN3000 series a personal workstation that is designed to bridge the gap between personal computers and technical workstations by running MS-DOS and AEGIS operating systems and supporting the PC AT I/O bus and peripherals. Apollo will offer a coprocessor board that will allow personal computer programs to be run in a display window concurrently with DOMAIN applications. MS-DOS and AEGIS files can be mixed on the same disk. This dual operating system strategy is designed to attract personal computer users who have run out of processing power.

Additionally, the DN3000 supports the PC AT bus structure, so all the peripherals developed to run on the PC AT will also run on the DN3000. However, the user or OEM must develop the software drivers, and the PC AT disk peripherals must reside outside the DN3000 chassis.

Performance

This system is four times as fast as the older DN300, which this product replaces. The graphics performance is equivalent to that of the older, previously high-end DN660, which was priced above \$45,000. The processor is an M68020 that runs at 12 MHz, not 16 MHz as the DN570 and DN580 do. It was necessary to slow the processor clock rate to accommodate the PC AT bus structure. This affects the graphics and computational performance slightly.

Applications

Apollo is targeting:

- Low-end electrical and mechanical CAD and CAE
- Computer-aided software engineering (CASE)
- Artificial intelligence
- Computer-aided publishing (CAP)
- Miscellaneous applications for the technical professional

The 4-Mbyte memory capability is necessary to penetrate the artificial intelligence application, where programs are typically large. The 19-inch, high-resolution, monochrome screen capability is ideally suited to the CASE and CAP markets, which need to display large diagrams or full pages of text.

With the ability to run MS-DOS applications in a display window and store MS-DOS files on the same disk as AEGIS files, Apollo has addressed the needs of engineers who often use word processing, spreadsheets, and data bases on the IBM PC AT. By supporting both operating systems and the PC AT bus structure, the DN3000 does away with the need for an engineer to have two computers.

DN3000 versus IBM RT PC

The DN3000 is Apollo's answer to the IBM RT PC, and it offers better price/performance and features. For example, the DN3000 has four times the floating-point performance (200,000 versus 800,000 whetstones per second), supports larger disks, and displays two times the number of pixels in color and three times the number of pixels in monochrome. Additionally, the price of a similarly configured DN3000 monochrome system is \$4,000 less than that of the monochrome RT PC, and the price of a color system is \$7,500 less than that of a color RT PC, not to mention the fact that the Apollo systems contain integrated networking and also support more than 500 applications running on AEGIS and UNIX.

Apollo has shipped approximately 100 systems so far and anticipates shipments of 5,000 to 8,000 in 1986. We believe that the DN3000 will be one of the most significant technical workstations of 1986 and will most likely trigger responses from other workstation vendors, especially Sun. Figure 2 illustrates the DN3000 series architecture.

DN570 and DN580

The DN570 and DN580 systems are midrange and high-end technical workstations. The floating-point performance of these systems with the FPX accelerator is three time as fast as the M68881 processor alone.

The DN570 is priced about \$12,000 lower than the DN580 and offers about 40 percent (40,000 vectors per second) of the graphics writing speed of the DN580. The company claims that the graphics performance of the DN580 system is as follows:

- Greater than 100,000 3-D floating-point transformed and clipped vectors per second with 3DGA option
- Up to 100,000 2-D integer transformed and clipped vectors per second with the DN580's basic display processor
- Up to 25,000 Gouraud-shaded polygons per second

The bit-block transfers and 3-D vector generation are done at near real-time speeds using the 3DGA real-time graphics processor option for fast manipulation of complex objects.

Figure 2



DN3000 SERIES ARCHITECTURAL DIAGRAM

Source: Apollo Computers

Additionally, the 3DGA options can execute graphics instructions directly from graphics metafiles stored in the system's virtual memory--not from a dedicated display list buffer as do traditional graphics systems. This unique capability brings virtual memory techniques to graphics processing, enabling a graphics object to be created and manipulated without regard for the size of the display list buffer.

Applications

Apollo is targeting mechanical CAD, electronic design automation, architectural-engineering-construction, and artificial intelligence applications. We believe that these systems will give 3-D solid modeling graphics applications a hardware platform not previously available, perhaps triggering a more widespread use of 3-D solid modeling in mechanical CAD and animation.

DN580 versus Digital's Color VAXstation II/GPX

The DN580 has substantially higher vector writing speeds and about 40 percent more processing power than the VAXstation II/GPX, which is priced at \$16,500 higher. We expect Digital to lower the GPX price in response to Apollo's new products.

DSP9000 Computation Server

Apollo also announced a computation server processor line that connects to the DOMAIN network to off-load computationally intensive applications to a fast processor. This product line is the Alliant FX/1 and FX/8, which Apollo is buying as an OEM from Alliant. See our newsletter "Alliant Computer's FX/Series Redefines Technical Superminicomputer Price/Performance Curve," dated December 2, 1985, for an in-depth analysis of Alliant's product line.

DATAQUEST CONCLUSIONS

Apollo and Sun have paved the way with technical workstations in engineering markets. Their success has caught the eye of large computer companies and competitive pressures are increasing as more vendors introduce products. Two years ago, Hewlett-Packard was the only traditional computer company in the technical workstation segment. Today, Data General, Digital, Harris, and IBM are included, and announcements are expected from others.

Processors

To date, the majority of the technical workstation manufacturers have converted from the 68000 to the full-32-bit 68020 microprocessor. Apollo has apparently opted to stop making its own processor design for high-end systems and to utilize computation servers such as Alliant's FX/8 in its place. In previous processor designs, much of the processing power was used for graphics manipulation and processing. The new graphics chips off-load these tasks from the central processor and free more computation cycles for computation.

Impact on Applications

Design Automation

The graphics enhancements will address many applications not previously accessible by Apollo. These include solid modeling, large finite-element mesh displays, and image processing. The processing power of the DN5X0 is 50 percent faster than that of the VAX 11/780 superminicomputer on which many engineering applications are currently run. Additionally, the 16-Mbyte memory capability allows a huge program to reside entirely in the system memory and eliminates the need for system paging to disk.

Computer-Aided Publishing

The computer-aided publishing market needs a low-cost (less than \$10,000) technical workstation with high resolution. Additionally, the combined graphics drawing and full-page text display capability suits this application well. The monochrome DN3000 should sell well into this application.

Artificial Intelligence

The artificial intelligence (AI) application is currently in a state of transition with respect to the type of system the software is implemented on. In the past, specialized systems, known collectively as LISP machines, such as those from LMI, Xerox, and Symbolics, were used to develop and run AI applications. As the market develops and AI software is refined, the market need is shifting toward technical workstations to run applications after they have been developed on a LISP machine.

AI applications frequently need low-cost systems with large screens, good monochrome graphics performance, huge processing and memory capabilities, demand-paged virtual memory architectures, and networking capability to access other programs. With 1.5-MIPS processing capability and the support of up to 16 Mbytes of memory, the new Apollo systems fulfill the needs of the AI application. A number of AI applications are expected to be sold on Apollo systems.

Apollo continues to introduce innovative technical workstations. The DN3000 offers new price/performance measures to the low end of the market, and we believe that it will become the standard low-end color system against which all others will be measured. The midrange DN570 and high-end DN580 products will offer strong competition for all vendors. The DN580 is Apollo's machine to penetrate the high end of the technical workstation market as it develops with new solid modeling applications.

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John Brew Brad Smith



RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: April-June 1986-10

ELECTRONIC EQUIPMENT UPDATE: A FINAL REVIEW OF 1985 POINTS TO MODERATE GROWTH AHEAD

INTRODUCTION

Year-end results compiled by DATAQUEST's technology services indicate that electronic equipment production grew more slowly in 1985 than previously believed. The disappointing results for 1985 were primarily caused by the following:

- Lower-than-anticipated computer sales
- Restricted capital spending associated with the sluggish growth of the U.S. economy

The 9.2 percent increase registered last year was substantially below the 16.3 percent improvement of 1984.

For 1986, DATAQUEST forecasts 10.3 percent growth for electronic equipment, with a CAGR (compound annual growth rate) of 8.6 percent from 1986 through 1990. The economy is now experiencing accelerated growth, in large part because of lower energy costs. This should help push capital spending above last year's totals. However, the slump in the computer industry continued through the first quarter of 1986 and will be the primary reason why electronic equipment growth will be moderate in 1986.

Figure 1 shows the historical relationship (1970 through 1985) between semiconductor consumption and electronic equipment production and includes our forecast through 1990.

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Figure 1

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Source: DATAQUEST April 1986

OUTLOOK FOR APPLICATION MARKETS

Table 1 contains our updated revenue forecast for North American electronic equipment by application market. The ensuing discussion highlights the final results of 1985 and discuss by end market the outlook for 1986 through 1990.

Table 1

NORTH AMERICAN ELECTRONIC EQUIPMENT FORECAST (Millions of Dollars)

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Segment	1983	1984	1985	1986	1987	1968	1989	1990	CAGR 83-84	CAGR 84-85	CAGR 86-90
			—	—		_	—				—
Computers	\$31, 286	\$41.873	\$46.587	\$59.574	\$55.373	\$63,170	\$66.985	\$68,725	33.27	11.85	8.07
Data Storage Subsystems	13.582	14.573	16,107	18.253	29,232	29.772	21.351	21.775	7.32	10.52	4.57
Terminole	4.354	4.940	4.617	5,009	5,195	5.698	6.123	6.592	13.5%	-6.57	7.17
Innut /Dutout	7.724	8,168	7.126	8.587	10.659	11.319	12.968	12.367	5.85	-12.8%	9.42
Dedicated Systems	5,218	5,985	5,943	5,885	6,298	6.979	7,970	8,600	14.7%	-0.7%	9.97
Subtotal	\$62,164	\$75,339	\$80,380	\$88,367	\$97,156	\$107,937	\$114,417	\$117,998	21.2%	6.7%	7.5%
COMUNICATIONS											
Customer Premises	\$10,042	\$11,866	\$13,003	\$13,998	\$15,473	\$17.421	\$19,562	\$21,548	18.25	9.67	11.47
Public Telecommunications	4,956	5,697	6.273	6,797	7,166	7,438	7,993	8,584	14.9%	10.17	6.97
Redio	3,429	4,207	4,954	5,748	6,613	7.578	6,830	10,140	22.7%	17.77	15.27
Broadcast and Studio	1,464	1,449	1,666	2,985	2.533	2.849	3,461	4,286	-1.65	15.67	19.7%
Other	2,322	2,558	2,720	3,136	3,648	4, 104	4,692	5,174	10, 17	6.37	13.3%
Subtotal	\$22,214	\$25,777	\$28,616	\$31,763	\$35,433	\$39,389	\$44,538	\$49,732	16.0%	11,655	11.9%
INDUSTRIAL											
Security/Energy Mgmt.	\$1,997	\$2,135	\$2,237	\$2,464	\$2,654	\$2,768	\$2.872	\$3,065	6.97	4.87	5.6%
Manu. Sys./Instrumentation	15,285	17,146	16,912	20,191	23,189	25,596	27,055	29,313	12.27	5,17	9.87
Robot Systems	224	428	622	739	968	1,249	1,453	1,928	87.5%	48. 17	27.1%
Medical Equipment	5,342	5,822	6,463	7,030	7,699	8,535	9,520	10,430	9.07	11.65	10.4%
Connercial Aviation	1,764	1,892	2,026	2,225	2,431	2,589	2,614	2,857	7.37	7.17	6.4%
Other	4,649	4.927	5,498	6,124	7,100	7,870	8,746	9,636	6.3%	11.65	12.0%
Subtotal	\$29,261	\$32,342	\$34,859	\$38,773	\$14,040	\$48,528	\$52,259	\$57,229	10.5%	7 87	10.2%
CONSIMER											
Audio	\$270	\$248	\$255	\$283	\$324	\$332	\$369	\$492	-8.1%	2.8%	9.2%
Video	3,938	4,400	4,618	4,656	5,127	5,291	5,647	6,254	11.7%	5.6%	7.7%
Personal Electronics	1,048	513	600	54 1	729	756	794	801	-51.1%	17.05	5.7%
Applifances	7,899	9,008	9,792	10,373	11,068	11,522	12.098	12,891	14.07	8.7%	5.8%
Other	634	778	. 976	1,059	1,116	1,167	1,218	1,270	22.87	25.5	4.6%
Subtotal	\$13,789	\$14,947	\$16,241	\$17,011	\$18,355	\$19,068	\$20,117	\$21,618	8.4%	8.7%	6.27
MILITARY	\$38,500	\$43,595	\$49,246	\$54,800	\$61,388	\$65,192	\$6 8,969	\$72,746	13.27	13.65	7 .57.
TRANSFORTATION	\$5,547	\$7,441	\$8,480	\$9,580	\$10,809	\$11,799	\$13.812	\$15,050	34.17	14.65	12.07
TOTAL EQUIPMENT	\$171,475	\$199,441	\$217.822	\$240.235	\$267,181	\$291.912	\$314,112	\$334,373	16.3%	9.254	8.67

Source: DATAQUEST April 1986

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Data Processing

1985

While a few segments of the computer industry fared well, especially midsize systems (higher-end PCs to small department systems), 1985 was a sobering year for much of this sector. The primary reasons include:

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- Confusion in the PC marketplace
- Anticipation of new product introductions (causing postponement of purchases) -- from personal computers to mainframes
- Longer planning cycles as users carefully plan for information network needs
- Emerging competition from Japanese and Korean manafacturers

The effects of poor computer sales can be seen throughout the data processing industry. Other product areas that had little or no revenue growth because of slow computer sales included:

- Alphanumeric terminals
- Printers
- Word processers

Outlook

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Through 1990, the forecast remains strongest for North American manufacturers of high-end personal computers through minicomputers; the workgroup environment will be the focus of much of the future competition, as companies are pushing to network their office computing equipment. Through 1987, revenue growth will be moderate compared with historical rates, primarily because of increased competition and price pressure. IBM's recent price slashing on all its PCs is an indication of this trend.

The terminal industry appears to be entering a more mature phase, with virtually flat revenue growth forecast for all alphanumeric terminal segments. However, the IBM RT PC and other multiuser products are expected to increase sales slightly in late 1986 and 1987.

Printer revenue growth is expected to mirror computer sales. Nonimpact technologies (thermal-transfer and ink-jet) are forecast to gain a majority of the new growth, replacing the older dot-matrix printers.

The copying and duplicating market will increasingly be dominated by the Japanese. While numerous North American companies sell copiers, few still manufacture their own products. The fastest-growing segment, the personal copiers, will continue to be a Japanese stronghold.

Communications

<u>1985</u>

The slowdown in computer sales was also felt in the communications sector. Although growth remained strong in 1985, anticipated levels of increase were not reached primarily because of lower revenues in:

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Local area networks (LANs)

Modems

Forecasts for LANs have dropped fairly dramatically. While strong growth rates are still anticipated in some segments, such as the PC segment, the LAN market has yet to explode as most had anticipated. In addition, anticipation of the IBM Token-Ring announcement prompted many users to delay buying. Although the product was announced in October 1985, shipping will not begin until this quarter.

For personal computer modems, 1985 was not the year we had anticipated. Besides slow computer sales, the following affected revenues:

- Continued price erosion in the 300-bps and 1,200-bps segments
- User confusion relating to new higher-speed products (2,400 bps) and related error-checking protocols

Shipments of 2,400-bps modems began to increase during the second half of 1985 and will continue to accelerate during 1986. Nevertheless, the market is still dominated by 1,200-bps modems.

<u>Outlook</u>

Despite the troubles in the past year, the communications segment should remain very strong in the years to come. The forecast CAGR of 11.9 percent through 1990 will be fueled by development of the ISDN (integrated services digital network), which is expected to enhance data communications and spur general market growth. Product areas that will benefit from the ISDN in the long term include:

- T-1 multiplexers
- DSUs/CSUs (data service units/channel service units)
- LANs
- Packet switches

The ISDN will likely have an adverse long-term impact on the following markets:

- Modems
- Statistical multiplexers
- Data PBXs

Industrial

<u>1985</u>

In addition to a sluggish economy, the modest growth of 7.8 percent in industrial electronics registered in 1986 can be attributed to the following:

- Key areas of semiconductor production and automated test equipment suffered badly in 1985, following the course of the semiconductor industry.
- Robotic industry enthusiasm was tempered as more realistic expectations for applications and economic practicality were realized.

Outlook

The robust American economy of 1986 will help foster moderate to strong growth in the next few years for the industrial electronics sector. High growth opportunities will continue to be found in many types of process control instrumentation, selected robotic applications, and laser system equipment.

Consumer

1985

Production of consumer electronic equipment rose a healthy 8.7 percent in 1985. While Japanese VCRs and compact disk players were the fastest-growing products sold in the United States, steady revenues in appliances (such as microwave ovens) helped the consumer market outperform its 1984 production growth.

Outlook

While traditionally strong areas for North American manufacturers (such as appliances) will see moderate growth, the big opportunity markets will continue to be dominated by Japanese companies. DATAQUEST forecasts a 6.2 percent CAGR in North American consumer electronic equipment production through 1990. High-growth products that are expected to keep the consumer market healthy for Japanese exports include:

- Compact disk players
- VCRs
- Stereo and projection televisions
- HDTV (high-definition television)

Although there is a push to move production facilities to the United States and Europe, the majority of equipment will still be manufactured in the Far East.

Military

<u>1985</u>

Military electronic equipment continued to be a very strong market as revenues advanced 13.0 percent in 1985, slightly below the 13.2 percent increase of 1984. The expanding fields of space-related research and command, control, communications, and intelligence ($C^{3}I$) systems showed remarkable growth in 1985 and are expected to continue to outpace the defense industry growth in the years ahead.

<u>Outlook</u>

Forecasts for military electronics have dropped slightly, reflecting mounting pressure on the government to control spending, with the military being an inevitable target. The strong revenue growth in 1985 (13.0 percent) will slow in the upcoming years, although the pervasiveness of electronics in military equipment will continue to increase. DATAQUEST forecasts a CAGR of 7.3 percent for military electronic equipment growth through 1990.

Transportation

1985

Auto and truck production reached the highest level since 1979 in both the United States and Canada, helping electronic systems to grow 14.0 percent in 1985. Estimates for North American car and truck production last year stand at 13.38 million vehicles, a 4.3 percent improvement over 1984.

Outlook

The transportation sector continues to be one area that we believe will remain strong. The electronic value of new cars is expected to reach \$900 by 1990. Driver information, body control, and safety and convenience applications should keep this segment growing at a CAGR of 12.0 percent through 1990.

Alliances between automotive participants and semiconductor houses point to the increased awareness of this stable application market. An example is a recent (March 1986) joint adventure between Bosch and Intel to address the needs of communication between different electronic systems in a car.

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DATAQUEST CONCLUSIONS

As the semiconductor industry continues to strengthen as forecast, the impetus behind the recovery appears to be the replenishing of inventories rather than a resurgence in equipment production. However, with favorable economic conditions foreseen, North American electronic equipment production is expected to increase 10.3 percent in 1986, and 11.2 percent in 1987. This modest growth should help create increased demand for the semiconductor industry over the next two years.

For future electronic equipment growth to match historical rates, the difference will be made up through now emerging products and markets. Promising new areas such as HDTV, stereo television, smart cards, graphics display applications, and ISDN may provide the necessary boost for growth in electronic equipment production. Semiconductor manufacturers will need to identify these emerging markets and work with equipment producers to capture their share of the future electronics market.

John Brew

RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: April-June 1986-11

1986 OPPORTUNITIES--THE HIGH-RESOLUTION MARKET

High-resolution dot matrix printers represent the major market growth potential for impact printing technology because of their inherent advantages:

- Integrated text and graphics capability combined with letter-quality output
- Products affordable for individuals and small businesses with pricing below alternative nonimpact technologies
- Significantly improved print quality/speed compared to the traditional 9-wire matrix printers

High-resolution printers rapidly gained market acceptance in 1985. DATAQUEST estimates that 210,000 high-resolution printers were shipped in 1985, and shipments are expected to more than double in 1986. This newsletter will highlight some of the emerging trends in this marketplace, including ribbon improvements and color availability.

BACKGROUND

Dataquest

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> DATAQUEST defines high-resolution printers as those that have 18 or more print elements. Epson, Fujitsu, Toshiba, and others initially developed 24-wire printers to accommodate the Kanji character set for the Japanese market. Most 24-wire printheads are manufactured by Japanese companies, while 18-wire printheads are manufactured by U.S. or European companies such as Genicom, Dataproducts, Anadex, Newbury Data, and, most recently, IBM. For a complete reference list of 18- and 24-wire printers, refer to Table 1.

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18-Wire versus 24-Wire Printheads

Many manufacturers in the printer industry closely examine each significant market event in search of an evolving single universal standard. Recent examples of multiple standards include:

- Page description languages--Postcript, Interpress, and VDI
- Page printer resolutions--240 dpi and 300 dpi
- High-resolution printers--18 needles and 24 needles

DATAQUEST believes that, for the examples cited, each alternative has its own advantages in different applications and environments. Specifically, parallels can be drawn between page printer and high-resolution printer densities.

IBM has developed software support for its 240-dpi products over several years, while most of the independent software vendors support the popular 300 dpi as well. Most of the 18-wire and some of the early 24-wire needle printers emulated the well-established 9-wire printers in graphics modes. By late 1985, many of the leading software products offered support for modern 24-needle graphics. DATAQUEST believes that the combination of established software support and the ever-growing base of new price/performance competitive 24-element printers are adequate evidence of an industry-developed de facto standard.

If the next generation of high-resolution impact dot matrix printers from IBM is based upon 18-needle printheads, DATAQUEST recognizes that-similar to the 240 dots/inch issue--18-needle graphics will be supported also. In the event IBM announces 24-needle products, it is doubtful that 18-needle graphic printers will ever become more than emulators of 9-needle printers.

RIBBONS

While high-resolution printers offer good print quality, the ribbon life and intensity of the printed material leaves much to be desired. Users of dot matrix printers historically have been confined to fabric ribbons. Recent cooperative developments between printer manufacturers and ribbon suppliers have resulted in print quality improvements. The new ribbons for the Epson LQ-800 and LQ-1000 appear to be made of a much denser fabric, which is specifically designed for the fine wire printheads. (The ribbons are not recommended for Epson's other product offerings.) NEC introduced an innovative multistrike film ribbon for the PSXL. DATAQUEST expects to see more printer manufacturers working with ribbon manufacturers to achieve further improvements in document quality.

THE WONDERS OF COLOR

While color enhances the information value of high-resolution graphics, the color market is still not well established. Manufacturers are offering more color features, but the market acceptance has been less than overwhelming. DATAQUEST anticipates that acceptance will improve as more software support and color copiers become available. Effective color presentation graphics can now be made with improved transparency material. Two companies, Arkwright and Folex, are supplying textured transparencies that tend to leave fewer voids than the traditional smooth transparencies, resulting in higher-quality graphics.

DATAQUEST ANALYSIS

DATAQUEST believes that 1986 offers the potential to be a strong year for the high-resolution market due to:

- New products offered by suppliers with well-developed distribution channels
- Color capabilities available
- Breadth of offerings, including both wide and narrow carriage printers at competitive prices.
- Pricing currently ranging from \$699 to more than \$2,000 (DATAQUEST anticipates that by Spring Comdex, printers will be available with prices ranging from less than \$600 to approximately \$1,500.)

The printer market price/performance ratios have been improving between 25 percent and 35 percent per year. For a given price band, draft speeds and basic features (such as graphics and color) are now approaching optimal values. Paper handling and quiet operation continue to improve. We believe that in 1986, the print quality/speed ratio will receive the most attention, both in terms of correspondence text and higher-resolution graphics. For the business workstation printer (\$500 and up), a trend toward incorporation of high-resolution printheads The higher-value printers (more than \$1,000) appears likely. are expected to include more features such as paper handling, higher duty cycles, greater font flexibility, and possibly graphics post processing These controllers will essentially be variations of controllers. vector-raster converters to speed up high-resolution graphics processing and/or support integrated text/graphics documents.

In 1985, more than 85 percent of the high-resolution printers were delivered through the classical distributor/retail channels to business users. DATAQUEST believes that the channel mix will be similar for 1986--high-resolution printers will be an expected element in the breadth of line offerings to retailers. However, a channel shift could occur if a major printer supplier that uses OEMs to distribute its products, such as Apple Computer, decides to enter the market. DATAQUEST believes that the essential market ingredients--technology, price, supplies, software, distribution, and user-perceived value--will be supported by several major participants to develop this 1986 market opportunity.

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John Brew Susan Ellenberger David Glidewell ş.

Table 1

				Number of	
Company/Model	Speed	<u>Columns</u>	Price	<u>Pins</u>	Comments
AMT					
Office Printer	250/100/45	132	\$2,195	18	
Anadex					
WP6000	230/125	132	\$2,295	18	
Brother					
2024L	160/80	136	\$1,295	24	
Centronics					
240	160/80	136	\$1,495	24	
358	. 400/100	132	\$2,895	18	Color
C. Itoh					
24LQ	200/133/67	136	\$1,299	24	
1570P	180/130	136	\$1,595	24	
Dataproducts					
8070	400/200/75	132	\$1,999	18	
6072	400/300/100	132	\$2,099	18	Color
Epson					
LQ-800*	180/60	80	\$ 799	24	
LQ-1000*	180/60	136	\$ 995	24	
LQ-1500	200/67	136	\$1,295	24	Price does not include interface
Pujitsu					
DL2400*	180/60	136	\$1,195	24	Dual interface
DotMax 24	240/80	136	\$1,495	24	
DotMax 24C	240/80	136	\$1,695	24	Color
Genicom					
1020*	200/100	136	\$ 899	18	
1025*	200/100	8 0	\$ 699	18	
3304	300/100	136	\$2,490	18	
3320	300/180	136	\$2,395	18	
3400	400	136	\$2,450	18	
3404	400/100	136	\$2,650	19	
3410	400/100	136	\$2,450	18	
3530	400/100	136	\$4,270	18	
3540	400/100	136	\$4,240	18	•
IBM					
4224 Model 102*	400/200/100	132	\$6,000	18	
4224 Model 1E2*	400/200/100	132	\$6,500	18	Expanded storage
4224 Model 1C2*	400/200/100	132	\$6,700	18	Expanded storage and color
JDL	•				
JDL 750	180/100	132	\$1,695	24	Color

18- AND 24-WIRE HIGH-RESOLUTION DOT MATRIX

*New models announced after November 1985

(Continued)

Table 1 (Continued)

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18- AND 24-WIRE HIGH-RESOLUTION DOT MATRIX

Table 1 (Continued)

18- AND 24-WIRE HIGE-RESOLUTION DOT NATRIX

				Number of	
Company/Model	Speed	<u>Columns</u>	Price	Pins	Comments
Mannesmann Tally					
MT 330*	300/150/75	136	\$1,495	24	
HT 490	400/150	132	\$1,995	18	
NEC					
PSXL*	240/200/83	136	\$1,725	24	Color and multistrike ribbo
P6*	180/150/54	80	\$ 695	24	
P7*	180/150/54	136	\$ 895	24	
CP2	100/90/30	60	\$ 995	18	Color
CP3	180/90/30	136	\$1,375	18	Color
P2	180/90/30	80	\$ 699	18	
P3	180/90/30	136	\$ 999	18	
P5	240/200/83	136	\$1,440	24	•
Newbury Data					
8935	200/90	132	\$1,200	18	
Nissel Sangyo					
5025	150/75	132	\$1,875	24	
Nissho					
NP-2410*	300/150	136	\$1,745	24	
Printek					
930	200/80	132	\$1,995	18	
Star Micronics					
NB15*	250/83	136	\$1,449	24	
SB10	144/60	80	\$ 749	24	
TEC					
GP-3401*	200	136	\$1,100	24	Color
GP-3801*	200	136	\$1,000	18	Color
Toshiba					
321*	180/60	80	\$ 699	24	
341*	180/60	136	\$1,099	24	
351C*	240/100	136	\$1,699	24	Color
P351	240/100	136	\$1,599	24	
P1340	144/56	80	\$ 799	24	

*New models announced after November 1985

Note: Prices are subject to change with exchange rate fluctuations.

RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: April-June 1986-12

THE FINAL RESULTS ARE IN--MAJOR USERS SHARE THEIR PERSPECTIVES

ANNUAL SEMICONDUCTOR PROCUREMENT SURVEY

Manufacturers that make up the <u>Electronic Business</u> 200 participated in SAM's first annual semiconductor procurement survey, which was announced last October. Preliminary results, published in March, are now final, with some 281 respondents having told our telephone interview staff their perspectives on 1985 survey procurement and their outlooks for 1986.

In all, users estimate their cumulative purchases in 1986 will rise some 7.5 percent over 1985. The data gathered for 1985 indicate that the responding locations accounted for approximately 46 percent of DATAQUEST's \$9.6 billion estimate for 1985 North American semiconductor consumption. This newsletter highlights the data and trend information derived from this year's survey.

The Survey's Structure

Dataquest

BR a company of the Dun & Bradstreet Corporation

> The primary purpose of the survey was to gather information for semiconductor manufacturers about their clients and markets in the largest electronic equipment manufacturers in the United States. Our target audience was manufacturers that are included in the <u>Electronic</u> <u>Business</u> 200--a comprehensive annual listing of the top electronics manufacturers in the United States.

> The original list of 200 companies was pared to eliminate semiconductor and other types of component manufacturers that do not represent electronic equipment manufacturers that buy semiconductors for use in their systems and subassemblies. We also eliminated distributors from the survey audience. After these eliminations, 178 companies remained to be surveyed. In all, DATAQUEST identified 439 purchasing sites within these companies. Each location was telephoned directly and individuals who are buyers, purchasing directors, or who are in material or corporate contract management were interviewed. Our staff conducted some 281 interviews, representing a 64 percent response rate. Figure 1

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shows the geographic locations of those respondents. DATAQUEST compared these locations with the geographic locations of the entire audience and found the regional shares very similar, leading us to believe that we have adequate representation across all regions. Below we have listed the split for the procurement locations of the entire <u>Electronic Business</u> 200:

- Pacific--34.1%
- Mountain--7.3%
- Midwest--16.7%
- Northeast--24.9%
- Atlantic--8.9%
- South--8.1%

Figure 1

PROCUREMENT SURVEY AUDIENCE



Source: DATAQUEST May 1986

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1985 RESULTS

On an aggregate basis, users are still cautious about their 1986 purchasing outlook and expect only mild growth compared with 1985. Overall, however, growth estimates are slightly more ambitious than those derived from the preliminary survey results and are up to 7.5 percent from an earlier estimate of 5.6 percent.

Technology

Tables 1, 2, and 3 profile 1985's semiconductor purchases, which we have analyzed by the manufacturer's respective lines of business. Its interesting to note particular differences in the use of semiconductors, and further, in their IC product and technology mixes, depending on their application markets. Data for certain markets, particularly communication and consumer, are quite different than our preliminary results because of the small sample of companies that we questioned for our earlier perspective on those markets.

We note the slightly higher concentration of IC devices in the data processing, military, and communication markets, which have been the traditional users of semiconductors. And as seen in our earlier survey results, industrial and consumer markets tend to be the heaviest users of discrete devices.

Table 1

1985 PROCUREMENT SEMICONDUCTOR MIX (Percent of Total)

Application <u>Market</u>	<u>IC</u>	<u>Opto</u>	<u>Discrete</u>	<u>Total</u>
Data Processing	83.0%	4.5%	12.5%	100%
Communications	75.7%	4.1%	20.2%	100%
Industrial	68.4%	6.9%	24.78	100%
Consumer	71.3%	3.8%	24.9%	100%
Military	78.8%	4.28	17.0%	100%
Transportation	74.6%	7.9%	17.5%	100%

Source:	DATAQUEST
	Mav 1986

Table 2

1985 PROCUREMENT IC TECHNOLOGY MIX (Percent of Total)

Application <u>Market</u>	<u>Bipolar</u>	MOS	CMOS	<u>Total</u>
Data Processing	47.38	36.8%	15.9%	100%
Communications	29.7%	50.7%	19.6%	100%
Industrial	46.28	30.6%	23.28	100%
Consumer	43.0%	30.0%	27.0%	100%
Milítary	46.4%	21.5%	32.18	100%
Transportation	36.8%	53.6%	9.6%	100%

Table 3

1985 PROCUREMENT IC PRODUCT MIX (Percent of Total)

Application						
Market	Memory	<u>Micro</u>	<u>Logic</u>	ASIC	<u>Linear</u>	<u>Total</u>
Data Processing	35%	18%	26%	98	12%	100%
Communications	39%	98	35%	88	98	100%
Industrial	25%	16%	30%	10%	19%	100%
Consumer	23%	23%	18%	14%	22%	100%
Military	21%	88	43%	98	198	100%
Transportation*						

*Sample too limited; detail unavailable at this product level.

Source: DATAQUEST May 1986 Į.

The process technology and product mix of IC procurement has balanced some since earlier results, particularly in the consumer area. Bipolar technology is used extensively by the data processing, industrial and military market. We were surprised to see the large use in the consumer market, especially since early results indicated that bipolar had only about a 2 percent share, lagging tremendously behind other MOS and CMOS. We believe that the shift in data occurred with the subsequent participation of large consumer users, who in particular, consume a lot of bipolar linear components. Another change in data appeared in the split between other MOS and CMOS usage by military manufacturers, who joined consumer manufacturers as favoring CMOS in their mix more than other application market areas.

ASIC consumption is still low compared with its IC product counterparts, and there is still heavy penetration in the standard logic area. Together, standard logic and ASIC purchases make up a large portion of ICs. In Table 4 we analyze the manufacturers that purchased ASICs in 1985 versus those that did not. Our original thinking was that ASIC users would be profiled differently from nonusers. The data indicate however, that there are parallels between the two, with most ASIC users and nonusers falling in the data processing and industrial communities. We believe that this is indicative of a fair amount of penetration in these two markets, with room for opportunity still existing, particularly in the industrial marketplace.

Table 4

ASIC USERS VS, NONUSERS (Percent of Total)

.. ..

Users	Nonusers
2/8	228
16%	16%
35%	45%
5%	28
16%	15%
1%	0%
100%	100%
Source:	DATAQUEST May 1986
	<u>Users</u> 27% 16% 35% 5% 16% <u>1%</u> 100% Source:

Distribution

Total distribution purchases did not change from preliminary data. On the whole, the group purchased approximately 13 percent of its semiconductor devices from distribution. In Table 5 we have listed distribution purchases by application market area, indicating the aggregate amount each community purchased from distribution. Overall, these companies purchase less through distribution than the typical industry estimates of 20 to 25 percent. As large electronics manufacturers, they are for the most part volume buyers, and as such, often directly contract with semiconductor manufacturers. Variations to this fall in the industrial area, where there is a more fragmented variety of companies that tend to purchase smaller amounts. The same is seen in military, where smaller runs are frequently the norm. Industry estimates for military distribution range as high as 30 percent, with our data indicating nearly 25 percent.

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Table 5

1985 PROCUREMENT DISTRIBUTION PURCHASES (Percent of Total)

Total Distribution Purchases	13.0%
Distribution Purchases by	
Application Market:	
Data Processing	10.7%
Communications	8.9%
Industrial	28.2%
Consumer	12.8%
Military	24.8%
Transportation	0.0%

Source: DATAQUEST May 1986

Regional Supplier Base

Final statistics on the regional base of semiconductor suppliers (see Table 6) mirrored our preliminary results. For the final tabulation, however, we added an "Other" category, which matched the choices on the survey questionnaire.

We defined the regional base as the semiconductor company's country of origin and found that overall approximately 82 percent of purchases were made from U.S.-based semiconductor manufacturers, with Japan and Europe coming in at 15 and 2 percent, respectively. We then analyzed the data by application market and found a higher concentration of Japan-based suppliers in the data processing, consumer, and This matches our perception of these markets transportation markets. because of the heavy use of MOS memory in data processing, the largely offshore production of consumer equipment, and the stringent requirements for quality by the automotive industry.

We also asked about offshore semiconductor purchases for U.S.-based equipment production (regardless of regional supplier base). Here again, as shown in Table 7, the data processing, consumer, and transportation manufacturers used more of this method of procurement.

Table 6

REGIONAL SUPPLIER BASE (Percent of Total)

	U.S. Based	Japan <u>Based</u>	Europe <u>Based</u>	<u>Other</u>	<u>Total</u>
Total	82.4%	15.0%	2.18	0.5*	100%
Data Processing	74.0%	22.5%	3.5%	0.08	100%
Communications	82.4%	15.2%	1.6%	0.8%	100%
Industrial	83.1%	14.1%	2.0%	0.8%	100%
Consumer	63.38	29.1%	7.6%	0.0%	100%
Military	95.8%	2.9%	1.3%	0.0%	100%
Transportation	68.5%	25.5%	6.0%	0.0%	100%

Table 7

SEMICONDUCTORS PURCHASED OFFSHORE FOR U.S.-BASED EQUIPMENT PRODUCTION (Average Percent of Total)

Data Processing	24.8%
Communications	22.0%
Industrial	10.8%
Consumer	45.8%
Military	23.7%
Transportation	29.7%

Source: DATAQUEST May 1986

OUTLOOK

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DATAQUEST asked several questions about our audience's future expectations. With most of these questions we simply qualified their ideas of where future trends might evolve. One such question asked to what extent the respondent anticipated any shifts to offshore equipment production. As indicated in Table 8, there were few who expected a great deal of movement, with more companies expecting "some" shifts. It was encouraging, however, to note that quite a few thought there would not be any shifts, and that overall, regardless of what was expected, most of the respondents thought that this would not affect future growth of their U.S. semiconductor procurement. DATAQUEST believes that one caveat to future growth lies in the data processing area, since the majority of respondents expected at least some shift and this application market is the largest for North American semiconductor consumption.

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We also asked if there was current activity in system design that was contemplating the adoption of ASICs. Across all segments: ł

- 56.6 percent said yes
- 33.4 percent said no
- 10.0 percent did not know

We also tried to quantify ranges in the number of designs that respondents said their company would do in 1986. Table 9 shows that gate arrays were most frequently mentioned, with standard cell and full custom design methodologies following close together. We believe that PLDs were mentioned least because they are generally procured as commodities and may not usually be thought of as "design methodologies."

Table 8

ANTICIPATED SHIFT TO OFFSHORE PRODUCTION (Percent of Total)

	A Great <u>Deal</u>	Some	Not At <u>All</u>	
Total	8.4%	35.9%	55.7%	
Data Processing	11.7%	50.0%	38.3%	
Communications	11.9%	35.7%	52.4%	
Industrial	8.2%	36.4%	55.4%	
Consumer	10.0%	30.0%	60.0%	
Military	2.1%	17.0%	80.9%	
Transportation	0.0%	50.0%	50.0%	

Table 9

PROJECTED DESIGN ACTIVITY BY DESIGN METHODOLOGY (Percent of Total)

	Gate		Standard	Full	
	<u>Arrays</u>	PLD	<u>Cell</u>	Custom	<u>Total</u>
All Ranges	47.4%	5.1%	23.1%	24.48	100%
< 25	47.0%	5.9%	22.4%	24.7%	100%
26-50	43.3%	2.5%	30.0%	24.28	100%
51-75	50.0%	0.0%	50.0%	0.0%	100%
> 76	61.0%	0.0%	7.0%	32.0%	100%

Key Procurement Issues

DATAQUEST reiterates the major procurement issues that respondents said they were facing in 1986, since they did not dramatically change after drawing our final conclusions. We believe that along with evaluating the other data from the survey, the following are strategic imperatives that will typify future successful business relationships between buyers and sellers:

- Quality/reliability
- On-time delivery
- Supply/availability/shortages
- Service/vendor relationships
- JIT/dock-to-stock/inventory control
- Lead times
- Reducing current supplier base
- Product obsolescence
- Second sourcing
- Forecasting

DATAQUEST CONCLUSIONS

The time members of the user community spent with us to discuss their use of semiconductors has provided insight on the dynamics shaping this aspect of the industry. We will continue to survey the <u>Electronic</u> <u>Business</u> 200 on an annual basis to take a tactical look at how a given year takes shape and what the outlook is for the forthcoming year. We look forward to the survey's next iteration, which will begin sometime in November or December. At that time, we will profile 1986 procurement and seek a near-term outlook for 1987. We invite further questions and comments from our clients regarding information that they would like us to gather.

Anthea C. Stratigos



SAM Code: 1985-1986 Newsletters: April-June 1986-13

BOARD COMPUTER INDUSTRY SEGMENT SUMMARY

SUMMARY

Dataquest

IFR a company of The Dun & Bradstreet Corporation

> The board computer market is alive and growing, although at a slower rate than expected. As silicon technology shrinks the size of computer systems, the board computer industry is playing an increasingly important role in technical applications by replacing older minicomputers. Additionally, new applications and market segments are opening up as vendors introduce new products in the 32-bit product segment.

> The board computer market developed out of the small niche between full systems and semiconductors. A board computer is not considered a complete computer system with a display and mass storage peripherals, but rather, a ported system that may include a CPU, memory, and an I/O module.

> We forecast that this segment will develop into a \$1.3 billion industry by 1990, up from \$574 million in 1985. The market is fueled by continually increasing performance of VLSI electronics, shrinking computer sizes, declining average selling prices, and expanding market opportunities.

> From an applications perspective, industrial automation, real time, medical, and laboratory automation continue to be the largest applications, totaling 82 percent of the market revenues.

Vendors supporting various bus structures are continuing to wage war, first at the bus level and secondly at the product level. Multibus and Q-bus together captured 76 percent of the market, with VMEbus placing third at 11 percent.

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MARKET SIZE AND FORECAST

<u>Size</u>

Tables 1 through 4 and Figures 1 through 4 present our estimates of factory revenues and unit shipments for the board computer industry for 1980 through 1990. The board computer industry grew 11 percent from 1984 to 1985. This was a slight increase over the previous year's growth of 4 percent. It is still significantly lower than the computer industry's normal growth rate of 20 to 25 percent. The growth was a result of a slight increase in capital spending over previous years and the sudden unavailability of older, traditional minicomputers, which were restricted from being sold because of FCC radio frequency emission legislation. The older, traditional minicomputers were replaced by board computers with equivalent or greater functionality and performance. Additionally, several applications are using board computers that previously used minicomputers.

In addition, advancements in silicon technology have reduced component costs. Many vendors reduced prices to stimulate demand and in response to increasing competitive pressure. This has slowed the growth of revenues somewhat.

Forecast

We expect the industry to grow slowly, stimulated by new market opportunities created by 32-bit architectures and continued recovery in capital spending in the technical markets. The board computer industry is sensitive to the state of the economy in much the same way as the semiconductor industry is. An expected economic recovery will fuel the growth of the board computer segment.

The 8-bit segment revenues are forecast to peak in 1986 and then decline gradually. The 16-bit segment represents the main line of the market; the 32-bit segment is expected to show strong growth over the forecast period. We expect a flood of 32-bit products based on the 68020 and 80386 to emerge in 1986, which will stimulate demand and a decline in prices.

Bus Wars

Intel and Motorola will continue to wage advertising wars, vying for design wins with their respective Multibus II and VMEbus architectures, although almost no CPU boards were shipped on either bus in 1985. We expect both of these buses to survive and succeed in a neck-to-neck battle. The other high-speed 32-bit buses such as Nubus, Future bus, and FASTbus still lack significant vendor support, and we expect this situation to continue, since most of the industry is focusing on relatively low-speed applications. We expect Digital to announce board computer products supporting the newly announced Q-Bus replacement--the VAXBI bus--later in the year. However, we do not anticipate that the VAXBI will significantly affect the industry until 1987. This bus is currently offered only on expensive computer systems costing more than \$130,000.

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Table 1

ESTIMATED WORLDWIDE FACTORY REVENUES HISTORY FOR BOARD COMPUTERS (Millions of Dollars)

<u>Board Size</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	CAGR 1980- <u>1985</u>
8-Bit	\$115	\$150	\$158	\$ 186	\$190	\$205	12.3%
16-Bit	141	214	242	311	325	365	21.0%
32-Bit	0	0	0	0	<u> </u>	4	N/A
Total CPU Board Revenues	\$256	\$364	\$400	\$497	\$516	\$574	17.58

Table 2

ESTIMATED WORLDWIDE FACTORY REVENUES FORECAST FOR BOARD COMPUTERS (Million of Dollars)

Board Size	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	CAGR 1986- <u>1990</u>
8-Bit	\$210	\$205	\$200	\$ 185	\$ 170	(5.1%)
16-Bit	440	541	666	819	983	22.38
32-Bit	12	<u> </u>	<u>65</u>	100	145	86.4%
Total CPU Board Revenues	\$ 662	\$ 776	\$ 931	\$1,104	\$1,298	18.3%

Source: DATAQUEST May 1986 ×

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Table 3

ESTIMATED WORLDWIDE UNIT SHIPMENTS HISTORY FOR BOARD COMPUTERS (Thousands of Units)

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<u>Board Size</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	CAGR 1980- <u>1985</u>
8-Bit	167	233	274	365	420	500	24.5%
16-Bit	64	174	222	309	380	474	49.3%
32-Bit	0	0	0	0	0	<u> </u>	N/A
Total CPU Board Units	231	407	496	674	800	975	33.4%

Table 4

ESTIMATED WORLDWIDE UNIT SHIPMENTS FORECAST FOR BOARD COMPUTERS (Thousands of Units)

Board Size	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	CAGR 1986- <u>1990</u>
8-Bit	580	700	800	850	875	10.8%
16-Bit	625	800	975	1,210	1,550	25.5%
32-Bit	3	10	28	50	77	120.6%
Total CPU Board Units	1,208	1,510	1,803	2,110	2,502	20.0%

Source: DATAQUEST May 1986

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ESTIMATED WORLDWIDE FACTORY REVENUES HISTORY FOR BOARD COMPUTERS 1980-1985

> Source: DATAQUEST May 1986

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ESTIMATED WORLDWIDE FACTORY REVENUES FORECAST FOR BOARD COMPUTERS 1986-1990

Figure 3

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ESTIMATED WORLDWIDE UNIT SHIPMENTS HISTORY FOR BOARD COMPUTERS 1980-1985



Figure 4



ESTIMATED WORLDWIDE UNIT SHIPMENTS FORECAST FOR BOARD COMPUTERS 1986-1990
Figure 5 shows percentages of worldwide 1985 factory revenues segmented by bus structure. Intel and Digital continue to fight tooth and nail for the number one position with Motorola's VMEbus. The VMEbus gained significantly over its 1984 position.

Applications

The board computer market is dominated by the industrial automation application, which has had restricted levels of capital investment spending for the last three years. Table 5 presents our estimates of percentages of revenue by application for 1980 through 1989. Figure 6 illustrates the 1985 board computer market revenue shares by application.

We anticipate that the applications percentages will not change much, with the exception of an increase in communications at the expense of the laboratory and medical markets.



Figure 5

Source: DATAQUEST May 1986

Table 5

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ESTIMATED BOARD COMPUTER MARKET BY APPLICATION 1980-1989 (Percentage of Revenue)

Application	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>
Design Automation	1%	1%	1%	1%	1%	1%	1%	1%	1%	18
Industrial Automation	21	21	21	24	26	30	33	33	35	35
Scientific	1	1	1	1	1	1	1	1	1	1
Earth Resources	1	1	1	1	1	1	1	1	1	1
Real-Time Data Acquisition										
and Control	16	16	17	17	17	18	18	18	20	20
Graphics	1	1	1	1	1	1	1	1	1	1
Communications	2	2	2	2	4	6	9	14	15	16
Software Development	1	1	1	1	1	1	1	1	1	1
Computer-Aided Publishing	0	0	0	0	0	0	0	0	0	0
Laboratory "	26	26	25	24	22	17	15	13	10	9
Medical	25	25	25	23	20	17	13	10	8	8
Other	5	5	5	5	6		<u> </u>	<u>7</u>	7	7
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

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Source: DATAQUEST March 1986

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APPLICATIONS AS PERCENTAGE OF REVENUE

Figure 6

Source: DATAQUEST May 1986

DATAQUEST CONCLUSIONS

The board computer was hit as hard as, if not harder than, the rest of the technical computer industry. Competition continues to remain tough with more than 100 vendors offering CPU boards. But there are few barriers to entering the market and the cost of entering remains low. Considerable forces are building to fuel the growth of the entire board computer industry as the computer industry evolves and scales downward in system size and price.

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> John Brew Brad Smith

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The Dun & Bradstreet Corporation

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: April-June 1986-14

DIGITAL NETWORK EVOLUTION--THE QUIET STORM

INTRODUCTION

DATAQUEST'S 1986 Telecommunications Industry Conference, which was held in San Diego, California, in March, was attended by management professionals representing a majority of the companies with a vested interest in Integrated Services Digital Network (ISDN). A total of 165 organizations were represented, with attendees arriving from all major markets throughout the world.

The conference topic was "ISDN: A Path to the Future--Challenges and Directions." Senior management speakers discussed the following ISDN topics:

- ISDN technology and standards
- Local telephone company, RBOC and long-distance carrier ISDN activities
- Equipment supplier views of ISDN

DATAQUEST believes that in order for ISDN to be functional, the current telephone network must undergo significant modernization. A digital network evolution is currently occurring and is the quiet storm that we expect will provide turbulent, exciting opportunities for industry participants.

However, while there was an enthusiastic response to the conference, many attendees left wondering if ISDN is either a solution in search of a problem or a new smoke-and-mirrors performance being orchestrated by AT&T and the RBOCs.

At Interface '86, which occurred the week after the TCIS conference, numerous vendors expressed doubt as to whether ISDN would happen in their lifetimes. However, while they were doubting its functionality, they were also saying, "We need T-1 products because our customers are demanding high-speed digital networking products." Interface was the third major trade show at which T-1 activities captured a majority of press attention.

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While some people doubt ISDN, customer demands for high-speed man-tomachine and machine-to-machine communications are becoming more significant. We believe that digital communications and wideband networks will be the only ways that customers' demands can be satisfied in the near future. As a result, we believe that ISDN will begin to occur in 1987 as outlined by Figure 1.

Figure 1





Source: DATAQUEST June 1986

DIGITAL NETWORK EVOLUTION

The current digital network evolution, which leads to ISDN, is being pushed along by three distinct, uncontrollable forces: telcos, users, and technologies. In this newsletter, we will discuss each of these forces and additional factors that we believe will have an impact on the movement toward ISDN.

The Telco Evolution

Outdated technology and poor service performance have forced the telcos to modernize their networks. The cost of providing wideband services exceeds the revenues received from some private line services in certain telco regions. Subsequently, the telcos are seeking ways to incorporate new digital technology to make special services profitable. Their objective for technology integration is to improve the quality of service and reduce operating expenses.

During the past several years the telcos have been investing billions of dollars in plant modernization to convert from analog to digital networks. Analog technology requires numerous, time-consuming, manual steps to set up and monitor circuit performance. Telcos can save hundreds of thousands of dollars a year by using digital facilities and new product technologies such as DACs and D5 channel banks. The result of this digitization is reduced expense, improved customer service, efficiently managed digital networks, and enhanced services to generate higher revenues.

The new digital telephone networks are using copper wire in the local loop, but only as an interim transport. The optimum wideband transport is fiber optics. The use of fiber optics is becoming more prevalent in the local operating company environment. DATAQUEST estimates that there are more than 1-1/2 million miles of multimode fiber installed today to serve loop and transport (trunk) services. We estimate that fiber will continue to grow at a 20 percent rate for the next two years. Fiber provides wide bandwidth capability, small core size, and long-range operations without need for numerous repeaters. It also allows the telcos to provide the user with transport speeds from 64 Kbps to 44.736 Mbps without cable rearrangements or replacements. Users can upgrade from 1.544 Mbps (DS-1) to 44 Mbps service (DS-3) just by adding fiber electronics. Our recent T-1 user surveys indicate that many major corporations are currently installing their own private fiber transports between their larger distributed processing sites.

However, a modernization investment must be made in order for the telephone companies to be able to provide their customers with efficiently managed, flexible digital networks. Many telcos are implementing triple-effort modernization strategies. One effort is to install digital functionality on the existing analog telephone networks. The IA ESS switches are being upgraded with adjunct processors to support digital functions that will allow the telcos to offer current customers new ISDN services via the current analog networks.

The second effort is to overlay the existing network elements with modern digital technology. Examples of this strategy can be seen in new transmission facilities (fiber), new central offices switches (such as 5ESS, DMS-100, and EWSD), and new ISDN telephones. The advantage of this effort is that digital services can be implemented quickly and over a widespread area by installing smaller digital switches and remote nodes. The third effort involves a combination of upgrade and overlay efforts depending on local telco conditions. The specific strategy implemented by each telco is based on its installed network base, strategy, economics, and services. In order for ISDN to be freely operated by the end of the 1980s, digital facilities and switches must be installed. Modernization is expensive and time consuming, but it is critical in order for new service offerings to be priced on an incremental basis.

We are beginning to see the early benefits of the current modernization activities as new services and products enter the customer environment. New products such as digital access and cross-connect systems, Class 5 switches, subscriber loop carrier products (SLC 96), D5 channel banks, and packet switches are being installed in order for new user services to be tariffed. Among these new services are Software Defined Networks (SDN), Megacom 800, Circuit Switched Digital Capability, and Accunet TL.5 Reserved. The combination of hardware and software are vital to the integration of digital subscriber carriers and digital switching systems. This integration will allow customers to obtain bandwidth for any type of application. Companies will be able to mix public network access with their private networks in order to obtain the optimum transport service at the lowest cost (see Figure 2).

Figure 2.

ISDN--INFORMATION AGE INTERACTION



Source: AT&T-C

The User Evolution

Information is, and will continue to be, the major product required by the majority of American workers. Information access and processing will enhance the way we do business while increasing the productivity of American business personnel.

There is considerable progress being made with regard to improving information sources such as data base management, office automation, and communications. Businesses are implementing multiple connectivity solutions to satisfy information-hungry demands. DATAQUEST estimates that there are more than 300 billion documents electronically stored by U.S. companies. We estimate that 72 billion documents are electronically stored each year. By 1990, we estimate that there will be 1.23 trillion paper documents electronically stored. DATAQUEST estimates that there will be more than 64.7 million desktop devices requiring access to electronically stored information by 1990. This is an increase of more than 4.5 million from today's 60.2 million desktop devices.

DATAQUEST estimates that business communications is a \$5.7 billion market today and will grow to more than \$6.5 billion in 1990. It is expected to grow 4.8 percent per year for the next several years. While voice communications will continue to be the major factor, data and office communications are expected to grow faster than voice mainly on the strength of new digital capabilities being offered by telcos and manufacturers.

Data communications is migrating to higher transmission speeds as users require higher-speed communications devices such as PCs, word processors, and graphics terminals. DATAQUEST's projections for modem growth clearly indicate the significant opportunities for 9600-, 14,400-, and 19,200-bps modems. The demand for 56-Kbps and 1.544-Mbps products and digital facilities are taxing the manufacturers' and providers' abilities to respond to user demand. DATAQUEST believes that some innovative users could use 45-Mbps services right now if they had products that could run at this higher speed.

The major reason for the popularity of high-bandwidth facilities is the significant cost savings available when more bits can be transmitted over a communications link. As the telcos continue to receive regulatory approval to introduce new services at lower rates, we believe that users will seek higher speeds.

The Technology Factor

The rate and magnitude of technology change in telecommunications today have exceeded those of any other period in our industrial history. The pace of technology change continues to be influenced by the progress in silicon integrated circuits. The number of components per chip continues to increase rapidly. The development time between the 64K DRAM and the 256K DRAM was only about two and one half years. We expect the 4Mb DRAM to be available by early 1990. Currently, about \$5 billion per year is being spent to advance semiconductor technology. The significance of gains in chip technology is cheaper, faster, and more reliable circuits. This, in turn, will make possible lower-cost digital products and systems.

DATAQUEST expects single-chip microcomputers to have the same processing power as conventional minicomputers and large, general-purpose computers by the end of the 1980s. Users will require microcomputer connectivity to numerous large, multiprocessor computer architectures for decision-making activities. We have been told by several T-1 users that their corporations have ordered additional IBM Sierra mainframes, with the goal of providing terminal connectivity for every employee at every site in the organization. They also hope to connect their firms' commercial clients to their corporate data bases. Universal host access and Chief Information Officers have been transformed from marketing brochure concepts to actuality in some corporations.

DATAQUEST believes that although chip development will continue to propel technology into the marketplace, software will control it. We expect software design, test, and installation to continue to be the "killer factors" with regard to product and market success. Software is the intangible ingredient that can create product success and failure. As product architectures respond to technology changes and user demands, vendors must keep competent, experienced software personnel within their organizations. Software personnel will be the precious assets that will develop mainstream products as well as incorporate features into new product designs.

Software interfaces to digital networks, ISDN, computer systems, and subsystems will be critical for company participation and survival in the new telecommunications environment. Software will be tailored to provide user access to data bases and to improve man-to-machine interaction for less sophisticated users. Users will demand that a single terminal be able to communicate with all appropriate application systems and subsystems. Encryption will be incorporated into communications transmissions to protect users and companies for both local and remote communications access.

Software design for communications networks is equally critical. Elements such as dynamic bandwidth allocation, alternate routing and switching, voice and data integration, and speech transmission will not function to user specifications without software. In the near future, we foresee networks operating as quickly as the host or site computer systems as companies use information for strategic purposes and better services at a lower cost per bit.

Continual, rapid technology change will force companies to be quick on their feet to support their own positions or to attack their competitors' positions. Time is the biggest factor, since there is never enough of it to serve our development needs. It takes time to integrate new technology into an existing product structure and organization. Organizations must be strong supporters of flexibility. Flexibility includes knowing which competitors to watch, defining markets correctly, responding to competitive entrants, and realizing that gradual change is no longer the norm.

Telecommunications is being directed by numerous forces that will significantly impact companies that are inflexible with regard to product and technology. DATAQUEST strongly believes that companies cannot continue to invest R&D and support resources in older products that do not contribute significant revenue and profit. Companies must invest in new technologies not only to maintain their market positions, but also to learn what is available from the semiconductor companies.

FUTURE USER REQUIREMENTS

DATAQUEST expects the user telecommunications environment to undergo significant change as the result of the digital revolution. In the future, we expect data files to be shared across corporate sites, with each site storing data that pertain directly to it. Periodically, data will have to be transmitted from remote sites to central sites so that central host updating can be accomplished. We also anticipate that user demands for information access will increase significantly between now and 1990 as users require additional decision support information. Table 1 is a Connection Matrix that shows DATAQUEST's forecasts for device connectivity. The increases in network transmissions (voice/data messages) will not only require reliable networking products, but also routing and switching functionality to get information to all sites.

Host computer communications software enhancements will be critical to meet user demands for accessing shared data and communications with Corporations using T-1 the various sites where data is stored. facilities will find themselves slaves, tied to the host computer master. Computer manufacturers must begin to look beyond today's archaic communications software (communications access methods and teleprocessing monitors) to direct host access to the 1.544-Mbps facility in order to allow users to gain the benefits of 1.544-Mbps transmission. As we have previously described, the digital networks will connect different types equipment including of graphics terminals, electronic publishing terminals, image and speech processing equipment, PCs, file processors, digital telephones, artificial intelligence systems, and digital speech processing interfaces.

Data processing or information processing communications systems must begin striving for the same degree of technology advancement that the telecommunications suppliers and telcos are implementing right now. We believe that mainframe communications architectures will be taxed to the limits before the end of 1987, due in part to the acceptance of T-1 transmission. Communications software can either enhance or deter user implementation of wideband digital applications, ISDN, and new high-speed terminal products.

Table 1

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DATAQUEST CONNECTION MATRIX

		Estimated							
		Installed							
		Base at		Est	imated Pe	rcentage (Connected V:	18:	
	Type of	Year End			Data	Hard-		Not	1
Year	<u>Desktop Device</u> (<u>Mi</u>	llions of Units)	LAN	<u>PBX</u>	PBX	wired	Renote	Connected	<u>Total</u>
1985	Display terminal	10.1	5,1%	0.5%	13.8%	56.8%	23.8%	0.0%	100.0%
	Word processor	1.1	9.4%	0.2%	2.2%	26.0%	5.9%	56.3%	100.02
	Integrated voice/data workstatic	om 0.2	1.72	51.6%	0.02	10.5%	26.7%	9.4%	100.0%
	Electronic Typewriter	3,3	0.0Z	0.02	0.0%	0.5%	1.5%	98.0%	100.0%
	Personal Computer*	9.7	4.3%	0.1%	3.8%	13.0%	10.4%	68.4%	100.0%
	TOTAL	24.4	4.2%	0.7X	7.3%	30.0%	14.7%	43.0%	100.0%
1986	Display terminal	11.5	7.5%	1.3%	18.4%	49.5%	23.2%	0.02	100.0%
	Word processor	1.2	11.4%	0.8%	3.4%	27.7%	5.8%	50.9 %	100.0%
	Integrated voice/data workstation	on 0.4	2.6%	48.8%	0.0%	13.8%	26.7%	8.1%	20.001
	Electronic Typwriter	4.6	0.0%	0.1%	0.0%	1.0	2.1%	96.8%	100.0%
	Personal Computer*	13.4	5.5%	0.2%	5.0%	12.5%	16.8%	60.0%	100.0%
	TOTAL	31.0	5.6%	1.3%	9.1%	25.1%	16.7%	42.2%	100.0%
1990	Display terminal	16.3	18.3%	8.2%	25.5%	27.0%	21.02	0.0%	100.0%
	Word processor	0.6	13.2%	2.6%	6.3%	39.8%	4.8%	33.3%	100.0%
	Integrated voice/data workstatis	on 3.2	7.5%	40.0%	0.0%	22. 8%	23.8%	5.9%	100.0%
	Electronic Typewriter	7.2	0.0%	0.9%	1.1%	3.3%	4.8%	89.9%	100.0%
	Personal Computer*	26.1	11.8%	0.9%	6.2%	13.0%	26.0%	42.2%	100.0%
	TOTAL.	53.5	11.9%	5.5%	11.0%	16.9%	21.2%	33.4%	100.0%

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*Excluding integrated voice/data personal computers

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Source: DATAQUEST June 1986

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REGULATION RELAXATION

Regulation, particularly the AT&T breakup, is the factor that has had the greatest impact on the telecommunications industry. On December 31, 1983, seven regional holding companies (the Regional Bell operating companies or RBOCs) were formed. Each of these seven companies comprised several Bell operating companies. They were divided up according to their geographic locations.

While there have been restrictions imposed on the RBOCs, they have been permitted to provide new customer premises equipment (CPE) and printed directory advertising and publishing. However, they may not engage in businesses that constitute exchange services or are natural monopoly services in which they could use their monopoly power to impede competitors in the markets they seek to serve. The RBOCs have been given broad legal guidelines in which to operate, but their primary mission is to provide local services. They have stockholders to serve just like IBM, GM, and Exxon. They are in business to make a profit from the services they provide. Cost control is just as important to them as it is to any publicly owned company.

Though the federal regulators have been slow to respond to the business requests of AT&T and the RBOCs, their actual approvals have been favorable. The RBOCs have received 54 line-of-business waivers permitting the BOCs to enter diversified fields. AT&T received approval to merge ATT-IS and AT&T-C into a single organization once again. In light of these decisions, the RBOCs are demanding even more freedom to provide even broader services.

DATAQUEST believes that federal and state regulatory agencies will continue to allow the telcos to introduce technological advances. However, they will hold down the price of telephone service for the senior citizens and be market based for high-volume users. We believe that the local operating companies will develop multiple pricing alternatives for business and residential users to support any applications that they desire. Offering this new connectivity will necessitate new tariff rate offerings that will provide buffet services at menu prices. In the not-too-distant future, we expect to see pricing tariffs for state and local government networks, local manufacturing, college and university systems, transportation companies, and medical Users will receive metered bandwidths so that they pay institutions. appropriate prices for only the bits used and the network resources that support their applications. Each of the digital switching systems being installed will provide detailed accounting subsystems.

We expect the continuance of telco deregulation and the final resolution of Computer III to influence growth and structural change within our industry. While predicting the regulatory future is difficult, we believe that the digital evolution will not be deterred by legal issues at this time.



ISDN DEPINITIONS AND STANDARDS

The CCITT Study Group XVIII has established the following definition for ISDN:

"A network evolved from telephony IDN that provides end-to-end digital connectivity to support a wide variety of services to which users have access by a limited set of standard multipurpose customer interfaces."

The CCITT has established two international primary rate interface standards. In North America, Japan, and South Korea the primary rate is 1.544 Mbps. This interface is also defined as 23 B channels and one D channel, all at 64 Kbps. In Europe the primary rate is 2.048 Mbps.

The Basic ISDN Access Rate is defined as two 64-Kbps B channels and one 16-Kbps D channel (2B+D) over a single digital subscriber line.

The B channel is defined as the 64-Kbps channel of a digital subscriber line (where there are two) or an extended digital subscriber line (where there are 23) that is circuit switched and can carry either voice or data.

The D channel is defined as the packet-switched channel on a digital subscriber line (where it is 16 Kbps) or an extended digital subscriber line (where it is 64 Kbps) that carries signaling messages and packetswitched user data.

CCITT #7 Signaling is the newest standard for signaling within telecommunications networks being developed by CCITT. This signaling standard is being implemented in digital switches for the early ISDN trials.

AT&T-C announced in January 1985, and reiterated in March 1986, that it will support the CCITT ISDN standard (1.544 Mbps) for digital access connections between customer's premises and AT&T central offices and that the AT&T network facilities (transports) will confirm with the ISDN standard (see Figure 3). DATAQUEST expects Bellcore (see Figure 4) and the RBOCs to also follow the CCITT recommendations for the primary rate interface standard for their own ISDN activities.

Pigure 3



AT&T'S ISDN BASIC PRIMARY ACCESS RATE INTERFACE

Source: AT&T-C

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These standards are established to achieve consensus among providers and manufacturers. Even though the standards have been established, the glaring inconsistency is the North American 1.544-Mbps standard and the European 2.048-Mbps standard. In order to provide true end-to-end digital connectivity and for users to have worldwide data transfers, these inconsistencies must be resolved.

DATAQUEST recommends that industry participants focus their attention on these standards to ensure that their products will be compatible with the ISDN networking standards. Companies should establish committees whose charter is to monitor ISDN activities in order for product line strategies to be developed that support ISDN.

1.544 Mbps-THE ISDN INTERFACE

1.544 Mbps, also referred to as T-1 and DS-1, is used by corporations for interoffice communications to economically integrate voice, data, and video. T-1 transmission can occur between two customer premises locations or it can occur between the customer premises and the telco serving office. T-1 service is also used to connect two central offices.

T-1 is being accepted by major corporations throughout the United States (1.544 Mbps) and the United Kingdom (2.048 Mbps) as the transport to serve high-capacity requirements for information movement needs. Communications users are realizing that 1.544 Mbps can be economically justified for use in networks ranging from several miles to distances of more than several thousand miles. While the economies favor shorter distances (up to 500 miles), major corporations plan to construct multinode T-1 networks to serve their needs.

We pointed out that CCITT has identified 1.544 Mbps as the primary rate interface. User companies that have installed T-1 products believe that these systems will become their access to ISDN when ISDN becomes an actual service. They are aware of T-1 compatibility with ISDN, and some users have expressed concerns that their vendors will have to upgrade existing products to comply with CCITT primary rate standards. We were surprised to find out how knowledgeable many of these T-1 users were regarding AT&T compatibility and ISDN interfaces.

DATAQUEST recommends that equipment suppliers closely monitor the 1.544 Mbps ISDN standards in order not to impact current user capabilities. We suggest that companies with desires to offer T-1 interface products participate in the AT&T Network Compatibility Testing Program. It makes good sense to be certified by AT&T. Vendors who want to participate in the CPE markets can protect themselves and their customers through this compatibility testing procedure.

Marketing Timing

DATAQUEST expects 1987 to be a significant year for the telecommunications industry. During the first quarter, we expect numerous, concurrent activities to occur that will offer visible proof that the digital evolution has been the vanguard for ISDN.

During this period, preliminary results from the Ameritech ISDN trial with McDonald's should be available. The U.S. West trial will be up and running in the Phoenix area. The Phoenix trial will be concurrent with the International Switching Symposium (ISS), which will be held at the end of March. There should also be other RBOC-sponsored ISDN trials under way during this period.

During the International Switching Symposium, we expect AT&T to publicly demonstrate a coordinated (ATT&T-IS, AT&T-C, and AT&T-NS) ISDN product showcase. We believe that AT&T-IS will publicly demonstrate the ISDN primary rate interface on the System 75 and 85 PBXs. In order to accomplish this primary rate interface, DATAQUEST believes that AT&T-IS will migrate from the present Digital Multiplex Interface (DMI) to the CCITT-defined primary rate interface. AT&T-IS has publicly stated that it will support and implement the CCITT standard interface. Since DMI and CCITT are quite similar, we believe that AT&T-IS will demonstrate the ISDN version in Phoenix. We also expect AT&T-IS to demonstrate a new family of ISDN terminal products that are under development today.

DATAQUEST believes that AT&T-C will publicly demonstrate digital PBXs, T-1 multiplexers, DACs, subrate DACs, and other CPE product interfaces to the 4ESS switch using the ISDN primary rate interface. The 4ESS switch is the key element in AT&T-C's ISDN services offerings. The 4ESS software is on schedule at the present time.

AT&T-NS will have already enjoyed widespread publicity when the early results of the 5ESS installed ISDN trials are made public. DATAQUEST expects AT&T-NS to demonstrate a substantial variety of ISDN interfaces connected to PBXs, host computers, X.25 packet network and interexchange carrier interfaces, and CPE products. AT&T-NS has announced a delay for the first release of ISDN software. While this six-month delay is typical for this industry, we do not expect AT&T-NS to be late with future software releases for the 5ESS. The host computer interface most likely to be demonstrated will be an IBM system, but we would not be surprised to see a new family of AT&T computers that are more powerful than the current 3B products.

DATAQUEST anticipates that numerous other ISDN-related demonstrations will occur in Phoenix. We expect the major 5E-type suppliers to be showing their ISDN systems and products. We believe that several companies will demonstrate ISDN CPE products that will include telephones, voice/data terminals, and residential products. The ISS will be NATA, Interface, and the Hannover Fair rolled into one show. We should have a clear picture of what the ISDN participants have developed for business and residential users. Industry participants who have a vested interest in ISDN should not miss visiting Phoenix in March 1987.

DATAQUEST CONCLUSIONS

The digital network evolution is providing benefits to both telephone companies and their communications customers. Benefits to the telcos include lower maintenance and repair costs, reduced provisioning expenses, new revenue-producing opportunities, faster response to user transport problems, shareholder returns, and improved customer services.

Benefits to the communications customers include integrated voice and data networking, wideband digital networking, universal access, attractive prices, communication savings by combining separate services into an integrated system, and service flexibility.

We believe that digital communications will continue to expand during the remainder of the 1980s and well into the 1990s due to decreasing technology costs and information access and transfer. This digital expansion will create numerous applications for equipment suppliers to introduce new switching, transmission, and CPE products. DATAQUEST anticipates that numerous applications will evolve that can economically be offered to business and residential users over the digital transport. Traditional and evolutionary applications and products will include: videotext, teletext, video, alarm and security systems, digital television sets, host-to-host transfers, digital telephones, office systems, speech recognition, data security, voice messaging store and forward, packet cellular telephones, open architecture interfaces, and a host of new, exciting products and applications. (See Figure 5).

Figure 5

ISDN INTEGRATED ACCESS



Source: DATAQUEST June 1986 The rate of new digital facility implementation and the upgrades to existing central office equipment continue to increase at a phenomenal rate. DATAQUEST suggests that industry participants not disregard ISDN as smoke-and-mirrors but as a digital transport that will appear in field trials during early 1987. We recommend that industry participants closely monitor the progress of the primary rate access interface (23 B+D) and the basic rate access interface (2 B+D). Equipment suppliers should include these interfaces into their near-term product development strategies so as to minimize equipment impacts when ISDN migrates beyond the field trial stage.

ISDN market demand is uncertain at this time. The cost and pricing issues must still be resolved. We are still uncertain of the ISDN regulatory climate. Users will require digital networks in order to achieve greater flexibility in designing communications networks to meet corporate and user needs. We believe that the initial ISDN thrust will be to the corporate communications customers and governmental agencies who will require end-to-end digital communications. We believe that the residential market will begin to develop after the corporations begin to implement computer and communications applications over the ISDN transports.

While ISDN is confusing and perplexing to many participants, market demand for high-speed communications is the fastest-growing segment of the communications industry. The quiet storm continues to gather momentum. The most visible sign of this storm gathering is the phenomenal growth of 1.544 Mbps products and facilities. User corporations that are installing these products realize they are on the threshold of ISDN.

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John Brew William C. Kanupke

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RESEARCH BULLETIN

SAM Code: 1985-1986 Newsletters: April-June 1986-15

EIA FIRST-QUARTER REPORT: ELECTRONIC EQUIPMENT FACTORY SHIPMENTS DOWN 2 PERCENT

A recent report published by the Electronic Industries Association (EIA) shows that U.S. factory shipments of electronic equipment were lower in the first quarter of this year than they were for the same period in 1985.

While the EIA's and DATAQUEST's segmentations for electronic equipment differ slightly, we believe that the EIA data (see Table 1) are good indicators of electronic equipment demand. DATAQUEST's figures for U.S. semiconductor consumption are also included in Table 1.

Table 1

U.S. FACTORY SHIPMENTS OF ELECTRONIC EQUIPMENT AND SEMICONDUCTORS (Billions of Dollars)

				Percent	Change
Segment	<u>Q1'85</u>	Q4 85	<u>Q1'86</u>	Q1'86/Q1'85	Q1'86/Q4'85
Computers and					
Industrial	\$17.93	\$18.17	\$15.74	(12.2%)	(13.4%)
Communications	12.60	13.80	13.09	3.9%	(5.1%)
Consumer	4.32	5.84	4.13	(4.4%)	(29.3%)
Other*	7.83	8.75	8.96	14.48	2.4%
Total Equipment	\$42.68	\$46.56	\$41.92	(1.8%)	(10.0%)
Semiconductor	\$ 2.70	\$ 2.22	\$ 2.30	(14.8%)	3.6%

*Other includes automotive, aircraft, and other electronic products

Source: EIA DATAQUEST June 1986

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DATAQUEST ANALYSIS

Although the severity of the computer slump is greater than most people had anticipated, the trends indicated in the EIA data are in line with our recent forecast for electronic equipment growth in the near future. DATAQUEST foresees strong growth this year for automotive electronics, with moderate improvement for the industrial, communications, and consumer segments.

However, for any significant recovery to occur in either the electronic equipment markets or the semiconductor industry, an upturn is needed in the computer segment. The question is when.

Recent Department of Commerce (DOC) data are not encouraging. While communications equipment shipments are in line with inventory, and bookings are on the rise, new orders for computer equipment continue their downward trend. Shipments of computers are still declining, leading to possible increases in equipment inventory in the next few months.

While the short term is not encouraging, we believe that the computer industry will improve by the end of this year, surpassing 1985's revenue by 8 percent. Although far below historical growth rates, we believe that the year-end upswing in computer sales, coupled with a strong 1987, will pull this industry out of its slump.

For semiconductor manufacturers, this translates into relatively little increase in demand from the data processing community for the short term. Nevertheless, an improvement is expected by the end of this year, leading to robust growth in 1987.

John M. Brew

RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: April-June 1986-16

ASIC: CROSSING THE APPLICATIONS THRESHOLD

"Adolescence is the awkward age when a child is too old to do something cute and perhaps too young to do something sensible."

--E. C. McKenzie

AT THE THRESHOLD

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It almost seems that the application-specific integrated circuit (ASIC) industry has crossed the threshold from youth to adolescence. Like the child who has grown and matured rapidly, who has seen his potential but is not sure how to achieve it, so too is the ASIC industry. Standing at the threshold, with great optimism, ASIC suppliers visualize end-use markets as opportunities and challenges. The ASIC industry knows it has a way to go, and believes it has the maturity, but it is not exactly sure what path to choose.

This newsletter summarizes a recent analysis of end-use ASIC applications done by our Semiconductor Application Markets (SAM) service and the Semiconductor Industry Service (SIS). Our analysis shows three important points:

- ASICs have diffused into most end-use applications but still have a way to go.
- Design starts are fueling the growth of the ASIC market.
- ASIC suppliers are going to face a number of challenges and opportunities.

We take a closer look at some of the more common applications for programmable logic devices (PLDs), gate arrays, and cell-based designs (CBDs), and we conclude with observations that indicate the strategic direction for both ASIC users and suppliers.

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Figure 1



ESTIMATED NORTH AMERICAN ASIC END-USE CONSUMPTION (Millions of Dollars)

ASIC PENETRATION: A LONG WAY TO GO

DATAQUEST has just completed a major survey of 200 of the largest electronic businesses in North America. These companies have more than 500 semiconductor procurement locations and represent a diverse group of buyers, material managers, purchasing directors, and corporate contract managers. While profiles of this group do not include all electronic businesses, which number in the thousands, we believe they represent at least 55 percent of the total dollars invested in ICs. From the ASIC point of view, these companies represent the largest and most influential body of procurement management to be found in North America. Perhaps the most startling finding is that ASIC penetration has yet to mature. This is because most users devote a major portion of their procurement budget to logic products and because only a fraction of the logic budget is currently devoted to ASIC. Figure 2 shows the end-use distribution of IC dollars subdivided into the five major product categories.

It is interesting to note that logic, which includes ASIC and standard logic, makes up a major portion of IC procurement in all the end-use segments. While ASIC is not currently consuming a major portion of logic, it does suggest its large potential. But the most important finding shows that there is a very large group of users that is contemplating using ASIC. Of all the system manufacturers that were polled, 57 percent said they were seriously considering ASIC, 33 percent said they were not, and 10 percent were undecided.

A corollary to the above finding is how ASIC procurement is distributed throughout the United States. Table 1 and Figure 3 show that ASIC purchases are concentrated in the Pacific area, followed by the Northeast and the Midwest. These findings reinforce our previous findings that most U.S. design centers are concentrated on the coasts and in the Midwest.

Figure 2



IC PROCUREMENT--1985 (Percent of Total)

> Source: DATAQUEST June 1986

Table 1

EXPECTED ASIC DESIGNS (Percent of Respondents by Region)

	Atlantic	Midwest	Northeast	Mountain	<u>Pacific</u>	South	Total
Gate Array	9.0%	13.4%	20.9%	7.5%	40.3%	9.0%	100.0%
Standard Cell	8.7%	13.0%	19.6%	6.5%	34.8%	17.4%	100.0%
PLD	6.3%	12.5%	25.0%	12.5%	25.0%	18.8%	100.0%
Full Custom	8.3%	25.0%	18.8%	2.1%	31.3%	14.6%	100.0%
					Sour	ce: DA Ju	TAQUEST ne 1986

Figure 3

ASIC PROCUREMENT SURVEY AUDIENCE



Source: DATAQUEST June 1986

DESIGN STARTS--FUEL FOR ASIC GROWTH

There is another way to look at ASIC growth--by examining the estimated design activity from the user's point of view. Table 2 measures the estimated 1986 North American design activity. Respondents were asked how many designs they were planning and what percentage was planned per each design method. For example, for users who plan to do greater than 76 designs, the percentage that will be done using gate arrays is expected to be 60 percent. The other designs are expected to be done using CBD or full-custom design methods. The data shown in Table 2 suggest that regardless of the number of designs per year, most users expect to buy more gate arrays than any of the other design tools.

Table 2

ESTIMATED 1986 NORTH AMERICAN DESIGN STARTS (Percent of Total)

Number of Designs <u>per Year</u>	Gate <u>Array</u>	PLD	CBD	Full <u>Custom</u>	<u>Total</u>
All Ranges	47.48	5.1%	23.1%	24.4%	100.0%
25	47.0%	5.9%	· 22.4%	24.7%	100.0%
26-50	43.3%	2.5%	30.0%	24.2%	100.0%
51-75	50.0%	-	50.0%	-	100.0%
76	60.0%	-	7.0%	32.0%	100.0%

Source: DATAQUEST June 1986

We believe that this preference for gate arrays can be traced to two areas. It is fueled first by very user-friendly electronic design automation (EDA) and second by the proliferation of low-cost workstations. Most design centers now offer easy access to EDA, which, in turn, can interface with ASIC suppliers.

While Table 1 shows a small percentage of design starts for PLDs, we believe that the data do not truly represent their use. PLDs are purchased like commodity ICs and the number of designs done are usually not known by the buyer. Therefore, one cannot infer the true number of PLD designs from the table. Furthermore, it does not reflect the long-term potential of the PLD market. DATAQUEST believes that PLDs will become a very significant factor in applications that require low gate count, i.e., below 3,000 gates on chip. The CBD segment shows significantly less starts than gate arrays, but each CBD start will generate three to five times the production revenue of a gate array. Thus, what seems like a low number of design starts does not imply less production revenue in the future. Also, remember that CBD EDA tools are not as mature as those found in gate arrays. As more sophisticated EDA tools emerge, we expect the gap in design starts to narrow. A factor that could fuel CBD growth is the full-custom category. The percentage of CBDs versus full-custom suggests that by the end of the decade, full-custom designs will be replaced by CBDs. This is because they are less costly to design and can be done in a fraction of the time. Therefore, we believe that CBDs have a very significant growth potential as better EDA tools emerge.

OPPORTUNITIES AND CHALLENGES

Table 3 shows some very interesting insights into what could be both a challenge and an opportunity in disguise. This table shows the number of respondents classified by the six end-use categories and is further subdivided into ASIC users and nonusers. Note that industrial users and nonusers make up the largest segment. DATAQUEST believes that industrial applications are a good opportunity for suppliers that position themselves properly.

• Table 3

ASIC USERS VERSUS NONUSERS (Percent of Total)

<u>Users</u>	Nonusers
27%	228
16	16
35	45
5	2
16	15
<u> </u>	0
100%	100%
	<u>Users</u> 27% 16 35 5 16 <u>1</u> 100%

Source: DATAQUEST June 1986

At the same time, the industrial segment provides most of the challenge. Industrial users are a large group, but they often buy low production quantities and are evenly distributed throughout the geographical regions. Thus, the challenge to the supplier is how to promote, educate, service, and capture designs from the user base. It appears that a well-positioned gate array or PLD supplier may have a competitive advantage in this market.

The findings are much different for the consumer segment. The number of North American buying locations is very limited, but they tend to consume very high volumes per design. It should be noted that most consumer procurement is off-shore and thus is not reported in the table. The ASIC users in the consumer segment prefer CBDs or full-custom, largely because they offer the lowest unit cost.

A CLOSER LOOK

The following discussion examines application trends for three growing markets: PLDs, CBDs, and gate arrays.

PLDs--Application Markets

DATAQUEST estimates that worldwide consumption of PLDs in 1985 was \$241.9 million, with more than 97 percent consumed in bipolar technology. We are estimating that worldwide consumption will be \$1,016.7 million in 1990 (a CAGR of 28.4 percent between 1985 and 1990), with CMOS products capturing 52 percent of the sales.

As with most ASIC products in North America, the data processing segment is the largest application market for PLDs. As noted in Table 4, data processing applications are expected to consume 77 percent of all PLDs shipped in 1986.

Table 4

ESTIMATED NORTH AMERICAN PLD MARKET BY APPLICATION MARKET

End Use	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1990</u>
Data Processing	82%	76%	778	73%
Communications	7	7	7	8
Industrial	8	8	8	9
Consumer	0	1	1	2
Military	3	8	7	7
Transportation	0	0	0	_1
Total	100%	100%	100%	100%

Source: DATAQUEST June 1986 Among the more common applications mentioned for PLDs are the following:

- Replacement of control logic in computers
- Peripheral controllers
- CRT display systems
- I/O port decoders

Speed has always been a critical issue for PLDs because of their use in control path (decoding), data path (arithmetic logic units, storage applications), and interface applications. As CMOS technology advances and propagation delay times become closer to bipolar (25 to 35ns), we expect fundamental changes in the PLD market.

For those data processing applications that constantly push for greater speeds, users will turn to ECL PLDs, which should reach speeds of 6 to 15ns. CMOS will find applications that require greater functionality and lower power, where speed is of secondary importance.

The primary reason cited for CMOS PLD applications has been the replacement of "glue logic," thus offering roughly a four-to-one savings in component count. The data processing segment has been the first and most active market in terms of pushing for reduced component count and power savings.

CBDs--Application Markets

A closer look at applications for CBDs shows that these are young markets with bright futures.

Data Processing

As shown in Table 5, during the 1984 and 1985 time frame, the data processing industry was by far the largest market for cell-based ICs. In the past, the emphasis on replacing TTL logic functions gave the first generation of the cell-based suppliers a window of opportunity within data processing applications. Most cell-based IC manufacturers believe that although the data processing application will continue to dominate the market, it will begin tapering off between now and the end of the decade because of the pervasiveness of other segments.

Table 5

<u>End_Use</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1990</u>
Data Processing	63%	60%	59%	478
Communication	16	16	17	22
Industrial	8	8	8	11
Consumer	2	3	3	5
Military	7	8	8	8
Transportation	<u> </u>	5	5	7
Total	100%	100%	100%	100%

ESTIMATED NORTH AMERICAN CELL-BASED DESIGN MARKET BY APPLICATION MARKET

Source: DATAQUEST June 1986

Communication

There is a tremendous optimism about this market in the long term. We believe that because of expected high growth in communication equipment markets themselves and because of general opportunities for semiconductors within this sector, cell-based technologies will experience positive growth within the communication arena. Most applications come within telephony, modem, and PBX applications. Incorporating analog functions will also provide communication market opportunities because of filter and data conversion needs within the telecom market. However, there seems to be little use of the technology in central office applications.

Industrial

We believe that industrial applications also provide opportunity for all sectors of the ASIC market, including cell-based products. Incorporating solid-state electronics in industrial applications traditionally has occurred slowly. Today, the emphasis is on replacing traditionally mechanical and discrete semiconductor functions.

Frequently cited applications are process and numerical control, robotics, and factory automation. The MAP program has provided clarity , and emphasis on standards and communication protocol within the factory; thus, many semiconductor products are seeing a "more quantifiable opportunity" within the traditionally nebulous industrial market.

Consumer

To date, our estimates for the consumer marketplace have been fairly pessimistic. U.S.-based production of consumer electronic equipment has fallen dramatically, and we believe that this trend will continue. The Japanese consumer marketplace has centered on gate array technology. None of the manufacturers we spoke to were placing major emphasis on the consumer sector.

Our belief in modest growth in this sector lies primarily in changing the design methodology. Consumer products will utilize semicustom solutions in early production volumes of new equipment. If the product is successful, then a full-custom design will be used.

Military

DATAQUEST is optimistic about short-term prospects in the military market. We are, however, cautiously optimistic about the military markets' long-term opportunity because of political emphasis on cutting both the budget deficit and defense spending, coupled with a changing presidential administration in the near future.

The military market is a relatively small part of CBD consumption; possibly even lower than our current projections of 7 percent. Many manufacturers, however, are implementing military programs and product lines and are optimistic about stronger growth throughout the decade. Some manufacturers believe that the military will account for as much as 10 to 15 percent of their cell-based business within the next couple of years. Design-to-production cycles are lengthy, but once into production, military products tend to remain stable and experience long life cycles.

Transportation

The automotive applications were perhaps the most eagerly discussed by the manufacturers with which we spoke. Major applications for cell-based products can be found in the dashboard, engine control, and safety-convenience features. CBDs not only offer cost advantages in large volumes, but can handle high voltage requirements and expand overall functionality.

One possible cloud on the horizon stems from the automobile manufacturers' general refocusing to reduce their semiconductor supplier base. DATAQUEST agrees with ASIC vendor observations that these reductions might impact the ASIC supplier base in particular. Nevertheless, a willingness to maintain historical alliances will probably prevail unless a rival ASIC vendor has substantial advances in technology, cost, and quality "to bring to the party."

Gate Array--Application Markets

Many of the company representatives we spoke with earn the majority of their gate array revenue from the data processing segment. As shown in Table 6, we believe that this market sector withstood 1985 fairly well, but lost some market share to the military segment.

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Table 6

<u>End</u> Use	<u>1984</u>	<u>1985</u>	1986	<u>1989</u>
Data Processing	53%	47%	48%	41%
Communication	• 18	16	16	18
Industrial	12	12	12	15
Consumer	2	2	2	3
Military	15	22	21	22
Transportation	0	<u> </u>	<u> </u>	<u> </u>
Total	100%	100%	100%	100%

ESTIMATED NORTH AMERICAN GATE ARRAY MARKET BY APPLICATION MARKET

Source: DATAQUEST June 1986

Telecommunications applications also represent a sizable part of the market today. We believe that telecommunications combined with industrial applications represent opportunities for gate array manufacturers. Here again, the small volumes typically associated with industrial applications makes gate arrays an attractive solution.

We have seen little activity in the consumer and transportation segments. We know of only one manufacturer that has gate array design revenue from the auto market, and evidence of any future growth in this market is not anticipated.

WILL THE ADOLESCENT REACH ADULTHOOD?

The answer is an emphatic yes, but not without a maturing process. When DATAQUEST contemplates the issues discussed in this newsletter, the following conclusions become apparent.

ASIC Has a Long Way to Go

There are major revenue opportunities in all ASIC market sectors. In effect, ASIC suppliers have not saturated any end-use markets. The fundamental question is: Will the suppliers see the opportunity and will they act on it? Each of these applications markets is very differenteach places different demands on the supplier and each requires a deeper level of understanding of the application. For some of the nimble suppliers the answer is a definite yes. This means that they must develop in-house expertise in application markets and form alliances that foster and develop that expertise. Such changes can ripple through suppliers and affect business strategies. Thus the suppliers will require a marketing organization that understands the characteristics of the end market, an engineering organization that understands the technical requirements, and a top management organization that understands the strategic factors that influence the end market. Therefore, the maturing process involves understanding what the customer really wants.

Complex Procurement and Fewer Suppliers

In reviewing the responses to our survey questions, one gets a clear message that many procurement managers are perplexed and overwhelmed by the rapid change in ASIC design methodology. On the one hand, they wish to narrow the base of suppliers and shorten the development schedule, while on the other hand they must seek out the very latest in technology, which may widen the vendor base. To make matters more complex, using requires an understanding of the caliber of ASIC each design methodology. Not only is the semiconductor technology critical, but the EDA tools are just as important. DATAQUEST believes that this complexity will force users to seek out suppliers that understand their end market and that are willing to develop close working relationships. Their commitment will narrow the supplier base, since most users will be willing to work closely with only a few suppliers.

ASIC Suppliers Will Concentrate on Certain End Markets

It also seems inevitable that many of the smaller ASIC suppliers that cannot afford to be broad-line suppliers must focus on certain applications. They will tailor their process technology, EDA tools, and design centers toward those end-use applications that best match their strengths. For example, some suppliers will focus on data processing while others may aim at the communication or industrial sectors.

So, like the adolescent who ultimately does something sensible, ASIC companies will develop those important characteristics that will sustain them through adulthood. Each will draw upon its own natural attributes and develop its own unique personality.

Anthea Stratigos John Brew Andy Prophet



July-September

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: July-September 1986-17

TWO MORE COMPETITORS ENTER THE PC RACE: BUSINESSLAND AND COMPUTERLAND

SUMMARY

Two events that will have major impact on the personal computer industry occurred in the last month. On June 11, 1986, Businessland upstaged its competitors by announcing a colabeling agreement with Wyse Technology, Inc., of San Jose, California, for an Intel 80286-based AT-compatible personal computer. On June 16, 1986, ComputerLand Corporation announced two private-label personal computers. Dataquest believes that these announcements will trigger additional private-label arrangements within the next 60 days. The impact will be felt most by IBM, Compag, AT&T, and ITT.

THE ANNOUNCEMENTS

The Businessland PC 286 Computer by Wyse

The Businessland PC 286 computer by Wyse, which will now be referred to as the BPC286CBW, is a switch-selectable 6- or 10-MHz system that has 640 Kbytes of RAM, a 1.2-Mbyte flexible disk drive, an enhanced 102-key keyboard, a disk controller board, eight expansion slots, a parallel and a serial port, and a battery-backed real-time clock for a suggested list price of \$3,295. A system with a 30-Mbyte rigid disk is offered for \$4,795. Volume availability is planned for late July or early August.

The two BCP286CBW systems are designed and manufactured in Taiwan by Wyse, with the BIOS from Phoenix Software. The keyboards and power supplies are also manufactured by Wyse. Wyse will make the systems available without keyboards, should customers desire an IBM or Keytronic keyboard in lieu of the Wyse keyboard. In addition to running DOS 3.1 and GW-Basic, the BPC286CBW will also run Santa Cruz Operations Xenix. Wyse will market its version of the BPC286CBW through its distribution network in the United States.



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The ComputerLand Business Computing Systems

ComputerLand Corporation announced two PC models: the BC88 and the BC286. The ComputerLand system consists of a chassis containing a 155-watt power supply, a keylock, brackets to mount up to four internal half-height storage devices, an AT-style keyboard, and eight expansion slots (five AT slots and three XT slots). There is no motherboard in the chassis. To configure a BC88, a store will add in a two-card set. The first card is a PC/XT motherboard with clock/calendar and an Intel 8088-2 processor, switch selectable for either 8 or 4.77 MHz. The second card is a multifunction card containing 256 Kbytes of RAM with sockets to expand to 640 Kbytes, a flexible disk controller, and a serial and a parallel port. The chassis has a smaller footprint and is roughly the same as the AT&T 6300 or the ITT Xtra.

The BC286 is a three-board set added into the same chassis. The first board contains the Intel 80286-2 processor at 8 or 6 MHz and clock/calendar. The second is a multifunction board with 512 Kbytes of RAM expandable to 2 Mbytes, two serial ports, and one parallel port. The third is a flexible/rigid disk controller card. All three boards take up AT-compatible slots. The chassis will accept other industry-standard add-in boards.

The BC88 is available as of June 16, 1986, but it is likely to be supply constrained through September. The BC286 card set will be available in six to eight weeks. The BC88 and BC286 have suggested retail prices of \$1,495 and \$2,895, respectively (chassis \$697.50, BC88 board set \$797.50, BC286 board set \$2,197.50). The BC88 and BC286 have been designed by Great West Technologies, Inc., a ComputerLand subsidiary. Dataquest has learned that they are manufactured by Tri-Gem in Korea.

DATAQUEST ANALYSIS

Semiconductor Impact

Both the Businessland PC 286 and ComputerLand models are indicative of the trend toward manufacturing of computer systems in the Far East. Taiwan and Korea are two of the emerging giants in production of inexpensive electronics hardware.

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The implication for North American semiconductor manufacturers is the continued loss of market to foreign suppliers. The problem is twofold:

- The foreign manufacturers are more likely to procure semiconductors from regional suppliers, as opposed to U.S. semiconductor vendors.
- The lost market share encountered by U.S. PC manufacturers will adversely affect the domestic semiconductor manufacturers trying to sell to these accounts.

Thus, the increased unit shipments expected from the PC industry in the next few years will most likely not have the frenzied impact on U.S. semiconductor manufacturers that the 1983 through 1984 boom caused. Nevertheless, the increase in revenue will be significant, especially for 1987 and 1988. Table 1 helps illustrate this point using recently published Semiconductor Application Markets data.

The increasing I/O ratio from 1985 on is a result of two factors:

- The cost of the end-product (the PC) continues to fall as the market is flooded with low-cost PC-clones, especially those coming from the Far East.
- Semiconductor pricing is stabilizing as the industry moves out of a depression into a growth period in 1987 through 1988.

Table 1

SEMICONDUCTOR VALUE ASSOCIATED WITH NORTH AMERICAN SHIPMENTS OF PERSONAL COMPUTERS (Millions of Dollars)

	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>
PC Revenue (<\$10,000)	\$10,722	\$17,914	\$21,616	\$23,295	\$25,646	\$30,756
I/O Ratio	9,2%	11.7%	6.1%	6.3%	7.9%	9.1%
Semiconductor	\$ 983	\$ 2,098	\$ 1,326	\$ 1,465	\$2,020	\$ 2,808

Source: Dataquest July 1986

Personal Computer Impact

Dataquest believes that these announcements by two retail leaders mark a significant turning point that will have a major impact on the PC industry. Businessland and ComputerLand are now direct competitors, in addition to partners and customers of AT&T, Compaq, IBM, and ITT. These colabel and private-label agreements provide product exclusives and higher margins to the stores (Dataquest estimates the margins at 50 to 55 percent) at lower suggested retail prices than AT&T, Compaq, IBM, and ITT. These machines are positioned and targeted against the high-end PC and compatible players, not the Leading Edge, Epson, or generic PC companies.

We believe that Businessland and ComputerLand will use these products as "fighting machines" against the IBM direct sales force in the volume bid situations, and we believe that they will have success. This success will come primarily at IBM's expense and secondarily at Compaq's, precipitating competitive responses. The likely responses are:

- Pricing actions
- Marketing actions
- Product actions

We believe that an IBM pricing action would not be offset by volume increases. Besides, Businessland and ComputerLand can easily match the price reductions. In this situation, no one wins and the dealers are hurt. Therefore, a pricing action accomplishes nothing. Marketing actions such as a sweetening of the ProPlan are likely but only short-term solutions. Again, Businessland and ComputerLand can match marketing actions.

We believe that these colabel and private-label moves will accelerate new product introductions. These new products must and will offer exclusives that cannot easily be copied.

The last two years have been relatively dull, from a product standpoint, in the PC industry. This dullness has been reflected in a flattening of the unit shipments. Dataquest believes that the next two years hold challenge, opportunity, and growth through new products and new functions that will be introduced by the leaders. These introductions will fuel a renewed growth of the industry.

The PC industry race will be won by the swiftest runners. Up to this point, some of the leaders have been coasting. It is now time to pick up the pace.

(Portions of this newsletter were originally published by Dataquest's Personal Computer Industry Service.)

John Brew Norm DeWitt Dataquest a company of The Dun & Bradstreet Corporation

RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletter: July-August 1986-18

QUARTERLY ELECTRONIC EQUIPMENT UPDATE: SLOW ECONOMY CONTINUES TO MODERATE GROWTH IN ELECTRONICS

SUMMARY

Electronic equipment production levels continue to be disappointing, as sluggish economic conditions are restricting capital spending by large corporations. Dataquest believes that North American electronic equipment production will rise a modest 9.0 percent in 1986, falling short of the 9.6 percent growth registered in 1985. With slightly improved conditions expected in the second half of 1986, an 11.9 percent increase is forecast for 1987.

Lower interest rates and energy costs were expected to greatly spark the economy. Unfortunately, the disappointing conditions are evidenced by the fact that:

- Industrial output has fallen four times in the first six months of 1986.
- Capital spending in the second quarter decreased a seasonally adjusted 1.4 percent from the same period last year.
- The GNP increased at a 1.1 percent annualized rate in the second quarter, making President Reagan's goal of 4.0 percent growth for 1986 seem unattainable.

Confusion over impending tax legislation and budget restrictions have also contributed to the uncertainty in the economy.

While the news is not all bad--a weakening dollar has helped U.S. exports--any recovery in the electronics industry in 1986 now appears likely to be modest, with no signs of strength until the latter part of this year and 1987.

Figure 1 shows the historical relationship (1970 through 1985) between semiconductor consumption and electronic equipment production and includes our forecast through 1990.

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COMPARISON OF SEMICONDUCTOR CONSUMPTION AND ELECTRONIC EQUIPMENT PRODUCTION



Source: Dataquest August 1986

OUTLOOK FOR APPLICATION MARKETS

Table 1 contains our updated revenue forecast by application market for North American electronic equipment production. The ensuing discussion highlights the events that are expected to affect the different application markets in the near future.

Table 1

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SEGMENT OVERVIEW NORTH AMERICAN ELECTRONIC EQUIPMENT REVENUE FORECAST (Millions of Dollars)

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Correct		1495		1086		1097		1989		1090		1000	CAGR	000
<u>Sedmeur</u>		1303		1700		1907		1700		1307		1330	1300-1	220
DATA PROCESSING														
Computers Data Storage	\$	50,335	\$	54,037	\$	61,225	\$	71,881	\$	80,160	\$	86,671	12.5	•
Subsystems		16,107		18,114		20,232		20,772		21,351		21,775	4.7	۹.
Terminals		4,512		4,758		4,907		5,292		5,493		5,827	5.2	•
Input/Output		7,326		8,348		10,059		11,319		12,068		12,307	10.2	•
Pedicated Swaters		E 043				5 200		£ 070		7 970		8.600	0.9	•
Siercens	-	31743		31003			-		-		-	07000	2.2	•
Subtotal	\$	84,222	\$	91,141	\$	102,720	\$	116,242	\$1	L27,042	\$.	135,180	10.4	1
COMMUNICATIONS														
Customer														
Premises	\$	9,712	\$	10,495	\$	11,648	\$	13,317	\$	15,032	\$	16,525	12.0	•
Pub. Telecom		6,273		6,797		7,166		7,438		7,993		8,584	6.0	8
Radio		4,854		5,575		6,503		7,325		8,432		9,494	14.2	
Studio		1.666		1.916		2.433		2.719		3.261		4.286	22.3	
Other		2,720		3,105		3.648		4,104		4,692		5.174	13.6	Ň
							_		_		_			-
Subtotal	\$	25,225	\$	27,868	\$	31,399	\$	34,902	\$	39,411	\$	44,063	12.1	8
INDUSTRIAL														
Security/														
Bnecgy Hgmt.	\$	2,237	\$	2,464	\$	2,654	\$	2,768	\$	2,872	\$	3,065	5.6	۹.
Mfg. Sys.								•						_
Inst.		18,113		19,292		22,287		24,160		25,087		26,960	8.7	9
RODOL Systems		528		048		757		393		1,122		1,320	19.5	*
Renices		6.463		7.030		7.699		8.535		9.520		10-430	10.4	•
Compercial		.,		.,		.,		•,••		5,524		10,100	1011	•
Aviation		2,141		2,263		2,443		2,616		2,702		2,893	6.3	
Other	_	5,498	_	6,124	_	7,100	_	7,870	_	8,746	-	9,636	12.0	8
Subtotal		34.979		37 821		47 939		46 947		50 .049		54.304	9.5	•
	•		Ť		Ť	12,702	-	10,212	•	50,045	•	54,004	515	•
CONSUMER										•			•	
Audio	\$	255	\$	283	\$	324	\$	332	\$	360	\$	402	9.2	
Video		4,701		5,092		5,201		5,370		5,656		5,935	3.9	ŧ –
Personal														
Electronics		600		641		720		756		794		10 001	5.7	8
Appliances		9,192		1 080		11,000		1 127		14,090		14,891	3.6	e e
orner .	-	370	-	1,033	-	1/110	-	4,107	-	1/210	-	11270	4.0	•
Subtotal	\$	16,324	\$	17,447	\$	18,429	\$	19,146	\$	20,126	\$	21,299	5,1	8
MILITARY	\$	49,833	\$	54,800	\$	60,679	\$	64,630	\$	68,301	\$	71,680	6.9	ŧ
TRANSPORTATION	\$	8,480	\$	9,580	\$	10,809	\$	11,799	\$	13,812	\$	15,050	12.0	•
Total	\$:	219,063	\$3	238,677	\$3	266,975	\$	293,662	\$3	318,740	\$:	9 41,575	9.4	2

Source: Dataquest July 1986

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Data Processing

Computers, especially larger systems, are directly affected by capital spending. Lower-than-expected corporate spending is slowing sales into the U.S. market. For North American personal computer (PC) manufacturers, sales revenue is expected to rise 3.0 percent in 1986, growing at a compound annual growth rate (CAGR) of 9.4 percent through 1990. For all other computer segments, 1986 revenue is expected to close 10.6 percent above 1985, with a CAGR of 14.6 percent through 1990.

In the PC segment, 1986 is shaping up as the year of the low-cost IBM PC clone. IBM, as well as most other PC manufacturers, has been forced to slash prices to stay competitive with imports. Taiwan, Korea, and other emerging electronics manufacturers in the Far East are making their presence felt as they grab the low end of the market, and they are supplying machines to retail outlets that have begun selling PCs under their own brand names. Hence, while unit shipments have recovered somewhat from last year, total revenue for the PC industry is expected to remain relatively flat as price reductions abound.

Companies with a strong presence overseas have been helped by the weakening dollar and strong yen. Foreign markets have been making up for the sluggish domestic demand, indicating that the United States is still trying to digest all the computing power that was purchased during the last industry upswing.

The one bright spot in the computer industry is the continued strength of technical computers. U.S. manufacturers have asserted a dominance in this field that is characterized by varied technical applications for high-performance computers. Figure 2 shows the percentage breakout (in terms of revenue) of technical applications for 1985 and 1990.



TECHNICAL COMPUTER APPLICATIONS

Revenue for technical computers is expected to increase at a CAGR of 25.5 percent through 1990, far outpacing PC (9.4 percent) and business computer (5.0 percent) growth. The remainder of the year should hold improved conditions for the entire computer industry, although a dramatic recovery is not forecast. The most recent (May 1986) Department of Commerce (DOC) data indicate that the rate of U.S. consumption for computers and office equipment is still declining, although it is apparently beginning to bottom out. These data are shown in Figure 3. Bookings, as shown in Figure 4, recovered slightly in May. However, it is still too early to conclude that these will turn into improved shipments in the second half of this year.

U.S. CONSUMPTION RATES OF CHANGE--COMPUTERS AND OFFICE MACHINES



Source: Department of Commerce Dataquest August 1986





Source: Department of Commerce Dataquest August 1986 Although the sluggishness of the computer industry has slowed growth in many related equipment industries, there continue to be new, rapidly expanding markets in high-capacity Winchester disk drives, graphics terminals, and nonimpact printing technologies (ink jet and thermal transfer). Revenue for the entire data processing sector is forecast to increase 8.2 percent this year, with a CAGR of 10.4 percent through 1990.

Communications

The communications sector is expected to grow 10.6 percent in 1986, with revenue increasing at a CAGR of 12.1 percent through 1990. This year has seen mixed results for the communications segment; the slow growth in telephones, telephone systems, and switching equipment has been offset by strong revenue gains in high-speed modems and T-1 multiplexers.

Telephone equipment manufacturers in the United States have felt the strong presence of the Japanese and Korean companies. This has been especially true in single-line telephone equipment and key systems. Growth has also been slow in most private branch exchange (PBX) segments as competition in this crowded market has eroded revenue in the last two years. While central office exchange networks (especially digital lines) have seen strong growth the past three years, shipments are expected to level off by the end of 1986.

Data communications equipment will provide much of the future growth in the communications market. Tying together the installed computing and communications power is seen as the major challenge for computer and telecommunications companies in the next few years. Dataquest's Telecommunications Industry Service recently published the matrix in Table 2, which illustrates the battling technologies for connectivity of the desktop.

Table 2

DATAQUEST CONNECTION MATRIX

...

Year	Type of Desktop Device	Estimated Installed Base at Year-End (<u>M Units</u>)	Perc	E: contage <u>PBX</u>	stimato <u>Conne</u> Data <u>PBX</u>	ed <u>ected '</u> Hard- <u>wired</u>	Via: Remote	Not Connected
1985	Display terminal	10.1	5.1%	0.5%	13.8%	56.8%	23.8%	0.0%
	Word processor	1.1	9.4%	0.2%	2.2%	26.0%	5.9%	56.3%
	IV/DW	0.2	1.7%	51.6%	0.0%	10.5%	26.7	9.4%
	Electronic typewriter	3.3	0.0%	0.0%	0.0%	0.5%	1.5%	98.0%
	Personal computer*	9.7	4.3%	0.1%	3.8%	13.0%	10.4%	68.4%
	Total	24.4	4.2%	0.7%	7.3%	30.0%	14.7%	43.0%
1986	Display terminal	11.5	7.5%	1.3%	18.43	49.5%	23.2%	0.0%
	Word processor	1.2	11.4%	0.8%	3.4%	27.7%	5.8%	50.9%
	IV/DW	0.4	2.6%	48.8%	0.0%	13.8%	26.7%	8.1%
	Electronic typewriter	4.6	0.0%	0.1%	0.0%	1.0%	2.1%	96.8%
	Personal computer*	13.4	5.5%	0.2	5.0%	12.5%	16.8%	60.0%
	Total	31.0	5.6%	1.3%	9.1%	25.1%	16.7%	42.2%
1990	Display terminal	16.3.	18.3%	8.2%	25.5%	27.0%	21.0%	0.0%
	Word processor	0.6	13.2	2.6%	6.3%	39.8%	4.8%	33.3%
	IV/DW	3.2	7.5%	40.0%	0.0%	22.8%	23.8%	5.9%
	Electronic typewriter	7.2	0.0%	0.9%	1.1%	3.3%	4.8%	89.9%
	Personal computer*	26.1	11.8	0.9%	6.2%	13.0%	26.0%	42.2%
	Total	53.5	11.9%	5.5%	11.0%	16.9%	21.2%	33.4%

*Excluding integrated voice/data personal computers

Source: Dataquest July 1986

The connectivity matrix is based on a forecast incremental addition of 29 million desks (of workers) that will gain information devices (display terminals, personal computers, electronic typewriters, word processors, or integrated voice/data terminals) in the next five years. Of the 24 million devices in the installed base today, more than half are connected. By 1990, two-thirds of the 53 million devices will be connected. Taking into account some replacements as well as additions to the installed base, this translates to about 25 million new desktop devices being connected in the next five years. At an average sales revenue of \$700 per connected unit, there is a \$17-billion market at stake.

With the battle for the desktop and upgrading of public transmission equipment, the entire communications sector is forecast to be the fastest-growing market segment through 1990.

<u>Industrial</u>

The industrial segment has felt the impact of the slow economy as much as any application market. Semiconductor production and automatic test equipment are both expected to record lower revenue figures in 1986 (versus 1985), due mainly to the overcapacity installed in the past two years and the current conditions in the semiconductor industry. Dataquest's Semiconductor Equipment and Materials Service (SEMS) forecasts that worldwide capital spending by semiconductor manufacturers will decrease 4.8 percent in 1986. Table 3 gives the complete forecast for all regions of the world through 1990.

Table 3

ESTIMATED WORLDWIDE CAPITAL SPENDING BY SEMICONDUCTOR MANUFACTURERS (Millions of Dollars)

	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	CAGR 1986-1990
North America	\$2,211	\$2,193	\$3,569	\$ 4,579	\$ 4,528	\$ 5,410) 25%
Japan	3,346	2,980	3,905	4,495	4,679	5,509) 17%
Europe	381	430	589	817	950	1,119) 27%
ROW	242	263	394	533	593	751	L 30%
Captive	<u> </u>	482	<u> </u>	<u>1,007</u>	<u> </u>	1,190	25%
Total*	\$6,667	\$6,349	\$9,242	\$11,432	\$11,746	\$13,980) 22%

*Columns may not add to totals shown because of rounding.

Source: Dataquest July 1986 As with so many other equipment areas, the weakening dollar and the more stable European market has greatly helped many North American manufacturers who have a strong presence in international trade.

Equipment areas within the industrial sector that are expected to show strong growth in 1986 and 1987 include portable oscilloscopes, robot systems (especially assembly and material-handling/loading applications), aircraft/navigational instruments, and laser systems.

Consumer

While consumption of consumer electronic goods continues to increase in the United States, the growth in manufacturing is occurring in Taiwan, Korea, Hong Kong, and other Far Eastern nations. Production of consumer electronic equipment in North America is expected to increase 4.7 percent in 1986, with a CAGR of 6.2 percent through 1990. Most of the revenue will continue to be from games, appliances, and color televisions.

Compact disk players (CDs) and videocassette recorders (VCRs) are expected to be the fastest-selling items in the U.S. market, with revenue advancing 65.9 percent and 11.8 percent, respectively, over 1985. Color televisions are forecast to continue their slight growth, despite the fact that an estimated 98 percent of American homes currently have a television. Additional features, such as remote control and digital pictures, have made new television products attractive replacement items.

Military

Although recent Department of Defense (DOD) forecasts project no real growth in the next 10 years for the defense budget, military electronics is one portion of the industry that is forecast to show revenue increases. The revenue growth for military electronics is expected to be 10.0 percent for 1986, down from the 13.1 percent increase in 1985. Through 1990, Dataquest forecasts that the CAGR for military electronics will be 6.9 percent.

A number of factors are causing the once stable, staid military market to undergo fundamental changes. Among them are:

- The Gramm-Rudman Act and its power to cut the budget
- The push to slow the defense buildup implemented under the Reagan administration
- The Packard Commission's examination of defense contractors

- Increased competition for contract bidding
- Mergers and acquisitions among defense contractors

The first two factors are the basis for the DOD's forecast for virtually no real growth in the defense industries for the next 10 years. Congress has been especially vocal concerning reductions in the military budget. While key provisions in the Gramm-Rudman Act were declared unconstitutional, there is a general consensus that the defense budget will be affected by this act in the future.

The Packard Commission (headed by Hewlett-Packard's chairman, David Packard), appointed by President Reagan to study the role between contractors and the Defense Department, has gained widespread notice for its recommendations. Essentially proposing that the government act more like a business in dealing with contractors, specific recommendations include:

- Increased purchase of off-the-shelf products, including more standardization of similar commercial and military components
- Reduction in the bureaucracy associated with scheduling of separate parts of a major program
- Greater use of prototypes before full-scale production of equipment

One of the ways in which the DOD is beginning to act more like private business is through the use of more competitive bidding; the U.S. Navy has been the leader in soliciting competitive proposals for work.

With the prospect of little future revenue growth (in terms of new projects), large defense contractors have been active in seeking acquisition of smaller, electronic defense and communication contractors. Lockheed's \$1.2-billion tender for Sanders Associates is indicative of the fundamental changes occurring in the defense industry. Just weeks before, Loral Corp. failed in an attempted hostile bid for Sanders. More activity and consolidation within the industry is likely as defense contractors struggle with the prospect of leaner years ahead.

Transportation

For the first six months of 1986, North American car and truck production stood at 7,350,955 vehicles. This represented virtually no growth over the first six months in 1985, when production was 7,349,268.

Despite widespread incentives, such as lower financing rates, domestic car sales were 4.1 percent lower than for the same period last year. Imports captured 26.7 percent of the U.S. market.

The revenue associated with automotive electronics continues to increase as numerous functions become more semiconductor-intensive. Dataquest forecasts that revenue for the automotive electronic market will rise 12.8 percent this year, with a CAGR of 12.0 percent through 1990.

John Brew

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RESEARCH NEWSLETTER

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THE INNOCUOUS FACSIMILE MACHINE--A WORLDWIDE PERSPECTIVE

After many years of effort, the facsimile (fax) machines are finally enjoying widespread popularity. Worldwide growth rates in the past two years have exceeded 75 percent and production should exceed 2 million units per year by the end of this decade. This newsletter is a joint effort of Dataquest's research offices in London, San Jose, and Tokyo, and investigates the market forces, suppliers, and distributors shaping this dynamic industry.

INTRODUCTION

The success of facsimile equipment can be summarized by the old adage, "a picture is worth a thousand words." Facsimile machines, capable of sending and receiving documents and connected together by the public switched telephone network (PSTN), have found their way into almost every large company and many smaller companies in the world today.

There are approximately 2 million units currently in operation. Japan is the largest market with approximately 55 percent of the total, and the United States is second with 21 percent. Production of facsimile machines, primarily in Japan, has grown significantly in the past two to three years, with an average annual growth rate of 70 percent.

Equipment placements, or consumption, varies significantly by country, as reflected in Table 1. Japan accounts for the majority of the placements, with 738,000 units expected to be installed in 1986. The United States is the second largest market with an estimated 206,000 placements in 1986, and Europe is expected to account for 128,000 placements.

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Table 1

FACSIMILE CONSUMPTION ESTIMATES (Thousands of Units)

				CAGR
	<u>1985</u>	<u>1986</u>	<u>1990</u>	<u>1986-1990</u>
Asia	30	40	121	32.0%
Europe	86	128	278	21.4%
France	15	18	33	16.5%
Italy	9	14	33	23.5%
Sweden	5	7	17	23.7%
United Kingdom	21	36 ·	77	20.8%
West Germany	11	15	34	22.4%
Rest of Europe	25	38	85	22.4%
Japan	529	738	1,299	15.2%
North America	171	227	444	18.3%
United States	157	206	403	18.3%
Canada	14	21	41	18.2%
Rest of World	20	25	61	25.0%
•			Source:	Dataquest

July 1986

Definitions

Group I machines transmit at either four or six minutes per page using analog frequency modulation; they have a resolution of 98 lines per inch in both horizontal and vertical axes.

Group II machines transmit at either two or three minutes per page using analog amplitude modulation; they have a resolution of 98 lines per inch in both horizontal and vertical axes.

Group III machines transmit at one minute per page using digital encoding; they have a standard resolution of 203 horizontal by 98 vertical lines per inch, and a fine resolution of 203 by 196 lines per inch.

EUROPEAN MARKET PERSPECTIVE

When looking at the European facsimile market, it must be noted that a homogeneous market does not exist. It consists of 26 separate national markets, each with its own culture, tradition, and preferred method of

- 2 -

doing business. Table 2 indicates the 1985 placements of the most significant of these markets. The United Kingdom is the largest European market; the second largest is France.

Table 2

ESTIMATED 1985 EUROPEAN FACSIMILE PLACEMENTS (Units)

Country	Units
United Kingdom	20,600
France	15,460
West Germany	10,900
Italy	9,040
The Netherlands	5,350
Norway	5,250
Sweden	5,180
Switzerland	2,450
Belgium	1,900
Greece	1,850
Finland	1,650
Denmark	1,450
Spain	1,050
Turkey	900
Ireland	900
Austria	600
Rest of Europe	<u>1,150</u>

Total

86,330

Source: Dataquest July 1986

Placements

Europe was initially slower to accept fax technology than Japan and the United States, and in consequence few Group I machines were installed in Europe. European consumption in 1982 reached 23,400 units, but with the arrival of the lower-cost Group III equipment, the market saw a significant increase in shipments in 1985, with approximately 86,300 units.

The United Kingdom experienced the largest growth rate in 1985, 106 percent, and continues to be the most dynamic and competitive of all European markets. In 1985, Dataquest noted 15 competing suppliers in this market.

In the whole of Europe, 1985 shipments grew by 73 percent from 1984 levels, although regional differences were common, for example, the French market. Although it is the second-largest market, the French

market grew by only 20 percent. Dataquest believes it would have grown considerably more if French government policy had permitted a greater choice of suppliers. Currently Thomfax (the only remaining European domestic manufacturer) has an 85 percent share of the French market.

The West German market is only the third-largest European market due to the Deutsche Bundespost's (the German PTT) policy of promoting alternative text messaging systems such as videotex and teletex. These alternative programs have, however, seen poor levels of acceptance and in consequence, fax shipments increased 72 percent between 1984 and 1985.

Dataquest expects Europe to continue to show good growth in 1986, with shipments expected to reach 128,000 units, which equates to an annual growth rate of 48 percent. The United Kingdom is forecast to have the largest growth rate, 110 percent, and is expected to reach 40,000 unit shipments for the year. These continued high growth levels reflect a less mature market situation than in the United States and Japan, but after 1987, shipments are expected to slow to an average 21 percent compound annual growth rate (CAGR) from 1986 through 1990.

Selling Price

European fax prices are 10 percent higher than those in the United States. Price fluctuations, however, have generally been in line with those of Japan and the United States, which reflects the overwhelming Japanese origin of these products. Some countries experience a generally higher price level due to either a less competitive or a less developed market as well as higher markups in the distribution channels. Large exchange rate shifts during 1985 and 1986 have also caused regional price differences. As a general indicator, however, 1985 saw a 21 percent reduction in prices.

An example of the pricing pressures is the Canon 220. In May 1986, the machine was introduced in the U.K. market. This product offers midrange features at a 20 percent lower list price than comparable machines and is likely to pull prices down. This trend is being resisted by other suppliers because Canon is currently unable to meet supply demands. The fluctuation of the yen is a second reason why manufacturers are resisting a downward pricing trend.

In each case, prices have come down to a level that makes fax a commodity product that is affecting channels of distribution.

Distribution

This is the area where there are major regional differences. In countries where markets are open and competitive, the channels of distribution have moved "down market." This trend implies that the vast majority of products are now being sold through indirect distribution channels, such as specialist office supply dealers.

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The United Kingdom is the best example of indirect distribution. Of the 15 suppliers active in the market, Dataquest notes that one has signed up 101 dealers. Three others have 40 dealers, while six other aggressive competitors each have at least 10 dealers.

As prices continue to decline with the entry of low-end machines, Dataquest expects to see an evolution of new low-end channels, such as catalog, specialty mail order, and retail stores.

In countries with more regulated markets, such as West Germany, distribution is still primarily through OEM arrangements with the main telecommunications manufacturers. This is slowly changing as more Japanese manufacturers establish operations and find most OEM companies already have partners. To penetrate the market, the manufacturer is forced to establish its own distribution dealer networks. Dataquest believes that in these more traditional markets, the largest market share will continue to be held by the OEM suppliers due to their strong, established, and relatively unchallenged position in the telecommunications market.

JAPANESE MARKET PERSPECTIVE

Since network deregulation in 1972, the facsimile market in Japan has grown more than any other market in the world. The last five years have seen a 55.8 percent CAGR, and we estimate that it will grow at 39 percent, to 738,000 units, in 1986. Dataquest expects the overall growth rate to moderate in the future to an estimated 15 percent CAGR through 1990.

Dataquest estimates that there were 1 million units in operation in Japan during 1985, and that Group III equipment accounted for 71 percent of the total. By 1990, we estimate that there will be 3.6 million units in operation in Japan.

Production

Japan is also the world leader in production of facsimile machines. As is true with low- and middle-range plain paper copier products, nearly 100 percent of the facsimile equipment is produced in Japan and exported to worldwide markets.

In 1985, 866,000 facsimile machines were produced by major Japanese office automation manufacturers such as Canon, Fujitsu, Hitachi, Mitsubishi, NEC, Panasonic, Ricoh, Sharp, and Toshiba. We estimate that Canon, Panasonic, and Ricoh are the market share leaders and together account for 60 percent of the total facsimile production.

Production of facsimile equipment has grown 61.5 percent in the last five years, and we expect production to exceed 1 million units in 1986. We believe that Japan will continue to be a world supplier of facsimile equipment, with a production volume expected to exceed 2 million units by 1990, as indicated in Table 3.

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Dataquest estimates facsimile semiconductor consumption will reach \$598 million in 1990, as reflected in Table 4. However, because almost 100 percent of all fax machines will probably continue to be produced in Japan, it will be difficult for North American semiconductor manufacturers to penetrate the fax machine market.

Table 3

FACSIMILE PRODUCTION ESTIMATES (Thousands of Units)

	<u>1985</u>	<u>1986</u>	<u>1990</u>	CAGR <u>1986–</u> 1990
Japanese Production	866	1,136	2,099	16.6%

Source: Dataquest August 1986

Table 4

ESTIMATED FACSIMILE SEMICONDUCTOR CONSUMPTION (Millions of Dollars)

	<u>1985</u>	<u>1986</u>	<u>1990</u>	CAGR <u>1986–1990</u>
Japanese Production	\$1,338	\$2,243	\$3,378	13.6%
Facsimile I/O Ratio	15.5%	16.0%	16.0%	N/A
Semiconductor Consumption	\$ 207	\$ 359	\$ 598	13.6%

N/A = Not Applicable

2

Source: Dataquest August 1986

Selling Price

The average selling price (based on manufacturers' shipment price) of facsimile equipment has declined 18.5 percent in the last five years. We expect this price decrease to moderate during the next five years when shipments of Group IV and plain paper-featured machines cause manufacturers to compete on price/performance rather than to decrease the list price.

Price reductions have been the largest contributing factor to the rapid growth of the last several years. Typical Group III prices in 1981 were 2.5 million yen (\$10,000), but today's low-end Group III facsimile machine is only 390,000 yen (\$2,295).

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As if the above example were not dramatic enough, street prices vary significantly, but are usually 30 to 50 percent less than the list price, depending upon the individual model and the level of competition. We believe that price competition in the Japanese domestic market will continue to be aggressive due to the need to maintain or to increase market share.

Distribution

Several years ago, facsimile equipment was almost exclusively distributed by the manufacturer's direct sales force. As a result of price reductions, increased performance, and 13 new competitors, facsimile equipment is now targeted at office automation markets, closely following the trend of plain paper copier products and key telephone systems.

Today office automation manufacturers are taking advantage of their well-established plain paper copier distribution network in order to sell facsimile equipment. Canon and Ricoh, which are strong in the copier industry, are becoming market leaders in the facsimile industry. Fuji Xerox, which mainly sells copy equipment through direct channels, is aggressively expanding distribution channels to meet the challenge.

U.S. MARKET PERSPECTIVE

Only in the past two years has the facsimile market in the United States grown to meet the expectations of many people in the industry. During this time, annual growth has exceeded 50 to 75 percent, with the majority of the growth by the newer, lower-cost, faster, Group III equipment. In 1985, placements of facsimile equipment increased 76 percent from 1984 volume levels, with Group III equipment accounting for over 93 percent of the volume.

In 1986 we expect to see smaller growth rates of approximately 31 percent, to just over 200,000 units sold. Dataquest expects that the growth rate will taper off in the next five years, stabilizing at an average of 18 percent.

Selling Price

Average selling prices have fluctuated significantly in the past year. During 1985, prices decreased an average of 17 percent. However, in the first quarter of 1986, prices climbed slightly to reflect the changing yen-to-dollar ratio. We expect prices to drop again as newer models are introduced. This trend will be moderated by new higher-cost plain paper and Group IV equipment. The 1986 prices should decline an average of 9 percent from 1985 levels, and we expect a 2 percent average annual decrease from 1986 to 1990.

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Distribution

Distribution outlets for facsimile equipment have changed significantly recently. Three years ago most equipment was placed by a manufacturer's direct sales force on a rental contract. Today, the majority of equipment is sold or leased through indirect distribution outlets such as an office supply dealer. Reasons for this shift can be attributed primarily to decreasing cost and profit margins of the equipment.

The U.S. market is experiencing a glut of facsimile distributors. All major suppliers are actively seeking dealer outlets in order to increase volume shipments. In addition to expanding dealerships, several companies are restructuring and/or merging to better penetrate today's market. Two recent examples of restructuring in the industry are the founding of the Harris/3M Business Products Inc. joint venture and Fujitsu's acquisition of the Burroughs Imaging Systems Division.

DATAQUEST ANALYSIS

Facsimile machines have reached "critical mass" in the market. The market is over the hump--there are now enough machines operating for the market to be self-perpetuating.

But caution should be exercised. Decreasing prices and the increasing commodity status of facsimile equipment have caused many suppliers to expand actively dealer distribution networks in order to maintain or increase volume and profit levels. This has created a distributor glut that will no doubt result in a shake-up of some suppliers and distributors.

Facsimile equipment has changed in the past and we expect more changes in the future.

- The trend toward plain paper is expected to continue. Considering the price reductions of laser printer engines, we believe that today's emphasis on thermal-transfer as a plain paper solution is short-lived and will not be accepted as a long-term plain paper solution.
- We expect the facsimile market to stratify into three components based on price points. At the low end (\$2,000 and lower), we believe there will be a plethora of new product introductions targeted at the dealer and mass merchandiser. These low-end products are expected to typify the traditional image of a commodity product with moderate features and thermal paper output.
- We expect the majority of the products to migrate to the midrange of our price scale (\$2,000 to \$4,000). This segment will be targeted at the general business community. The products are expected to be differentiated by features and characteristics such as memory storage capability.

• At the high end (\$4,000 and higher), we expect to see equipment targeted at high-volume users. Expected features include laser plain paper output and the ability to interface with a computer network.

Dataquest believes that the following points are critical for the continued success of this market:

- Attention to the customer. The customer is, and will always be, the king. This simple statement is all too often forgotten in the world of high technology. For facsimile equipment manufacturers, there are actually two customers for every product: the distributor/dealer and the end user. The manufacturer must focus on the specific requirements of each customer for long-term success.
- Customer service, support, and training of both the distributor/dealer and end user. Competitive information, sales and
 service training programs, financing options, and other general support programs are critical to the health of these relationships.
- Office automation has always been the key phrase with facsimile equipment. As the world evolves to a digital/data environment, the facsimile machine has the potential to integrate the digital and analog worlds. The facsimile manufacturer must be ready with Group IV equipment and other integrated office products to take advantage of this fundamental market shift.

(The majority of this newsletter was originally published by Dataquest's Telecommunications Industry Service.)

Dave G. Norman Edward M.A. Mier



RESEARCH NEWSLETTER

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IBM'S PC CONVERTIBLE: IMPLICATIONS FOR BOTH PERSONAL COMPUTER AND SEMICONDUCTOR MANUFACTURERS

SUMMARY

IBM expanded its PC product family with the announcement in April of its long-awaited true portable PC, the Convertible. While the success of the Convertible is still uncertain, the product holds some important clues to the future direction of IBM's manufacturing and use of semiconductors. Analysts from Dataquest's Semiconductor Application Markets service (SAM) and Personal Computer Industry Service (PCIS) took the opportunity to examine the Convertible's semiconductor content. This newsletter discusses:

- The high-end true portable computer market
- The semiconductor content of the Convertible
- The significance to both the computer and semiconductor industries of the design and manufacturing standards employed by IBM

PRODUCT OVERVIEW

With a suggested retail price of \$1,995, the Convertible is targeted at sales representatives, field engineers, researchers, students (the carrying case converts into a backpack), and others who require full-function computing in a portable package.

The standard configuration of the Convertible weighs 12.2 pounds and operates for 6 to 10 hours from a rechargeable battery pack. It has an 80C88 microprocessor; 256 Kbytes of memory; an 80-column x 25-line, detachable liquid crystal display (manufactured by Hitachi); an inclined,

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built-in, 78-key keyboard with full-size typing keys (manufactured by Alps); dual 720-Kbyte, 3.5-inch diskette drives (from Toshiba); a clock; and an AC adapter.

Options are an internal (non-Hayes compatible) 300/1,200-baud modem; an RS-232-C serial/parallel adapter; memory expansion to 512 Kbytes; a 24-element, nonimpact, dot matrix, 40-cps graphics printer; a display adapter for a 9-inch monochrome display, PCjr color display, PC color display, or standard television set; and a Convertible RGBI color display with a speaker, battery charger, and automatic power adapter. See Appendix A for more details on the technical specifications.

PORTABLE COMPUTER MARKET

In addition to IBM's announcement, this year has seen other significant events in the portable computer market:

- Zenith was awarded a major contract with the IRS, valued at \$28 million for 15,000 machines; they are to be delivered over 18 months. The average cost for a system with software plus printer is \$1,866. This is more than \$500 less than the retail list price of the 2171 (February).
- Olivetti announced the first true portable with internal 10-Mbyte hard disk drive for the European market (February).
- Zenith announced the Z181, the first portable with an electroluminescent backlit display offering true aspect ratio, a 12:1 contrast ratio, and a 10.5-inch (diagonal) viewing angle (June).

While this flurry of activity has signaled the arrival of significant sales volume for the true portable computer, the market is a long way from maturity. The implications for the portable computer market can be seen in the light of recent events in the personal computer market.

During 1986, desktop 8088-based systems have seen a dramatic reduction in price. The recently announced Tandy 1000SX, a complete system with a monochrome monitor, is priced just above \$1,300. The well-documented flood of IBM PC clones from the Far East have helped drive prices even lower. This has forced users to pay a premium for portability and, in some cases, has been detrimental to sales of true portables.

Portable computer vendors are discovering that their major market is found through direct sales channels to large corporations with field and outside sales personnel. Examples include sales to the IRS, insurance companies, and service organizations. Grid Computers has successfully marketed \$1 million worth of Gridcase portables to Mead Data General Inc., whose sales force will use them to demonstrate Mead's legal, news, and medical on-line data base services.

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As IBM and others have discovered, interest has been low in the retail channels. However, sales of portable computers are expected to gain momentum as corporate buyers recognize the greater productivity results obtained by field sales users.

Figure 1 gives the 1985 market share rankings for worldwide unit shipments. Total shipments for the year are estimated at 168,600 units.



Figure 1

HIGH-END TRUE PORTABLE WORLDWIDE UNIT SHIPMENTS 1985

The figures for 1986 should look dramatically different, with the entrance of IBM and the strong showing of the Zenith models and the Kaypro 2000. Worldwide unit shipments are expected to reach 340,130 units in 1986. Figure 2 gives the market share estimates for 1986.



PROJECTED HIGH-END TRUE PORTABLE WORLDWIDE UNIT SHIPMENTS 1986

Source: Dataquest August 1986

SEMICONDUCTOR CONTENT

With two main boards (main logic and memory expansion), the Convertible that we examined contained 49 integrated circuits (ICs). All components were CMOS, and, with the exception of the disk controller chip, surface mount technology was applied throughout. Table 1 lists in detail the components of the system.

The 49 chips have an estimated cost of \$169.62 (based on contract volume pricing); the suggested selling price of \$2,385 (with the memory expansion board) gives the Convertible an input/output (I/O) ratio (a measure of the value of one input, semiconductors, against the value of the end product) of 7.1 percent.

Although we can only estimate the value of the semicustom chips manufactured by IBM, the I/O ratio found in the Convertible compares favorably to our estimate of a 6.3 percent I/O ratio for PCs in the \$1,000-to-\$5,000 segment.

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Table 1

SEMICONDUCTOR CONTENT OF IBM PC CONVERTIBLE

Description	<u>Number</u>	Manufacturer	Estimated <u>Cost</u>
Memory Expansion Board			
(Located under the keyboard)		-	
64K (8Kx8), 150ns SRAMs	24	S-MOS Systems	- #33 13
Logic array (1,264 gates)	4	S-MOS Systems	- \$72.12
Main Logic Board		_	
64K, 150ns SRAMs	3	S-MOS Systems	
Octal latch, 3-state	1	Signetics	
4-to-16 decoder/demultiplexer	1	Signetics	
Octal bus transceiver, 3-state	1	Signetics	
256K (32Kx8) BIOS ROMS	2	S-MOS Systems	
Disk controller chip	1	NEC	
Proprietary logicI/O	4	IBM	- \$97 50
80C88, 8-bit MPU	1	Harris	- 491.30
Phase-frequency detectorTTL	1	Motorola	
MultivibratorTTL	1	Motorola	
Real-time clock	1	Motorola	
Hex inverter	1	Signetics	
Quad comparators	2*	Motorola	
Dual op amp	1*	Motorola _	

*Found on power supply board

Source: Dataquest September 1986

THE CONVERTIBLE'S DESIGN/MANUPACTURING SIGNIFICANCE

The Convertible's significance as a product goes far beyond merely announcing IBM's entrance into the portable computer market. The product exhibits important advancements in the areas of:

- Manufacturing and packaging
- CMOS technology and ASIC use

Examination of these issues in light of the new Convertible will help illustrate IBM's possible future directions in the personal computer business. In the past, IBM has demonstrated its ability to foster fundamental changes in the PC and semiconductor businesses. With the Convertible, IBM not only again demonstrates its manufacturing and technical clout, but it appears to be on the verge of restructuring the PC industry and its relationship to the semiconductor industry.

Manufacturing/Packaging

The construction of the Convertible is impressive. The small, lap-top computer comes in a compact, lightweight package that can be manufactured at a very competitive cost. Produced in IBM's Austin, Texas, facility, the Convertible demonstrates the ability of that automated production facility to manufacture future-generation PCs.

The surface-mount technology used in the Convertible will most likely be employed in future IBM PCs. Reduction in board size, weight, and costs are a major advantage to IBM, which has made enormous investments in a surface-mount facility. With the resources to spend on advanced production techniques, IBM will make it increasingly difficult for smaller manufacturers to match its production efficiency.

CMOS Technology and ASIC Use

Low-power CMOS chips are essential to building an efficient portable computer. IBM has used all CMOS chips in the Convertible, allowing a smaller, less expensive power supply to be used.

The use of ASIC logic chips, which are manufactured at IBM's Burlington, Vermont, facility, is not surprising. IBM, along with many other manufacturers, has demonstrated the capability and advantages of integrating standard logic that was prevalent in previous systems. This allows for the obvious advantages of reduced manufacturing and testing cost, as well as savings in board space.

Upon closer examination of the four ASICs employed, rather than simple logic replacement, the chips appear to be treated by the system software as I/O devices. This would allow them to respond to special I/O references that are embedded in the operating system. This gives IBM the ability to tightly couple internal hardware logic and future enhancements of MS-DOS. This relationship between the ASICs and the operating system will allow enhancements for certain features (such as networking or multitasking) to be implemented in the chips and accessed through special I/O calls in the operating system. While this does not suggest incompatibility of future IBM systems with the already established software base, it does indicate that IBM will be able to add features and performance enhancements in hardware that will be difficult for clone manufacturers to duplicate. Reverse engineering of a 13- to 15-layer, 2-micron, CMOS ASIC, which was fabricated using ion implantation, can be very time consuming.

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DATAQUEST ANALYSIS

With aggressive pricing, improved manufacturing techniques, and the capability to produce a product with performance features that are not easily duplicated by its competition, IBM appears positioned to restructure the IBM-compatible PC market. The question is, When, and in what form, will these next-generation PC products be introduced?

We believe that IBM could introduce a low-end PC during the last quarter of this year that would be based on the Convertible's semiconductor content and design. Having a suggested retail price between \$600 and \$1,400, IBM's new product would be targeted at the home/educational market at the low end and small business applications at the high end. IBM's estimated \$200 million investment in its Austin, Texas, manufacturing facility is considered part of an overall IBM plan for future PC products.

IBM will be capable of building high-quality, cost-efficient products using robotic systems and computers at each step in the manufacturing process, and these new products will allow it to recapture an eroding market share from low-cost Asian and compatible manufacturers.

> Anthea C. Stratigos Stella Kelly Ken McKenzie

APPENDIX A

IBM PC CONVERTIBLE TECHNICAL FACT SHEET

The IBM PC Convertible is a full-function personal computer system featuring a CMOS microprocessor, a display, two diskette drives, a keyboard, and memory and weighs less than 13 pounds.

HIGHLIGHTS

Features included in the Convertible are:

- CMOS 80C88 microprocessor
- 64-Kbyte CMOS ROM containing power-on self-test of system components, basic input/output system (BIOS) support, and BASIC language interpreter
- Two 128-Kbyte CMOS RAM cards
- Two 3.5-inch, 720-Kbyte (formatted) diskette drives
- 80-column x 25-line detachable liquid crystal display (LCD) panel with 640 x 200-pixel and 320 x 200-pixel graphics support
- LCD controller
- 16-Kbyte RAM display buffer
- 8-Kbyte LCD character font RAM
- 78-key keyboard
- IBM PC Convertible printer interface
- Battery pack
- AC adapter
- Time-of-day clock
- 72-pin I/O feature connector
- Start-up diskette
- Speaker

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IBM PC Convertible Options

- IBM PC Convertible 128-Kbyte memory card (512-Kbyte system maximum)
- IBM PC Convertible printer
- IBM PC Convertible serial/parallel adapter
- IBM PC Convertible 9-inch monochrome display
- IBM PC Convertible 13-inch color display
- IBM PC Convertible CRT display adapter
- IBM PC Convertible internal modem
- IBM PC Convertible printer cable
- IBM PC Convertible battery charger
- IBM PC Convertible automobile power adapter

Currently Supported Options

- IBM Personal Computer graphics printer
- IBM Proprinter
- IBM Personal Computer printer cable
- IBM Personal Computer color display
- IBM communications adapter cable
- IBM PCjr color display
- IBM PCjr connector for television
- IBM PCjr adapter cable for the IBM PC color display
- IBM network control unit
- IBM eight-port communication adapter
- IBM modem--1,200 bps

TECHNICAL DATA

- CMOS 80C88 microprocessor
- 4.77-MHz clock speed
- 20-bit addressing
- 8-bit data path
- 8-level interrupt controller
- 3-channel DMA controller
- Two programmable timers
- Dimensions: 14.72 inches (D) x 12.28 inches (W) x 2.64 inches (H)
- Weight: 12.2 pounds
- Electrical (AC adapter input range) -- 90 to 265 volts, 50/60Hz, AC

RELATED PRODUCTS

IBM PC 3.5-Inch External Diskette Drive

There are two models of the IBM PC 3.5-inch external diskette drive. One model attaches to the PC, PC XT, or Portable PC. The other model attaches to the PC AT. Both models show the transfer of information to and from the Convertible.

IBM Internal 3.5-Inch Diskette Drive Option

This feature is a half-height, double-sided, 3.5-inch diskette drive that allows more compatibility between the PC XT and the Convertible. The drives uses the diskette drive adapter that is standard on the new models of the PC XT.

IBM PC CONVERTIBLE OPTIONS

IBM PC Convertible 128-Kbyte Memory Card

Convertible 128-Kbyte memory cards may be installed until a maximum of 512 Kbytes is reached.

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IBM PC Convertible Printer

The IBM PC Convertible printer is a microprocessor-based, 40-cps (burst rate), serial, nonimpact, dot matrix machine capable of low-power operation. Standard ASCII 96-character uppercase and lowercase character sets are printed using a high-resolution, 24-element printhead. An all-points-addressable print mode for graphics is also provided. The IBM PC Convertible printer uses multiuse copier paper, thermal paper, or thermal transfer paper. The ribbon has a 26,000-character minimum average yield (10 pitch).

IBM PC Convertible Serial/Parallel Adapter

The IBM PC Convertible serial/parallel adapter provides an RS-232-C asynchronous communications interface and parallel printer interface compatible with the IBM PC asynchronous communications adapter and the IBM PC parallel printer adapter.

IBM PC Convertible CRT Display Adapter

The IBM PC Convertible CRT display adapter connects a separate CRT display to the system. The 9-inch IBM PC Convertible monochrome display attaches by using this device. It also permits the attachment of the IBM PCjr color display, IBM PC color display, or a standard television set through the use of optional connectors and cables.

IBM PC Convertible Monochrome Display

The IBM PC Convertible monochrome display is a 9-inch composite video display attached to the system unit via the IBM PC Convertible CRT display adapter. Text modes are 80×25 and 40×25 . Graphics support is 640 x 200 and 320 x 200.

IBM PC Convertible Color Display

The IBM PC Convertible color display is an RGBI direct-drive 13-inch display. It attaches to the system unit via the IBM PC Convertible CRT display adapter. Text modes are 40×25 and 80×25 . Graphics support is 320×200 . The display includes a speaker for external audio output.

IBM PC Convertible Internal Modem

The IBM PC Convertible internal modem provides communication capabilities between the IBM PC Convertible and other compatible systems using telephone lines. Modulation methods and frequency tolerances are equivalent to either Bell 212A (1,200 baud) in high-speed mode or Bell 103A (300 baud) in low-speed mode. The IBM PC Convertible internal modem is programmable and supports auto dial, auto answer, and other software-controlled features.

IBM PC Convertible Printer Cable

The IBM PC Convertible printer cable is 22 inches long with a custom 72-pin system-type connector attached to each end. It provides the option of operating an IBM PC Convertible printer adjacent to the system unit.

IBM PC Convertible Battery Charger

The IBM PC Convertible battery charger is a small, 110-volt device to charge the internal battery pack of the system while the system is not in operation.

IBM PC Convertible Automobile Power Adapter

The IBM PC Convertible automobile power adapter is designed to power the system unit. The adapter plugs into the cigarette lighter outlet of any vehicle with a 12-volt, negative-ground electrical system.

START-UP

A start-up diskette is included in the <u>Guide to Operations</u> provided with the IBM PC Convertible. It directs the user to create a system/applications diskette that contains "Application Selector" and "SystemApps," and to optionally merge DOS 3.2 (licensed separately). Also included on the start-up diskette are "Exploring the IBM PC Convertible" and diagnostic routines:

- "Application Selector" -- An application module installed as an • extension to DOS providing a menu-driven interface to select and or "SystemApps." run DOS 3.2 applications "Application Selector" includes "Tools." When DOS 3.2 is merged with "Tools" "Application Selector," performs such tasks as printing, copying files, erasing files, formatting diskettes, and copying diskettes
- "SystemApps"--Includes four basic functions: "NoteWriter,"
 "Schedule," "Phone List," and "Calculator"
- "Exploring the IBM PC Convertible"--A program designed to familiarize the user with the PC Convertible through the use of pictures, animation, and simulations of software screens



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RESEARCH NEWSLETTER

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MINISUPERCOMPUTER INDUSTRY SEGMENT SUMMARY

SUMMARY

Since 1982, a number of new companies have been formed with the common objective of building and selling computers that would occupy the "performance gap" between high-end superminicomputers and supercomputers. Although there is some disparity in design objectives and product characteristics among these companies, their machines are generally claimed to provide one-sixth to one-fourth the performance of a supercomputer at one-tenth the cost or better. The press has variously dubbed this class of machine "minisupercomputers," "near-supercomputers," "crayettes," or "affordable supercomputers." Whatever the name, it is clear that a new class of machine has come into its own and has at least some chance of becoming the next major new opportunity in the computer industry. Dataquest will refer to these computer systems as "minisupercomputers."

To qualify as a minisupercomputer, a system must meet the following criteria:

- It must perform at least some scientific applications using 60- or 64-bit floating-point arithmetic at a speed of not less than one-tenth that of a low-end supercomputer.
- It must be capable of running an entire compiled program.
- The maximum price for a fully configured system is \$2 million, but a typical price should range between \$200,000 and \$1 million.

Minisupercomputers are poised for explosive growth over the next five years. From a 1984 base of near \$300 million in factory revenue, worldwide sales are expected to reach \$1.8 billion in 1990. Dataquest expects design automation, currently 58 percent of the market revenue, to continue to be the largest application segment, with growth opportunities in software development, graphics, and scientific processing.

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This newsletter summarizes Dataquest's recently completed research on minisupercomputers. We are conducting ongoing studies in this area, and the completed results are available as an "add-on" service for Dataquest's Technical Computer Systems Industry Service (TCSIS) clients.

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SUPERCOMPUTERS

The production of computers designed to solve numerically intensive scientific problems dates back to the earliest days of the computer industry. By the mid-1960s, Control Data had achieved a dominant position in the scientific computer market. Its 6000 series machines, particularly the 6600 announced in 1964 and the 7600 introduced in 1969, were the supercomputers of their day. Control Data now provides an extremely wide range of systems known as the Cyber 180 series. From the air-cooled model 810 at an ASP of \$250,000, the line extends through nine models up to the model 990 dual processor with a base price of approximately \$5 million. In raw computing power, the high-end Cyber systems operate in the supercomputer performance range.

In 1983, Control Data moved its supercomputer activities into a new company, ETA Systems. ETA took over the Cyber 205 and is planning to ship its first new machine, the ETA-10, later this year. The ETA-10 promises to deliver 10,000 MFLOPS (millions of floating-point operations per second) for approximately \$20 million.

In 1972, Seymour Cray, Control Data's chief designer for the 6600 and 7600, left Control Data to establish Cray Research. His objective was to develop a supercomputer that would use vector processing with fast scalar hardware. The Cray line has grown to many models; at the high end is the Cray-2, a four-processor, UNIX-based system offering more than 1,000 MFLOPS for about \$14 million.

Three major Japanese companies, Fujitsu, Hitachi, and NEC, are also producing supercomputers.

SUPERMINICOMPUTERS

The development of superminicomputers began indirectly when manufacturers of 16-bit minicomputers introduced 32- or 36-bit generalpurpose systems. There are now dozens of firms selling superminicomputers, including Data General, Digital, Gould, Harris, IBM, and Prime.

These systems are characterized as 32-bit word-length computers that support many users simultaneously. Originally, the major impetus for their growth came from engineering departments seeking systems that were large enough to handle reasonably complex problems and that would be under their control so they would no longer have to rely on corporate MIS departments' large mainframes. In recent years, superminicomputer

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vendors have turned their attention toward office and other commercial applications. Today, only about 40 percent of the installed base of superminicomputers is devoted strictly to engineering and scientific (technical) environments.

Superminicomputer vendors rarely rate their machines in terms of MFLOPS, preferring to use the traditional MIPS (million instructions per second) rating system. Thus, Data General's MV/20000 dual processor is rated at 10 MIPS, the Digital VAX model 8650 is rated at 6+ MIPS, and Toshiba's G8050 leads the race with a rating of 18 MIPS.

MINISUPERCOMPUTERS

Systems aimed at the "performance gap" between supercomputers and superminicomputers have been available for some time. Products in the midrange of the Cyber line fit the performance criteria for minisupercomputers, although they are at the upper end of the price range.

Floating Point Systems (FPS) entered the market in 1981 with its FPS-164 computer. Rather than adopt the CDC approach of providing standalone computers with proprietary operating systems, FPS chose to make its computer perform as a back-end processor to other general-purpose computers.

The start of what was to become a virtual flood of new minisupercomputer companies began in 1982. The first of these to ship product was Convex Computer Corporation in March 1985, followed by Alliant Computer Systems, Intel, Culler Scientific, Loral, and Ametek. Further company and product announcements are expected in 1986 and 1987. In addition to the companies developing products for the minisupercomputer market, the high-end systems offered by the 32-bit parallel processor companies may overlap into this product range.

The minisupercomputer product segment has already matured sufficiently for several vendors, including ELXSI and Sequent Computer Systems, to introduce upgrades to existing CPU and memory products. Lower-priced minisupercomputers from firms like Culler have been recently announced. Dataquest believes that these trends will exert pressure to continue to improve the price/performance characteristics of the products in the minisupercomputer group.

Most new minisupercomputer company marketing programs are based on the architecture of their computers. Each company claims to produce the optimum architecture and provides supportive evidence, while criticizing and downgrading competitive architectures.

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Underlying Market and Technological Forces

We anticipate that minisupercomputer market growth will be fueled by the engineering and scientific communities, where a revolution has been occurring in the way that work is being done. This change is being driven by the need to achieve:

- Faster time to market for new products
- Better-tested products
- Higher-quality products
- Reduced manufacturing and material costs

Coincident with the changes in the marketplace, technology is changing, allowing performance improvements and reductions in computing costs to a level that fits the budget of a typical scientific/engineering organization. Technology-driven influences include:

- Higher level of component density and, thus, greater system integration
- Higher performance at the device level
- Improvement of computer-based system/circuit design tools
- Development of new architectural approaches to enhance system performance (e.g., parallel, dataflow, RISC)
- Availability of new mathematical models and related computer algorithms
- Availability of an increasing library of third-party applications software
- Acceptance of UNIX as a de facto operating system standard

By meeting the needs of a large and growing user group with fast, accessible, and cost-effective number-crunching power, minisupercomputers have emerged as a new product segment with considerable sales potential.

Market Size and Forecast

Dataquest's forecast for the market for minisupercomputer-class systems is summarized in Table 1. Table 2 shows Dataquest's estimates for the associated semiconductor consumption in the minisupercomputer market for the same period from 1986 through 1990. Figure 1 shows a further breakdown of that estimated semiconductor consumption by major product category. Figures 2 and 3 show the estimated factory revenue and ASP trends, respectively, for the minisupercomputer products.

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Most of the systems on the market today and expected in the next 18 months have or will have an average system price near \$500,000 to \$750,000. Dataquest expects the minisupercomputer market to expand to a range of systems offered at various price levels. We believe that the proliferation of low-priced systems expected in 1988 and beyond will drive down the overall average selling price to \$490,000 in 1990.

Table 1

WORLDWIDE FACTORY REVENUE AND UNIT SHIPMENTS FOR MINISUPERCOMPUTERS

Forecast	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	CAGR <u>1986-1990</u>
Factory Revenue (\$M)	\$551	\$747	\$1,011	\$1,353	\$1,757	34%
Percent Growth	40%	36%	35%	34%	30%	
Shipments (Units)	644	961	1,506	2,306	3,556	53%
Percent Growth	75%	49%	57%	55%	53%	

Source: Dataquest September 1986

Table 2

ESTIMATED WORLDWIDE SEMICONDUCTOR CONSUMPTION FORECAST FOR MINISUPERCOMPUTERS

	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
I/O Ratio	9%	9%	10%	9%	9%
Consumption (\$M)	\$49	\$67	\$101	\$122	\$158

Source: Dataquest September 1986



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Source: Dataquest September 1986







Source: Dataquest September 1986

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Figure 3



ESTIMATED TECHNICAL COMPUTER SYSTEM AVERAGE SELLING PRICE MINISUPERCOMPUTER SYSTEMS 1981-1990

Applications

The minisupercomputer market has been dominated by the design automation application. We expect this application to decline as a percentage of total revenue, with the software development and graphics applications growing rapidly in the next five years. Figure 4 presents Dataquest's forecast of the breakdown of factory revenue by application segment in 1990.

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Figure 4

ESTIMATED PERCENTAGE SHARES OF 1990 MINISUPERCOMPUTER SYSTEM FACTORY REVENUE



DATAQUEST CONCLUSIONS

There are now at least 20 companies that are shipping products or have plans to do so within two years. Most of these companies have adopted a combination of relatively new architectural concepts in their product development. Each vendor claims that its architecture is the state of the art and builds its marketing story around the product's uniqueness, but architecture and related performance are only the beginning.

A major challenge is a company's ability to satisfy the application requirements of its prospects. While this is primarily a software problem, Dataquest believes that the relative ease of porting software to various architectures will play a crucial role in a vendor's ultimate An appropriate software suite, including systems software, success. languages, and application programs, must be provided. Much of this will involve arranging access to third-party-developed effort applications products. Firms unable to obtain commitments from third-party software developers will not be competitive.

The potential actions of major computer vendors such as Digital and IBM, as well as Japanese vendors, may increase the competitive pressures in this market. Although there is no evidence to suggest that any of these companies have a minisupercomputer product in development, Dataquest is confident that they will all be participants by the time the market approaches \$1 billion in size. We believe that the minisupercomputer's impact on users will be nothing short of revolutionary, enabling companies to solve the complex engineering problems required to build their products more quickly and less expensively. Even supercomputer owners will benefit by using minisupercomputers as front-end and development machines, thereby maximizing their supercomputer investment. We expect the proliferation of these smaller machines to spur the development of new software across a broader front than if supercomputers alone were available.

(Portions of this newsletter were originally published by Dataquest's Technical Computer Systems Industry Service.)

David G. Norman Gregory P. Kosinski



October-December

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SAM Newsletters

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: October-December 1986-22

EIA SEES A TOUGH TIME AHEAD FOR THE DEFENSE INDUSTRY

After the largest peacetime military buildup in the history of the United States, the Electronics Industry Association (EIA) projects a second year of decline in the Department of Defense (DOD) budget for fiscal 1987. The EIA's 10-year forecast for DOD budget projections, keynote speaker David Packard, and a variety of panel discussions drew more than 350 participants to the Sir Francis Drake Hotel in San Francisco, California, on October 7 through 10 for the EIA's annual fall symposium on the military electronics market.

The theme of the conference was "Doing Business with the Government in the Future," and it featured panel discussions on the following topics:

- EIA Forecast
- DOD Program Perspectives
- Investment Analysts' Assessment
- Analysis and Forecasts of Specific Markets
- DOD Organization Reforms
- DOD Acquisition Reforms

This newsletter gives an overview of the issues facing the defense industry today as presented in the various panel discussions at the conference. The areas addressed include the effects of the smaller defense budget on the industry, new industry opportunities, Wall Street's view of the industry, discussion of the Packard Commission results, public opinion, and the effects of public opinion on congressional legislation. Table 1 shows the EIA's forecast of DOD budget projections for procurement through 1996. The total research, development, test, and evaluation (RDT&E) budget is displayed in Table 2.

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Table 1

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Program	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
Aircraft	\$ 44.3	\$37.9	\$31.2	\$31.1	\$30.4	\$30.1
Missiles	10.8	13.3	13.4	12.8	12.3	12.1
Space	4.1	4.0	4.1	4.1	4.3	4.4
Ships	13.2	11.4	9.4	8.9	8.6	8.6
Ordnance and Weapons	5.3	4.7	4.3	4.1	4.2	4.1
Vehicles	7.5	6.0	5.4	5.0	4.8	4.8
Electronics and						
Communications	7.4	8.0	7.9	8.0	7.9	7.9
All Other	<u> 11.3</u>	10.5	10,2	9.4	8.8	<u> 8.7</u>
Total	\$103.9	\$95.8	\$86.0	\$83.5	\$81.3	\$80.7
Percent Change	13.9%	(7.8%)	(10.3%)	(2.8%)	(2.7%)	(0.8%)

TOTAL DOD PROCUREMENT FORECAST (BA) BY MAJOR PROGRAM* (Billions of Dollars)

<u>Program</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>
Aircraft	\$30.2	\$30.4	\$30.8	\$31.4	\$31.9	\$32.7
Missiles	11.9	11.7	11.6	11.5	11.4	11.3
Space	4.8	5.0	5.5	5.9	6.3	6.8
Ships	8.6	8.6	8.7	8.8	8.7	8.7
Ordnance and Weapons	4.1	4.2	4.2	4.3	4.4	4.5
Vehicles	4.8	4.9	5.0	5.1	5.1	5.0
Electronics and						
Communications	7.9	8.1	8.3	8.7	8.8	9.1
All Other	<u> 8.7</u>	<u> 8.7</u>	8.8	8.8	8.7	<u> 8.7</u>
Total	\$81.0	\$81.6	\$83.1	\$84.5	\$85.4	\$86.9
Percent Change	0.3%	0.8%	1.8%	1.7%	1.0%	1.8%

BA = Budget Authority
*In constant FY 1987 dollars
Note: Columns may not add to totals shown because of rounding.

Source: Electronics Industry Association Dataquest October 1986

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Table 2

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Program	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
Aircraft	\$ 5.6	\$ 5.6	\$ 5.4	\$ 5.4	\$ 5.1	\$ 4.9
Missiles	7.6	7.9	7.9	7.3	6.9	6.7
Space .	4.0	4.8	5.3	5.7	6.0	6.1
Ships	1.9	1.9	1.8	1.7	1.6	1.6
Ordnance and Weapons	1.6	1.8	1.8	1.7	1.6	1.6
Vehicles	0.3	0.3	0.3	0.2	0.2	0.2
Electronics and						
Communications	6.2	6.4	6.3	6.0	5.9	5.8
All Other	6.5	6.2	<u> </u>	<u> 5.9</u>	5.9	<u> 5.8</u>
Total	\$33.7	\$35.0	\$35.0	\$34.0	\$33.2	\$32.6
Percent Change	28.7%	3.9%	0	(2.9%)	(2.4%)	(1.7%)

TOTAL DOD RDT&E FORECAST (BA) BY MAJOR PROGRAM* (Billions of Dollars)

Program	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>
Aircraft	\$ 4.7	\$ 4.7	\$ 4.4	\$ 4.3	\$ 4.4	\$ 4.6
Missiles	6.4	6.3	5.8	5.5	5.5	5.4
Space	6.3	6.4	6.3	6.5	6.6	6.6
Ships	1.5	1.3	1.3	1.3	1.3	1.3
Ordnance and Weapons	1.5	1.3	1.3	1.3	1.3	1.3
Vehicles	0.2	0.2	0.2	0.2	0.2	0.2
Electronics and						
Communications	5.9	5.9	5.8	5.9	6.1	6.0
All Other	5.6	<u>5,4</u>	5.1	5.0	4.9	
Total	\$32.1	\$31.4	\$30.2	\$30.0	\$30.2	\$30.4
Percent Change	(1.7%)	(2.1%)	(3.9%)	(0.7%)	1.0%	0.4%

BA = Budget Authority *In constant FY 1987 dollars Note: Columns may not add to totals shown because of rounding.

> Source: Electronics Industry Association Dataquest October 1986

ISSUES AND ANSWERS

Budget Pressure

How will the shrinking defense budget affect defense contractors? General consensus of the EIA panelists held that there will be increased competition, combining of resources, more up-front company-sponsored research, more overseas joint ventures, and increased risk. According to James Lee, chairman of the EIA panel on new defense industry opportunities, the DOD will be looking for second sources for many programs that were once handled by just one contractor. Second sourcing is one method the DOD is using to obtain the best value for products that it procures. Other methods include:

- Buying nondevelopment items from the commercial market
- Recompeting mature products
- Setting up "horse races" where a group of vendors is chosen to develop one product (Each vendor develops the product, and the vendor providing the best value wins the contract.)

Efficiency will be another key issue affecting the industry in the coming years. As one speaker put it, "We think we are efficient now, but when it comes down to surviving, you will find many new ways to be efficient. A lot of nice things you have now will have to go." With the number of new project starts decreasing, the RDT&E budget forecasted to go down, and the DOD pressuring contractors to take on more of the RDT&E expense and risk, it is obvious that efficiency will be a key issue for the survival of many contractors.

According to Don Weaver of Aereojet TechSystems, chairman of the EIA forecast subcommittee, the DOD also wants to decrease operations and maintenance costs, making more money available for equipment. In order to decrease operations and maintenance costs, new products will have to be more reliable and efficient. The consequence of this will be higher quality constraints for new products shipped to the military. According to EIA panelists, combining resources will become very important for defense industry corporations in the future. The DOD wants companies to take the risks and make the up-front investment in research without government subsidies. EIA panelists believe that the only way for many defense companies to take on that burden is to pool their resources.

Opportunities

Despite all of the bad news, the EIA offered some glimmers of hope. According to James Lee, "Defense contractors have more new business opportunities than ever. The problem is picking the winners." Half a day of the conference was spent on a presentation that rated programs by the opportunities they provide. The ratings were based on probability of reaching initial operation capability (IOC) by 1997. There were three possible ratings: good, fair, and poor. The panel listed 86 specific program opportunities with a good chance of reaching IOC by 1997. One area of opportunity is recompetition of mature products. When recompetition occurs, the DOD breaks out a mature product for competition and chooses the contractor that provides the product at the best value. As with second sourcing, recompetition is a blessing for companies wanting to enter the program and a burden for the contractor currently producing the product. The 41 programs cited by the EIA as candidates for recompetition by 1997 are listed in Table 3.

Table 3

SELECTED RECOMPETITION OPPORTUNITIES

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<u>Program</u>	Description
AH -64	Advanced Attack Helicopter
BFV/ISU	Bradley Fighting Vehicle/Integrated Sight Unit
STINGER	N/A
TOW	Tube Launched, Optically Tracked, Wire-Guided Missile
COPPERHEAD	N/A
CHAPARRAL RSS	Short-Range Air Defense Surface to Air Missile System, Rosett Scan Seeker
MELIOS	Mini Eyesafe Laser Infrared Observation Set
SINCGARS	Single Channel Ground Air Radio System
F/A-18	Fighter/Attack Aircraft
TRIDENT SUB	N/A
TRIDENT RV (MK5)	N/A
TRIDENT II	N/A
DEADEYE	Semiactive Laser-Guided Projectile
SKIPPER	Laser-Guided Bomb-Powered
P-3 AVIONICS	N/A
SQQ-89	N/A
SQS-53B	N/A
K116 FCS	N/A
UYQ-Z1	N/A
VL ASROC	Vertical Launch Anti-Sub Rocket

(Continued)

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Table 3 (Continued)

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SELECTED RECOMPETITION OPPORTUNITIES

Program	Description
AWG-9	Fire Control Systems for the F14
AEGIS INTEGRATION	Navy Anti-Air Warfare Weapon System
SPY-1	Aegis Radar
SeaLance	Anti-Submarine Weapon System
SH-60F	N/A
SPS-48E	N/A
EMSP	Enhanced Modular Signal Processor
IRST	Infrared Search and Track
HARM	High-Speed Anti-Radiation Missile
атв	Advanced Tactical Bomber
C-17 Wing	N/A
OTH-B	Over the Horizon Back Scatter Radar
SFW (CBU-97)	Sensor Fused Weapons
LANTIRN	Low Altitude Navigation and Targeting Infrared Night
TRC-170	N/A
ALE-47	N/A
ALR-56C	N/A
CEM	Combined Effects Munitions
JTIDS	Joint Tactical Information Distribution System
AGM-130	Air to Ground Missile
WIS/CUS	Worldwide Military Command and Control System Infor- mation System/Common User System
TEWS SPT SYS	Tactical Electronic Warfare Support System
N/A = Not Available	
	Source: Electronics Industry Association

Dataquest October 1986

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The EIA sees the Strategic Defense Initiative (SDI) and the Air Defense Initiative (ADI) as major opportunities along with command, control, communications, and intelligence (C3I). There was some skepticism from the audience about the survival of SDI in the event of a Democratic administration taking office in 1988. The EIA panel response was, "The name may not survive, but the technology will." The reasons for SDI's survival cited by Charles Lent of GTE, the session chairman, were that the program has been going on since 1984 and the Soviets have been trying to develop space-based defense for the past 20 years. Figure 1 shows the EIA estimates regarding the SDI budget through 1996.

Figure 1





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Source: EIA Dataquest October 1986

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Table 4 shows the EIA forecast for electronic equipment at a higher level. The bottom line shows a decrease of 4.5 percent from 1986 to 1987, flat growth from 1988 to 1991, and a 1.6 percent compound annual growth rate (CAGR) from 1991 to 1996. The fastest-growing area will be space, where the EIA expects a 4.9 percent CAGR from 1987 to 1996.

Table 4

ELECTRONIC CONTENT SUMMARY TOTAL PROCUREMENT AND RDT&E BY MAJOR PROGRAM* (Billions of Dollars)

Program	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
Aircraft	\$13.2	\$11.7	\$10.0	\$10.0	\$ 9.8	\$ 9.8
Missiles	10.0	11.4	11.5	10.9	10.4	10.2
Space	5.1	5.6	6.0	6.3	6.7	6.9
Ships	5.0	4.4	3.7	3.6	3.5	3.4
Ordnance and Weapons	1.5	1.5	1.4	1.4	1.4	1.4
Vehicles	1.2	1.0	0.9	0.9	0.9	0.9
Electronics and						
Communications	12.0	12.9	12.8	12.6	12.4	12.3
All Other	<u> </u>	1.2	1.2	1.2	<u> 1.2</u>	<u>1,2</u>
Total	\$49.4	\$49.7	\$47.5	\$46.9	\$46.3	\$46.2
Percent Change	N/M	0.6%	(4.5%)	(1,3%)	(1.4%)	(0.1%)
Program	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>
Aircraft	\$ 9.9	\$10.0	\$10.2	\$10.4	\$10.7	\$10.9
Missiles	10.0	9.9	9.6	9.3	9.3	9.2
Space	7.3	7.6	7.9	8.4	8.9	9.2
Ships	3.4	3.4	3.5	3.5	3.5	3.5
Ordnance and Weapons	1.4	1.4	1.4	1.5	1.5	1.5
Vehicles	1.0	1.0	1.0	1.1	1.1	1.1
Electronics and						
Communications	12.5	12.7	12.9	13.3	13.6	13.8
All Other	1.2	<u>1,2</u>	<u> 1,2</u>	<u> </u>	1.2	<u> </u>
Total	\$46.7	\$47.2	\$47.6	\$48.7	\$49.8	\$50.6
Percent Change	1.0%	1.1%	1.0%	2.1%	2.3%	1.6%

*In constant FY 1987 dollars
N/M = Not Meaningful
Note: Columns may not add to totals shown because of rounding.

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Source: Electronics Industry Association Dataquest October 1986

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Wall Street's View of Defense

The EIA invited three stock analysts to the conference to express the Wall Street view on the condition of the defense industry. Their consensus was that there are too many companies in the industry today. As times get tougher in the next 10 years, there will be considerable merger and takeover activity. According to Paul Nisbet of Prudential Bache, the prime targets for takeovers will be companies with high institutional investment. The panel felt that defense stocks are terribly undervalued, especially stocks of firms with an emphasis in defense electronics. The feeling was that small companies (less than \$500 million) will be virtually ignored by all of the merger activity. There was some discussion about why the stocks are undervalued. The reasons cited were ignorance of what is happening in the industry, unpopularity of the industry on Wall Street, and general disinterest in the industry. The main point of their presentation was that the defense industry is facing a period of takeovers, mergers, and maybe even bankruptcies. However, they believe that defense stock prices will rise in the near future and that there is room for financial growth for some defense electronics corporations.

Packard Commission Recommendations

Public concern over waste in government spurred the creation of the Packard Commission, the main objective of which was to streamline the DOD procurement system. The attitude of some defense contractors present was that the Packard Commission is well intentioned, but their recommendations will never be implemented. David Packard's response was that the implementation has already begun. The Undersecretary of Acquisition has been chosen and is in place in the DOD.

Mr. Packard discussed some of the problems in the DOD procurement system and the solutions suggested by the commission. One problem mentioned was that under the current system, program directors do not report directly to the DOD personnel that make decisions about their programs. The contractor spends time corresponding with DOD personnel that have nothing to do with the project, causing waste and delay in both organizations. The commission's solution is to have the program directors deal directly with the decision makers in the DOD.

Another problem discussed was the use of custom parts for the military when similar parts are available at a significantly lower price Solving this problem falls under in the commercial market. the responsibility of the Undersecretary of Acquisition. Mr. Packard recommends changes in the management style of the system to incorporate incentives for a job well done instead of incentives for surviving the job. He stated that people should be trained to strive for excellence and to be innovative in creating solutions to problems in the procurement Implementing this new management style also falls under the system. responsibility of the Undersecretary of Acquisition. One speaker at the conference stated, "The only way the Packard Commission recommendations can be implemented is if the Undersecretary of Acquisition is a very " strong executive." David Packard seemed to have confidence that the right man has been chosen for the job.

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Public Opinion and Congress

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One of the major problems in the defense industry today is low public opinion. In his keynote address, David Packard explained a Packard Commission survey of public opinion regarding the defense industry. On a scale from 0 to 100, with 100 being high and 0 being low, defense contractors rated a 25. Because of political pressure, this low public opinion is mirrored in congressional attitudes. Ellen Brown, the EIA's defense industry lobbyist on Capitol Hill, quoted a congressman as saying, "The contractors are robbing the bank, and the DOD is driving the getaway car." Looking at the industry with this view, Congress has proposed some new watchdog legislation and some modifications to old legislation that take a closer look at the defense contractors' business practices. This is a partial list of legislation discussed at the EIA conference:

- False Claims Act Amendment--This law is being modified from actual knowledge of a false claim to include those people who actively avoid knowledge of such a claim or have reckless disregard for the truth.
- Quitam--This law states that a private citizen can bring charges of fraud against a defense contractor in any local court. The citizen is then eligible to receive a percentage of damages awarded to the government.
- Program Fraud Civil Remedies Bill--This bill gives various government services the ability to prosecute a fraud case if the Department of Justice deems the case too small for its resources.

The defense contractors' major concern about this legislation is that it will cause many unnecessary court battles. One person called the Quitam law "bounty hunter" legislation. The contractors are afraid that the sizable reward will entice people to bring fraud charges against a company whether or not the individual has any knowledge of the company being involved in fraudulent activities.

SUMMARY

The overall message of the conference was that the defense industry is entering a very interesting period--a time of fierce competition, combination, and adaptation. There are pressures from Congress, the DOD, and the public to increase efficiency and decrease waste. Even though the budget is decreasing, there are still opportunities in certain defense markets. However, the boom years are over; now is the time to trim down and adapt to the new markets.

David G. Norman

Dataquest

Conference Schedule

1986

Semiconductor	October 20-22	Hotel Inter-Continen San Diego, Californ
Technical Computer	November 3-5	Silverado Country C Napa, California
Asian Peripherals	November 5-7	Hotel Okura Tokyo, Japan
Semiconductor Users/ Semiconductor Application Markets	November 10	Sheraton Harbor Isla San Diego, Californ
Electronic Publishing	November 17-18	Westin Copley Place Boston, Massachuset
CAD/CAM EDA	December 4-5	Santa Clara Marriot Santa Clara, Califor
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Semiconductor Users/ Semiconductor Application Markets	February 4-6
Copying and Duplicating	February 23-25
Electronic Printer	March 23-25
Japanese Semiconductor	April 13-14
Telecommunications	April 13-15
CAD/CAM	May 14-15
Display Terminals	May 20-22
European Semiconductor	June 4-5
European Copying and Duplicating	June 25-26
Financial Services	August 17-18
Western European Printer	September 9-11
European Telecommunications	October 1-2
Semiconductor	October 19-21
Office Equipment Dealers	November 5-6
Electronic Publishing	November 16-17
CAD/CAM EDA	December 10-11

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Saddlebrook Resort Tampa, Florida

San Diego Hilton Resort San Diego, California

Silverado Country Club Napa, California

The Miyako Kyoto, Japan

Silverado Country Club Napa, California

Hyatt Regency Monterey Monterey, California

San Diego Hilton Resort San Diego, California

Palace Hotel Madrid, Spain

The Ritz Hotel Lisbon, Portugal

Silverado Country Club Napa, California

Palace Hotel Madrid, Spain

Monte Carlo, Monaco

The Pointe Resort Phoenix, Arizona

Hyatt Regency Monterey, California

Stouffer Hotel Bedford, Massachusetts

Santa Clara Marriott Santa Clara, California

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Vendor Support

- The IBM 3270 Market: 1986 and Beyond
- Korean Semiconductor Industry Analysis
- Diskettes—The Market and Its Requirements

Directory Products

I.C. Start-Ups-1987

- SPECCHECK—Competitive Copier Guide
- SPECCHECK—Competitive Electronic Typewriter Guide

SPECCHECK—Competitive Whiteboard Guide

Who's Who in CAD/CAM 1986

Future Products

- Industry Services
- Manufacturing Automation Computer Storage—Optical Computer Storage—Subsystems
- Focus Reports
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 Strategy
 Canon CX Laser—User Survey
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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: October-December 1986-23

BIOMETRICS AND SECURITY: A NEW AREA OF OPPORTUNITY?

INTRODUCTION

How do we let the people we want in and how do we keep those that we do not want out? These are questions that man has been dealing with throughout the centuries. It was also the main topic of the U.C. Berkeley extension seminar on biometrics and security. Thirty people representing identification device manufacturers and device users attended the seminar. It was led by Ben Miller and George Warfel of the <u>Personal</u> <u>Identification News</u> newsletter.

In his outline of the history of identification, George Warfel showed how the process of identification has become and will continue to be electronic. According to Mr. Warfel, identifying people started with the Bertillon method of recording body measurements, it then graduated to face photography, then passwords, and then personal identification numbers (PINs). We are now moving toward the next step: biometrics. This newsletter will define biometrics and discuss the methods of identification and possible future applications.

DEFINITIONS AND APPLICATIONS

Ben Miller splits identification into three areas: knowledge, possession, and biometrics. Knowledge can be a password, a personal identification number, or biographical data. Photo ID badges, driver's licenses, and smart cards fall into the possession area. Biometrics can be grouped into two areas: the physiological biometric, which is a physical characteristic that can only be changed by an accident or surgery; and a behavioral biometric, which can be changed but is unique to the individual (i.e., the way one signs his or her name, walks, or types). Historically, if a biometric was used to identify an individual, a person's picture or fingerprints would be checked and verified by a guard or by a data base off-site. Now it is possible to use electronic devices on-site to identify individuals by their own biometric characteristics.

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In fact, using biometric verification devices is already happening in everyday situations. According to one seminar attendee, an employer is using a retinal scanner in place of a time clock. The employer rationalizes the retinal scanner because it prevents employees from clocking in for each other when they left early or were absent. Table 1 shows the <u>Personal Identification News'</u> list of currently available biometric systems as well as those that are still in the prototype stage. Table 2 displays a list of companies that are spearheading development of biometric identification devices. Ï.

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According to Mr. Warfel, new identification techniques are being used because the concept of identification is changing rapidly in the United States. Historically in the United States, we have always tried to identify individuals who we do not want to enter the mainstream. "What do these people have to do to assimilate? They simply lose their ID," said Mr. Warfel. For this reason, Mr. Warfel believes that some type of standard nationwide identification will develop in the future. According to Mr. Warfel, this identification will be a standard driver's license throughout the United States. As evidence, Mr. Warfel mentioned a conference that he attended in Wisconsin in which 32 states and 6 Canadian provinces discussed driver's license standards. One standard that was proposed was to make the license electronic (i.e., a smart card). Mr. Warfel believes that the smart card may be used in driver's licenses much sooner than, for example, VISA or MasterCard begin to issue their smart cards for mainstream use. Mr. Warfel said that in testing, the difficulty with VISA and MasterCard smart cards was the use of PIN codes for identification. The public will never accept PIN codes for credit card applications. Mr. Warfel's solution is to use biometrics for card authorization, specifically signature dynamics, credit and eventually fingerprints. Other smart card applications discussed at the seminar included password generators, smart keys, and biometric template (or pattern) storage (such as fingerprint patterns, retinal patterns, or voice patterns).

Table 1

BIOMETRIC INDUSTRY SUMMARY (Number in () is the Subset of Devices Applicable for Computer Security)

	Firms with <u>Products</u>	Firms with <u>Prototypes</u>	
Fingerprint	3 (2)	5 (3)	
Hand Geometry	2 (0)	4 (2)	
Voice	2 (1)	4 (3)	
Retinal Scanner	1 (1)	-	
Key Stroke Dynamics	1 (1)	1 (1)	
Signature Dynamics	3 (2)	4 (3)	

Source: <u>Personal Identification News</u> Dataquest August 1986

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Table 2

COMPANIES PARTICIPATING IN BIOMETRICS IDENTIFICATION DEVELOPMENT

<u>Company</u>

ŧ.

<u>Technology</u>

CFA Technologies Comparator Systems Confirma DeLaRue Printrak DigiScan Ecco Industries Eyedentify Fingermatrix Identix International Bioaccess IBM Onset PalmGuard PI DEAC Recognition Systems Signify Stellar Systems Textron Thomas DeLaRue Thumbscan **Voxtron** Systems Ving Cord

Fingerprint Fingerprint Signature Fingerprint Signature Voice Verification Retinal Patterns Fingerprint Fingerprint Key Stroke Dynamics Signature Hand Geometry Palm Creases Hand Geometry Hand Geometry Signature Hand Geometry Voice Verification Signature Fingerprint Voice Verification Hand Geometry

Source: <u>Personal Identification News</u> Dataquest November 1986

The seminar focused on one message: securing information, finances, and locations is becoming very important, and potential security applications are pervasive. New and more sophisticated methods to identify individuals are constantly being created to fill the gap in security.

David G. Norman

Dataquest

Conference Schedule

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1986

Semiconductor	October 20-22	Hotel Inter-Continental San Diego, California
Technical Computer	November 3-5	Silverado Country Club Napa, California
Asian Peripherals	November 5-7	Hotel Okura Tokyo, Japan
Semiconductor Users/ Semiconductor Application Markets	November 10	Sheraton Harbor Island San Diego, California
Electronic Publishing	November 17-18	Westin Copley Place Boston, Massachusetts
CAD/CAM EDA	December 4-5	Santa Clara Marriott

1987

Semiconductor Users/ Semiconductor Application Markets	February 4-6
Copying and Duplicating	February 23-25
Electronic Printer	March 23-25
Japanese Semiconductor	April 13-14
Telecommunications	April 13-15
CAD/CAM	May 14-15
Display Terminals	May 20-22
European Semiconductor	June 4-5
European Copying and Duplicating	June 25-26
European Copying and Duplicating Financial Services	June 25–26 August 17–18
European Copying and Duplicating Financial Services Western European Printer	June 25–26 August 17–18 September 9–11
European Copying and Duplicating Financial Services Western European Printer European Telecommunications	June 25–26 August 17–18 September 9–11 October 1–2
European Copying and Duplicating Financial Services Western European Printer European Telecommunications Semiconductor	June 25–26 August 17–18 September 9–11 October 1–2 October 19–21
European Copying and Duplicating Financial Services Western European Printer European Telecommunications Semiconductor Office Equipment Dealers	June 25–26 August 17–18 September 9–11 October 1–2 October 19–21 November 5–6
European Copying and Duplicating Financial Services Western European Primer European Telecommunications Semiconductor Office Equipment Dealers Electronic Publishing	June 25–26 August 17–18 September 9–11 October 1–2 October 19–21 November 5–6 November 16–17

Santa Clara Marriott Santa Clara, California 4

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San Diego Hilton Resort San Diego, California

Silverado Country Club Napa, California

The Miyako Kyoto, Japan

Silverado Country Club Napa, California

Hyatt Regency Monterey Monterey, California

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The Ritz Hotel Lisbon, Portugal

Silverado Country Club Napa, California

Palace Hotel Madrid, Spain

Monte Carlo, Monaco

The Pointe Resort Phoenix, Arizona

Hyatt Regency Monterey, California

Stouffer Hotel Bedford, Massachusetts

Santa Clara Marriott Santa Clara, California

October 1986

Dataquest

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Executive and Financial Programs

Corporate Alliance Program Coporate Technology Program Financial Services Program Strategic Executive Service

Newsletters

European PC Monitor First Copy Home Row I.C. ASIA I.C. USA

Focus Reports

The European PC Market 1985-1992 European PC Retail Pricing PC Distribution in Europe PC Software Markets in Europe PC Local Area Networking Markets in Europe The Education Market for PCs in Europe Japanese Corporations in the European PC Markets Home Markets for PCs in Europe Integrated Office Systems--The Market and Its Requirements European Market for Text Processing

Image Processing in the Office

Work Group Computing

Translation Systems

Vendor Support

- The IBM 3270 Market: 1986 and Beyond
- Korean Semiconductor Industry Analysis
- Diskettes-The Market and Its Requirements

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I.C. Start-Ups-1987

SPECCHECK—Competitive Copier Guide

SPECCHECK—Competitive Electronic Typewriter Guide

SPECCHECK—Competitive Whiteboard Guide

Who's Who in CAD/CAM 1986

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- Focus Reports
 - Japanese Printer Strategy Japanese Telecommunications Strategy Canon CX Laser—User Survey Digital Signal Processing PC-based Publishing Taiwan Semiconductor Industry Analysis China Semiconductor Industry Analysis PC Distribution Channels

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters, October-December 1986-24

DO 3270 TERMINAL EMULATION PRODUCTS THREATEN 3270 TERMINALS?

SUMMARY

Dataquest

FR a company of The Dun & Bradstreet Corporation

Personal computers have become the productivity tool of choice on an increasing number of corporate desktops over the past five years. The desire to make central data bases and 3270 network resources accessible by those desktop PCs has fueled a growing market to equip PCs with a link to the mainframe. The use of add-in interface boards and software packages that enable the PC to emulate the functions of a 3278- or 3279-type terminal has become the most common method of establishing that link.

This newsletter focuses on 3270-type interface boards because they make up the major portion of the terminal emulation market. We estimate that there were more than 280,000 such interface boards installed in PCs in the United States at year-end 1985. The prevalence of IBM System/370 computers and 3270 networks in the corporate DP/MIS domain assures that this market niche will continue to provide the largest number of opportunities for the next several years.

The market for 3270 terminal emulation products is expected to provide increasing opportunities for its participants, at least through 1988. We forecast that shipments into the U.S. market will grow from 158,300 units in 1985 to 289,000 units in 1988, a compound annual growth rate of more than 22 percent. If-sold market value is expected to be about \$200 million in 1988.

Competition from within, and from outside, the present field of suppliers will drive user prices down. We expect to see unit prices decrease at an average of more than 10 percent per year through 1988--dulling much of the luster of the increased shipment levels.

It is our opinion that the net near-term impact of terminal emulation board products on the overall market for traditional 3270 terminal devices will be minimal. On the positive side, adding new users into the 3270 environment via PCs creates an accompanying need for more controller

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functionality and capacity. On the negative side, some fraction of the desktops that elect to use PCs to communicate with the mainframe may have been potential users of standard 3270 display terminals. However, we believe that most users of communicating PCs are not prime candidates for display terminals.

This newsletter examines the following issues confronting participants in the 3270 terminal emulation board market:

- Marketplace needs and characteristics
- Currently available products
- Market size and trends

We believe that an understanding of these issues is critical to participants in the display terminal industry.

MARKETPLACE NEEDS AND CHARACTERISTICS

Personal computers, particularly the IBM PC family and its compatible counterparts, increasingly fill needs for desktop information processing capabilities in business environments. Many of the spreadsheet and analytical applications for which those PCs are used require the input and processing of data from host-based DP/MIS systems. By providing a PC with the capability to emulate a display terminal, the resources and data bases of the DP/MIS system to which it is attached become accessible--and the PC retains all of its local processing functionality.

Most frequently, the data processing system to which access is desired consists of an IBM 370 or plug-compatible computer and a 3270-type display control system. Over the past five years, a handful of different schemes have been developed to provide PC connectivity through 3270 networks to mainframes. These have included:

- Standalone protocol converters with controller emulation capabilities
- Gateway devices for interlinking local area PC networks with 3270-type networks
- Host-based software packages
- Fully integrated microcomputers, such as the IBM 3270 PC, that provide both display terminal and PC functionality
- Add-in communications boards coupled with terminal emulation software that emulates a 3270 device

PCs have infiltrated the corporate environment gradually; and the need for access to host data files has most often been justified on an individual basis. The first add-in boards and emulation software

provided PCs with what might be called "read-only" access to mainframe files. Host data usually had to be rekeyed in order to be used in the PC. But the add-in boards were relatively inexpensive and uncomplicated to install and use--so they became popular with PC users. By contrast, the other available solutions suffered from lengthy planning cycles, host system modification requirements, larger capital investment requirements, and lack of industry standards.

In late 1982, Technical Analysis Corporation (soon thereafter merged into Digital Communications Associates) introduced the IRMA terminal emulation product for PCs. A product that could conveniently and economically utilize existing PCs and available controller ports, it essentially opened up the market for the current generation of add-in emulation boards. Within the following year, competing products were introduced by AST, CXI, Forte, and IBM (not necessarily in that order). Since then, terminal emulation products have been widely accepted over competing solutions for PC-to-mainframe connectivity.

Hardware and software enhancements have evolved those early terminal emulation products to the point where a PC can duplicate essentially all 3278/3279 terminal functions, with the exception of physical keyboard differences and display size limitations.

CURRENTLY AVAILABLE 327X TERMINAL EMULATION PRODUCTS

PC connectivity into 3270 networks involves a series of hardware and software translations between the differing environments. Some of the key disparities between the PC's asynchronous architecture and the synchronous 3270 world are:

- The physical link between the PC's bus structure and the cable that connects into a 327X control unit or modem
- Keyboard function and layout
- ASCII-to-EBCDIC code conversion
- Data file formats and structures
- Character-mode versus block-mode transmission
- Operating system incompatibilities

The board and software products available today resolve most of these conflicts. Differentiation between the most successful products is largely a matter of the interface with the terminal operator. Keyboard mapping, command line and menu implementations, ease and speed of file transfers, methods of switching between sessions, and windowing capabilities are among such differences. User preferences and the applications being performed by a particular PC user often govern the selection of products. Therefore, most present and near-future product innovations are expected to focus on the emulation and user-interface software.

The most prolific product entries in the add-in terminal emulation board market are what have become known as "coax boards." Basically, these boards are the physical and electrical interface between the PC bus and a coaxial cable that attaches to a 3270 control unit. Other emulator board variations support RS-232-C cable attachments to modems (or modem eliminators), which, in turn, are linked to remote 3270 controllers.

The IBM 3270 PC offers another option for combining local computing and 3270 terminal functionality in the same desktop system. This product is a special version of the IBM PC family designed specifically for attachment to a 3274/3174 control unit. The 3270 PC is equipped with hardware and software that enables it to fully emulate the functions and screen formats of an IBM 3278 or 3279 display terminal. The 3270 PC uses a special keyboard and a different display unit from those of a standard PC. The 122-key keyboard integrates many 3270 keytops--most particularly, all of the special-function keys--with those of a standard PC. The display is a high-resolution, eight-color unit. With the IBM Distributed Function Terminal (DFT) feature installed in the controller, the 3270 PC can manage multiple 3270 and PC-DOS sessions in a windowed scheme.

Depending on RAM, disk storage, and display requirements, basic models of the IBM 3270 PC carry list price tags ranging from \$3,620 to \$8,585. Several independent suppliers--such as AT&T, Businessland, and Telex--have made available their own versions of the 3270 PC models. Others offer add-in products that upgrade existing standard PCs to 3270 PC functionality.

More than 20 suppliers of 3270 terminal emulation board products are currently active in the marketplace. The range of their products is too extensive to compare in this newsletter. In general, the capabilities and features available from each vendor are a function of the PC software that supports the specific emulator board. Software implementation methods vary (as do efficiency and ease of use) among the product offerings. Generally, however, almost all of the products offer the following capabilities:

- Terminal/controller emulation--The minimum acceptable level of emulation consists of being able to establish sessions with the mainframe that permit all of the capabilities of an IBM 3278/ 3279 display terminal or of a 3274/3276 control unit.
- File transfer--This requires software capabilities in both the host computer and the communicating PC. Binary and text files must be transferred between host and PC. The two predominant types of host software support the DCA IRMA emulator products, and the IBM 3278/79 Emulation Adapter. To address a reasonable share of the market, compatibility with at least one of these is essential; some independent suppliers of emulation products offer both.

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- Multiple host sessions/windowing--Most current applications of 3278/3279 emulation products require relatively light use of interactive host resources. However, the ability to toggle between multiple concurrent sessions is a capability that is increasingly desired. Most current products provide (either standard or as an option) the capability to support more than one host session. Windowed display of multiple host sessions and notepad areas are also generally available, allowing for the integration of two or more host applications on the PC's monitor.
- Application program interface (API) support--This feature allows the PC application software to support access to and manipulation of message-oriented data transfers from and to the mainframe. In effect, the PC application becomes a programmatic controller of mainframe data. The two most common APIs on the market are, of course, the IRMA and 3270 PC interfaces. Compatibility with one or both of these APIs assures that an emulation product can support a wide base of PC application software.
- Enhancements/upward migration--Most vendors offer a family of emulation products, from basic 3278 terminal capabilities through full 3270 PC and 3274 controller functionality. Upward migration from basic levels is accomplished via progressively complex software modules that can be loaded into and run on the PC. Generally, the availability of sufficient RAM in the PC is the only hardware complication.

The 3270 terminal emulation board product is almost always purchased as a package consisting of the interface board, PC programs on 5.25-inch floppy disks, installation/operating instructions, and a keyboard template or quick-reference card for remapped keytops.

Manufacturer's suggested list prices range from less than \$600 to about \$1,600 for nearly all of the standard 3270 emulator board packages--with most of the best-selling products positioned in the \$895 to \$1,145 range. We believe, however, that the actual user price is between \$850 and \$900 currently, reflecting competition among sellers. Adding functions to products has allowed prices to remain in that range for the past year, but we expect further price erosion to take place in the 1987 through 1988 period.

MARKET SIZE AND TRENDS

The market for 3270 PC emulation boards is quite young--the first real products were not installed until 1983. Unit shipments have grown dramatically over the past 2-1/2 years--and we anticipate that major growth will continue in the near term.

We estimate that shipments of 3270 terminal emulation board products and attendant software produced revenue exceeding \$157 million in 1985. DCA (which now includes Forte), IBM, CXI, and AST have dominated, and

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continue to dominate, the market. More than 90 percent of recent shipments and the current installed base are attributable to those suppliers. Table 1 lists our estimates of their U.S. market shares.

We estimate that at year-end 1985, more than 2.5 million PCs were installed in U.S. businesses that also had IBM 370-type host computer/3270 network DP facilities. Some 280,000 of those PCs, or about 11 percent, were linked into 3270 networks via emulation interface boards.

The growth of PC installations within large businesses, where 3270/370 networks prevail, is expected to exceed 2 million additional units per year through 1988. A high percentage of those new units, plus many of the unlinked PCs that are already installed, will become market opportunities for 3270 terminal emulation boards. We forecast that 727,000 additional emulator boards will be shipped by the end of 1988 to support the connection of those PCs to 3270 networks.

Table 1

MANUFACTURERS' 1985 MARKET SHARES U.S. SHIPMENTS AND INSTALLATIONS (Thousands of Units)

		<u>Ship</u>	<u>ients</u>	<u>Instal</u>	<u>lations</u>
		<u>Units</u>	<u>Share</u>	<u>Units</u>	<u>Share</u>
DCA		76.0	48.0	165.6	59.0%
IBM		28.5	18.0	41.3	14.7
Forte		20.0	12.6	26.4	9.4
CXI		19.0	12.0	26.0	9.3
AST		7.9	5.0%	11.1	4.0
Others'	k	6.9	4.4	<u>10,0</u>	3.6
Te	otal	158.3	100.0%	280.4	100.0%

*Includes Attachmate Corp., Emulex Corp., IDEAssociates, Pathway Design, and others.

> Source: Dataquest October 1986

Table 2 presents our estimate for shipments of 3270 terminal emulator boards and 3270 PC-type products for 1986 through 1988. We believe that these estimates are significant to terminal industry participants, because they collectively affect the profile of the market for 3270 control units and attached devices. In order to address the total available market, competitors must give continuing consideration to broader product line offerings.

Table 2

ESTIMATED U.S. SHIPMENTS OF 3270 DEVICES (Thousands of Units)

	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	CAGR <u>1985-1988</u>
Emulator Boards	158.3	198.0	240.0	289.0	22.2%
3270 PCs	83.2	101.9	137.6	170.9	27.1%
3270 Terminals	776.4	892.0	<u>1,016.0</u>	<u>1,127.6</u>	13.2%
Total	1,017.9	1,191.9	1,393.6	1,587.5	

Source: Dataquest October 1986

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According to our forecast, shipments of emulator boards and 3270 PC-type products will grow much more than shipments of standard 3270 display terminals. In 1985, combined shipments of boards and 3270 PCs were less than 24 percent of the total units shipped. By 1988, we expect those products to account for 29 percent of the total shipments.

We believe that competitive pressures among the suppliers of terminal emulation products and from the developers of alternative solutions will cause price erosion in the marketplace. Those pressures, coupled with manufacturing economies of scale, are forecast to cause unit prices to decline at a rate of about 10 percent per year. Combined with increased functionality and user-friendliness, the products will therefore become more cost effective--fueling continued expansion of the installed base.

The future market for add-in emulator board products will face challenges from several quarters. Some of those challenges will be:

- Incorporation of protocol conversion capabilities into 3270 control units, enabling simplified connectivity of PCs and other asynchronous devices
- Gateway capabilities, sometimes integral to the control unit, that support the attachment of PC LANs

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- The IBM 3270 PC (and its competitors)
- Shared processor attachments for 3270-type controllers that can provide common computing power to standard 3270 display terminals that are attached to that controller

Recently, many emulator board manufacturers have focused their development and marketing emphasis on LAN gateway products. These add-in boards convert a networked PC to a server through which the other PCs establish communications sessions with the 3270 network host system. Some semblance of LAN standards have emerged around IBM NETBIOS compatibility--which may help to overcome buyer hesitancy in selecting and implementing LANS. If, in fact, there is a "LAN-slide" in the corporate market, a new set of opportunities will open up for those products.

DATAQUEST ANALYSIS

There is no doubt that personal computers will occupy increasing numbers of desktops in large business establishments. And, users of those PCs are expected to create corresponding demands for mainframe access through existing 3270 networks. In turn, that should cause growth in the demand for add-in terminal emulation board products, as well as other connectivity products.

Since much of the resident mainframe software was generated to support the DCA IRMA products, that product line has become a de facto standard in the emulator board marketplace. This is one of those rare exceptions in the 3270 product domain where IBM is not the standard setter. In our opinion, product vendors are at a disadvantage if they do not offer IRMA compatibility.

Early market participants established effective distribution channels, and they continue to dominate those channels by providing product innovations, good support, and reasonable margins. That increases the entry barriers for developers of new 3270 terminal emulator board products.

We forecast an expanding market for add-in 3270 terminal emulation board products because they are comparatively inexpensive, easy to install and use, and commonly understood, and because they provide a connectivity avenue for already installed PCs. Concerns about central data base integrity and security will, however, continue to present resistance to their proliferation.

Manufacturers of terminal emulation board products face mounting competitive pressures--from within their own numbers as well as from alternative 3270 connectivity products and capabilities. Controllerbased protocol conversion and LAN connectivity are becoming common features in many 3270 control units. Both of these connectivity schemes promise some price and support advantages over present terminal emulation products. Our 1986-1988 forecast assumes that these alternatives will displace a small portion of the market opportunities otherwise addressable by add-in 3270 emulator boards. Longer-term effects have yet to be determined.

It is our opinion that the incursion of PCs into 3270 networks has, thus far, been largely limited to accommodating users who were not previously connected into corporate 370 computing resources. We believe that only a small percentage of these new users would have been potential users of standard 3270 display terminals. We anticipate that this will continue to be the case for at least the next several years.

Proliferation of communicating, terminal-emulating PCs will drive terminal manufacturers to incorporate more PC-like features into their products. The eventual result of this trend will be the processing 3270 terminal. We believe that the major consideration is when--not if--the processing terminal will appear in the 3270 world.

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Joe Wagner David G. Norman

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Financial Services	August 17–18
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RESEARCH BULLETIN

SAM Code: 1985-1986 Newsletters: October-December 1986-25

GOMAC '86 FOCUS: SUPERCOMPUTERS--ELECTRONICS FOR THE 1990s

The 1986 Government Microcircuits Applications Conference (GOMAC) in San Diego, California, November 10 through 13, 1986, featured papers by more than 120 speakers and exhibits by 30 companies. Participating U.S. government agencies include the DOD; the army, navy, and air force; NASA; DARPA; National Bureau of Standards; and others. Attendance, which was limited to U.S. citizens and immigrant aliens, exceeded 600. This year's theme reflects the increasing impact of computers and microelectronics on both the public and the private sectors.

SUPERCOMPUTING MOVES AHEAD

The rate of improvement in computing power has slowed, and increased attention is being directed toward architecture of both hardware and software. Speakers addressing issues in this area included Dr. Steven Chen, Senior Vice President of Development, Cray Research; Dr. Paul Schneck, Director of Supercomputing Research Center, Institute for Defense Analysis; Dr. Sidney Karin, Director of San Diego Supercomputer Center, GA Technologies; and R.M. Williams, Naval Air Development Center. Topics included supercomputing trends, increased parallelism, real-time signal processing, and the application of AI to avionics.

MICROCIRCUITS KEEP IN STEP

To offset the slowing rate of progress in components, considerations such as increased levels of integration, increased parallelism, and new software designs are receiving additional attention. Entire sessions featuring four to eight papers each were devoted to topics such as VHSIC architectures, fault-tolerant technology, GaAs ICs, testing, packaging, reliability, and discontinued parts.

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DATAQUEST ANALYSIS

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As U.S. electronics companies' shares of the world market shrink, military electronics applications represent increasing opportunities to those companies willing to focus on the critical issues of performance, reliability, and life-cycle costs as affected by military systems needs.

Gene Miles



SAM Code: 1985-1986 Newsletters: October-December 1986-26

MILITARY SEMICONDUCTOR OUTLOOK 1986-1987

SUMMARY

Dataquest

FR a company of The Dun & Bradstreet Corporation

> On November 10, Dataquest presented its outlook for military semiconductors at a one-day Military IC Procurement Conference sponsored by the Semiconductor User Information Service and Semiconductor Application Markets. This newsletter summarizes the major points covered in the presentation and includes additional information on Congressional action regarding the DoD budget. Topics covered include:

- Government programs
- DoD funding and budgeting
- Technology trends
- Semiconductor trends
- QPL suppliers and products
- 1985-1986 military semiconductor consumption
- 1987 forecast

DEFENSE BUDGET AND PROGRAMS

The Defense Department's budget continues to be driven by major program requirements, such as the Strategic Defense Initiative. Defense outlays have lagged significantly behind overall budget authorizations by as much as 15 percent, in any given year since 1982. The long-term trend line for the U.S. Defense budget has a slope of approximately 1 percent per year (in constant dollars). However, authorizations and outlays have varied substantially from this trend line depending on the state of world affairs (reference Figure 1).

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Dataquest Incorporated, 1290 Ridder Park Drive, San Jose, CA 95131-2398, (408) 971-9000, Telex 171973, Fax (408) 971-9003

Figure 1

DEFENSE BUDGET TREND



In FY'86, the estimated Defense RDT&E (Research Development Test & Evaluation) was \$35.4 billion, 14.9 percent above FY'85. DoD's estimate for FY'87 is for further growth of more than 18 percent, to \$42.1 billion. The major benefactor of this increase is advanced technology development (reference Table 1).

Because of the trend in recent years toward increased defense spending, numerous programs were exempted from budget cutbacks in FY'86 (see Table 2). The Strategic Defense Initiative (SDI) remained unchanged at \$2.76 billion.

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Table	1
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DEFENSE RDT&E (Billions of Dollars)

			*5		*	
•	<u>FY'85</u>	<u>FY'86</u>	<u>Chg.</u>	<u>FY'87</u>	<u>Chg.</u>	•
Technology Base	\$ 3.1	\$ 3.4	10.5%	\$ 3.6	3.9%	
Advanced Technology Development	2.8	4.2	54.0%	6.6	55.3%	
Strategic Programs	8.2	8.1	(1.4%)	9.4	17.1%	
Tactical Programs	9.1	10.9	20.3%	12.8	16.2%	
Intelligence & Communications	3.9	4.7	19.0%	5.1	8.5%	
Defense-wide Mission Support	<u>3.8</u>	4,1	8.1%	4.6	10.7%	
Total RDT&E	\$30.9	\$35.4	14.9%	\$42.1	18.2%	

Source: Department of Defense

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Table 2

PROGRAMS EXEMPTED FROM CUTBACKS IN FY'86 (Millions of Dollars)

. Program	<u>A</u> 11	ount
Strategic Defense Initiative	\$2	,760
Mobile Subscriber Equipment	\$	335
A-6F Upgrade	\$	239
F-14 Upgrade	\$	348
EA-6B R&D	\$	78
Navstar Satellite	\$	197
DSCS-3 Communications satellite	\$	142
Nuclear Detection Satellite	\$	44
T-45 Trainer	\$	116
AV-8B R&D	\$	65
T-56 Engine R&D	\$	45
VH-60 Presidential Aircraft	\$	103

Source: Electronic News

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Command, control, communications, and intelligence $(C^{3}I)$ is a growing component of the DoD budget, receiving increasing attention by Congress. DoD estimates that this part of its budget will grow to \$17.4 billion in FY'87, up almost 22 percent. Table 3 summarizes the FY'86 and FY'87 C³I budget figures at the major department level.

Table 3

C³I BUDGET SUMMARY (Billions of Dollars)

	Source:	Department	of Defense
Totals	\$14.3	\$17.4	21.7%
Air Force RDT&E	2,8	2,9	3.4
Air Force Procurement	3.0	4.2	41.2
Navy RDT&E	. 2.1	2.4	12.4
Navy Procurement	1.1	1.5	29.0
Army RDT&E	0.7	0.6	(8.5)
Army Procurement	2.3	3.1	35.6
Defense Agencies RDT&E	\$ 2.3	\$ 2.7	19.6%
	<u>FY'86</u>	<u>FY'87</u>	<u>Chg.</u>
			76

HOUSE/SENATE BUDGET ACTIONS

For FY'87, the U.S. House of Representatives Armed Services Committee (HASC) favored cutting \$1 billion in EW programs, cancelling the Army's SHORAD and Aquila RPV programs and the Navy's ASPJ and airborne EW, cutting the Air Force's JSTARS to \$0 and NAVSTAR to half, and setting SDI at \$3 billion. However, much funding was restored in conferences with the Senate Armed Services Committee (SASC) (see Table 4).

<u>c³i</u>

Table 4

FY'87 BUDGET AUTHORIZATIONS CONGRESSIONAL COMMITTEE AGREEMENTS FOR MAJOR DoD PROGRAMS (Millions of FY'87 Dollars)

•	<u>DoD Re</u>	<u>quest</u>	<u>House</u>	Auth.	<u>Senate</u>	Auth.	<u>Conf.</u>	<u>Agrmnt.</u>
	R&D	Proc.	R&D	Proc.	R&D	Proc.	R&D	Proc.
<u>Program</u>	<u>\$</u>	\$	<u>\$</u>	<u>\$</u>	<u>\$</u>	<u>\$</u> .	<u>\$</u>	<u>\$</u>
SDI	5,347		3,125		3,953		3,530	
F-16	81	3,842	• 54	2,668	81	3,481	65	3,121
F/A-18	59	3,406	35	2,399	59	2,443	59	2,495
Trident II								
Missile	1,632	1,426	1,500	1,426	1,632	1,426	1,595	1,426
DDF-51	107	2,527	82	951	107	Z,545	102	2,470
SSN-688	4	2,332	0	2,332	4	2,332	0	2,250
F-15	209	2,027	139	1,152	209	2,02	179	1,816
M-1	35	2,116	25	2,050	35	2,116	30	2,050
CG-47 Aegis	- 38	1,924	28	2,725	38	1,924	38	2,725
C-5B	0	1,954	0	1,954	0	1,937	0	1,935
M-X Peacekeeper	352	1,473	200	1,146	322	1,418	290	1,146
Trident Submarine	51	1,509	41	0	51	1,509	41	1,446
Midgetman/SICBM	1,375	0	1,375	0	675	675	1,200	0
AH/64	13	1,342	13	1,184	13	1,103	13	1,166
Bradley IFV	20	1,200	10	890	20	1,005	15	974
Patriot	40	1,033	0	1,002	40	965	40	997
F-14A/D .	268	696	240	506	268	696	260	675
Tomahawk	68	790	68	712	68	735	68	735
MSE	0	903	0	853	0	903	0	903
KC-135 Engines	0	865	0	836	0	997	0	997
C-17	612	217	587	180	547	217	547	180
LANTIRN	40	784	10	784	40	784	40	784
AV-8B	48	762	65	762	48	762	56	762
Amraam	58	756	39	431	58	756	58	617

Source: Dataquest December 1986

TECHNOLOGY TRENDS

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As in the past, defense electronics technology, including military semiconductors, continues to be driven by major program requirements. These include SDI; smart-skin aircraft; compact radar; VHSIC insertion; increased demands for DSP, AI, and RISC architectures; and application of photonics to replace electronics where practical. Projected 1990 military signal processing improvements needed beyond today's technologies are shown in Table 5.

Table 5

PROJECTED 1990 MILITARY SIGNAL PROCESSING REQUIREMENTS

		Volume	
	Processing	x Power	Reliability
Application	Improvement	Reduction	Improvement
Signal Intelligence	100x	3x	>10x
Radar	50-100x	4-10x	2-10x
Weapons Targeting	100x	16x	10x
Image Processing	200-500x		-
Wideband Communications	50-70x	4x	100x
ASW-Global Search	4,000x	-	-
Electronic Warfare	1,000x	-	-

Source: Naval Research Laboratory

The M³I (monolithic microwave/millimeter wave initiative) is a concerted effort by DoD to bring new high-speed GaAs IC technology to production status in military programs, in response to many of the demands listed in Table 5. Table 6 summarizes the major aspects of this initiative.

Table 6

M³I/MIMIC MONOLITHIC MICROWAVE AND MILLIMETER-WAVE INITIATIVE

- Similar to VHSIC; GaAs instead of Si
- Four Phase program
 - Feasibility studies
 - Development
 - Pilot production
 - CAD/CAE, packaging, test technology
- Technology insertion
 - ATF, MILSTAR, etc.
- Budget request exceeds \$130 million

Source: DoD

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SEMICONDUCTOR TRENDS

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The move to photonics and integrated photonics/electronics in military hardware design is putting tremendous speed demands on the ICs involved. Figure 2 shows the present speed-power relationships of existing production IC technologies. These data, coupled with the demands of Table 5, imply increasing demand for GaAs IC technology in new designs. We believe that the more mature D-MESFET GaAs process will be quickly displaced by enhancement/depletion (E/D) processing because of the superior speed-power product of E/D devices.

Figure 2



IC TECHNOLOGY COMPARISON

Source: Vitesse Electronics Corp.

OPL IC SUPPLIERS

At least 16 companies are qualified parts list (QPL) suppliers of MIL-M-38510 ICs. However, the cost of achieving QPL status for a given product is such that none of these companies offer the full range of standard ICs (see Table 7). This situation implies a major role for IC distributors in satisfying particular customers' needs. It also contributes to continuing cost problems in military electronics systems. IC users must make careful choices in selecting alternative sources. The recent announcement of Fujitsu's intent to buy a major stake in Fairchild has raised additional concerns in this area.

Table 7

MIL-M-38510 QPL SUPPLIERS AND PRODUCTS

	1	Logic-N	Memorie:	<u>s </u>		A/Ds,	
<u>Company</u>	TTL	ECL	<u>CMOS</u>	<u>NMOS</u>	<u>uPs</u>	D/As	<u>Other Linear</u>
AMD	x						
Analog Devices						x	
Fairchild	x					X	x
GE/RCA			x			۰.	
Harris			x				
Intel				X	X		
Linear Tech.							· X
MMI	x						
Motorola		x	x				
NSC	х		X	2	•		X
PMI						Х	x
Raytheon	x					X	x
Signetics	x						
Thomson/Mostek				x	X		
TI	x		X				
Zilog					x		
		•					

Source: Dataquest December 1986

DOD BUDGET FORECAST

The present forecast of DoD budget authority is for spending (in constant 1987 dollars) to decline for the next three fiscal years (see Figure 3). Figures 4 and 5 break out the DoD total procurement and RDT&E budget authority forecasts extended to 1995. While the RDT&E budget is forecast to continue declining for the next decade, it remains well above the long-term trend throughout the period. Details of the EIA 1987 forecast of budget authority through 1996 are in Tables 8 and 9.

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Figure 3

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EIA DOD BUDGET AUTHORITY FORECASTS 1986 versus 1987



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Table 8

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ELECTRONIC CONTENT SUMMARY TOTAL PROCUREMENT FORECAST BY MAJOR PROGRAM (In Constant FY 1987 Billions of Dollars)

Program	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
Aircraft	\$11.5	\$10.0	\$ 8.3	\$ 8.4	\$ 8.3	\$ 8.3
Missiles	4.9	6.0	6.1	5.9	5.7	5.6
Space	2.6	2.6	2.6	2.7	2.8	2.9
Ships	4.4	3.8	3.2	3.0	3.0	3.0
Ordnance & Weapons	1.3	. 1.2	1.1	1.1	1.1	1.1
Vehicles	• 1.1	0.9	0.9	0.9	0.9	0.9
Electronics & Communications	6.5	7.2	7.1	7.2	7.2	7.2
All Other	0.9	0.9	0.9	<u> 0.8</u>	0.8	<u> 0.8</u>
Total	\$33.3	\$32.6	\$30.2	\$30.0	\$29.6	\$29.7
Percent Change	-	(2.2)	(7.3)	(0.7)	(1.2)	0.3

<u>Program</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>
Aircraft Missiles Space Ships Ordnance & Weapons Vehicles Electronics & Communications	\$ 8.4 5.6 3.2 3.0 1.1 0.9 7.2	\$ 8.5 5.5 3.4 3.0 1.2 1.0 7.3	\$ 8.8 5.5 3.7 3.1 1.2 1.0 7.6	\$ 9.0 5.5 4.0 3.1 1.2 1.0 7.9	\$ 9.2 5.5 4.4 3.1 1.3 1.0 8.1	\$ 9.5 5.4 4.8 3.1 1.3 1.0 8.4
All Other Total	<u>0.8</u> \$30.2	<u>. 0.8</u>	<u>0.8</u>	<u>0.8</u>	<u>0.9</u>	<u>0.9</u>
Percent Change	1.5	2.0	2,9	3.1	2.5	2.5

Note: Columns may not total due to rounding.

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Source: EIA

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Table 9

ELECTRONIC CONTENT SUMMARY TOTAL RDTSB FORECAST BY MAJOR PROGRAM (In Constant FY 1987 Billions of Dollars)

Program .	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
Aircraft	\$ 1.7	\$ 1.7	\$ 1.6	\$ 1.6	\$ 1.6	\$ 1.5
Missiles .	5.1	5.4	5.4	5.0	4.7	4.6
Space	2.5	3.0	3.3	3.6	3.8	4.0
Ships	0.6	0.6	0.6	0.5	0.5	0.5
Ordnance & Weapons	0.2	0.3	0.3	0.3	0.3	0.3
Vehicles*	0	0	0	0	0	0
Electronics & Communications	5.5	5.7	5.6	5.4	5.2	5.2
All Other	0,4	0.4	_0.4	0.4	0.4	0.4
Total	\$16.1	\$17.1	\$17.3	\$16.9	\$16.6	\$16.5
Percent Change	-	6.4	1.0	(2.2)	(1.8)	(0.7)

Program	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>
Aircraft	\$ 1.5	\$ 1.5	\$ 1.4	\$ 1.4	\$ 1.4	\$ 1.5
Missiles	4.5	4.4	4.1	3.9	3.8	3.8
Space	4.2	4.2	4.2	4.4	4.5	4.5
Ships	0.,5	0.4	0.4	0.4	0.4	0.4
Ordnance & Weapons	0.3	0.2	0.2	0.2	0.2	0.2
Vehicles*	0	0	0	0	0	0
Electronics & Communications	5.3	5.3	5.3	5.3	5.5	5.4
All Other	0.4	0.4	0.4	0.4	0.4	0.4
Total	\$16.5	\$16.4	\$16.0	\$16.0	\$16.3	\$16.2
Percent Change	0	(0.5)	(2.7)	0.2	1.9	(0.4)

*Less than \$0.05 billion per year Note: Columns may not total due to rounding.

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Source: EIA

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NORTH AMERICAN SEMICONDUCTOR CONSUMPTION

Dataquest forecasts semiconductor consumption growth in North America at 12.4 percent through 1991 (reference Table 10). IC consumption is expected to grow slightly faster at 13.9 percent CAGR. These data include all merchant consumption, both commercial and military.

Table 10

NORTH AMERICA SEMICONDUCTOR CONSUMPTION FORECAST (Millions of Dollars)

<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1991</u>	CAGR <u>1986-1991</u>
\$9,607	\$1 0,219	\$11,445	\$18,329	12.4%
\$7,710	\$ 8,214	\$ 9,414	\$15,735	13.9%
2,006	2,143	2,302	3,442	9.9%
4,247	4,438	5,377	9,799	16.9%
1,457	1,634	1,735	2,593	9.7%
\$1,528	\$ 1,599	\$ 1,612	\$ 2,008	4.7%
\$ 369	\$ 406	\$ 419	\$ 586	7.6%
	<u>1985</u> \$9,607 \$7,710 2,006 4,247 1,457 \$1,528 \$ 369	19851986\$9,607\$10,219\$7,710\$ 8,2142,0062,1434,2474,4381,4571,634\$1,528\$ 1,599\$ 369\$ 406	1985 1986 1987 \$9,607 \$10,219 \$11,445 \$7,710 \$ 8,214 \$ 9,414 2,006 2,143 2,302 4,247 4,438 5,377 1,457 1,634 1,735 \$1,528 \$ 1,599 \$ 1,612 \$ 369 \$ 406 \$ 419	1985 1986 1987 1991 \$9,607 \$10,219 \$11,445 \$18,329 \$7,710 \$8,214 \$9,414 \$15,735 2,006 2,143 2,302 3,442 4,247 4,438 5,377 9,799 1,457 1,634 1,735 2,593 \$1,528 \$1,599 \$1,612 \$2,008 \$369 \$406 \$419 \$586

Source: Dataquest December 1986

MILITARY SEMICONDUCTOR CONSUMPTION

Military semiconductor consumption is estimated at \$1,567 million in 1986. It is expected to grow to \$1,803 million in 1987, a gain of 15.1 percent. Significantly, MOS IC shipments are forecast to exceed bipolar for the first time in 1987. Figure 6 and Table 11 show the forecast details.

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MILITARY SEMICONDUCTOR CONSUMPTION FORECAST



Source: Dataquest December 1986

Table 11

MILITARY SEMICONDUCTOR CONSUMPTION FORECAST (Millions of Dollars)

	<u>19</u>	85	1	986	1	987	Percen <u>1986-</u>	t Chg. 1987
Total Semiconductor	\$1,	486	\$1	,567	\$1	,803	15.	1%
Total Integrated Circuit	\$1,	160	\$1	,225	\$1	,394	13.	8%
Bipolar Digital		498		529		571	7.	9%
MOS		442		487		578	18.	7%
Linear		220		209		245	17.	2%
Total Discrete	\$	278	\$	284	\$	330	16.	.2%
Total Optoelectronic	\$	51	\$	58	\$	79	36.	.2%

Source: Dataquest December 1986

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DATAQUEST CONCLUSIONS

Despite the fact that many military-range semiconductor distributor locations are well stocked, currently causing downward price pressure, the 1987 military market is expected to be one of the strongest segments of the North American semiconductor market. Because DoD outlays still lag authorizations, this segment is expected to enjoy improved growth in the near term.

U.S. military IC suppliers have cause for concern as non-U.S. firms such as Fujitsu (Fairchild), Philips (Signetics), Siemens (MSC and others), Thomson (Mostek), and possibly others attempt to grow their shares of the military market through their U.S. subsidiaries. Although Dataquest believes that DoD and the Department of Commerce will attempt to prevent the transfer of key IC technology from Fairchild to Fujitsu, it is not clear that the U.S. government shares the concern of the IC suppliers across the board.

Gene Miles



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Dataquest **Conference Schedule**

1986

Semiconductor	October 20-22	Hotel Inter-Continental San Diego, California
Technical Computer	November 3-5	Silverado Country Club Napa, California
Asian Peripherals	November 5-7	Hotel Okura Tokyo, Japan
Semiconductor Users/ Semiconductor Application Markets	November 10	Sheraton Harbor Island San Diego, California
Electronic Publishing	November 17-18	Westin Copley Place Boston, Massachusetts
CAD/CAM EDA	December 4-5	Santa Clara Marriott

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Semiconductor Users/ Semiconductor Application Markets	February 4-6	Saddlebrook Resort Tampa, Florida
Copying and Duplicating	February 23-25	San Diego Hilton Resort San Diego, California
Electronic Printer	March 23-25	Silverado Country Club Napa, California
Japanese Semiconductor	April 13-14	The Miyako Kyoto, Japan
Telecommunications	April 13-15	Silverado Country Club Napa, California
CAD/CAM	May 14-15	Hyatt Regency Monterey Monterey, California
Display Terminals	May 20-22	San Diego Hilton Resort San Diego, California
European Semiconductor	June 4–5	Palace Hotel Madrid, Spain
European Copying and Duplicating	June 25-26	The Ritz Hotel Lisbon, Portugal
Financial Services	August 17-18	Silverado Country Club Napa, California
Western European Printer	September 9-11	Palace Hotel Madrid, Spain
European Telecommunications	October 1-2	Monte Carlo, Monaco
Semiconductor	October 19-21	The Pointe Resort Phoenix, Arizona
Office Equipment Dealers	November 5-6	Hyatt Regency Monterey, California
Electronic Publishing	November 16-17	Stouffer Hotel Bedford, Massachusetts
CAD/CAM EDA	December 10-11	Santa Clara Marriott Santa Clara, California

Santa Clara, California

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October 1986



RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters, October-December 1986-27

JAPAN'S EXPANDING SPACE PROGRAMS DEMAND HI-REL ICS

SUMMARY

Dataquest expects Japan to increase emphasis on high-reliability (hi-rel) GaAs and Si ICs in support of its expanding space programs. While Japan claims to have a zero military budget, it has massed tremendous capabilities in aerospace hardware in recent years, and has aggressive plans for the next decade. This bulletin details some of Japan's capabilities and plans in this area.

Japan's space activities include the following programs, which require mil range and, in many cases, radiation-hardened (rad-hard) ICs and discrete semiconductors:

- Three new expandable boosters: H-I, M-38-2, and H-II
- More than ten advanced satellites
- Space platforms
- A space shuttle
- Participation in a U.S. shuttle mission
- Participation in the U.S./international space station
- Moon and Venus probes

Japan's space activities represent an increasing threat to Western leadership in satellites, platforms, and shuttles. Dataquest believes that there will be increased international interest in Japan's satellite launch capability as a result of 1986's shuttle, Ariane, and other launch failures.

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DISCUSSION AND ANALYSIS

• Japan has two space agencies: NASDA (National Space Development Agency) and ISAS (Institute of Space and Astronautical Science). These agencies have been responsible for launching about one satellite per year since 1970. MITI (Ministry of International Trade and Industry) serves to create competitive pressures by funding specific payloads.

Japan's space agencies are developing more than 10 satellites and space probes, many designed for geosynchronous orbit (approximately 22,000 miles altitude). These satellites require state-of-the-art GaAs and Si ICs to accomplish the intended functions within launch payload constraints. In addition, rad-hard requirements are expected to impact the IC designs.

Thirteen Japanese companies are studying the MITI/ISAS platform concept for launch by the U.S. shuttle and Japan's H-II booster (developed by Mitsubishi). The H-II booster will support manned launches by 1995. A summary of Japan's spacecraft including launch dates, type of payload and other pertinent data is given in Table 1. These include four communications satellites and two meteorological satellites designed for geosynchronous orbit.

DATAQUEST CONCLUSIONS

Japan is developing a demand for low volumes of domestically produced hi-rel, rad-hard ICs. To achieve better economies of scale, the next logical step is to take these ICs to the international marketplace. Western suppliers of mil-range ICs may experience increased market pressure as a result of Japan's space efforts.

Japan's investment in its space efforts is resulting in far greater capacities in hi-rel semiconductors, satellite systems, and launch hardware than required to support the programs listed in Table 1. In view of recent Western launch failures, we believe that Japan will likely experience increasing difficulty in attempting to keep a low profile regarding its space programs.

Gene Miles

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Table 1

JAPANESE SPACECRAFT

Launch <u>Date</u>	Туре	Name	<u>Cospany</u>	Payload <u>(Lbs.)</u>	Orbit <u>Height</u>	Comments
8/1/86	EGP	Experimental Geodetic Payload	Rawasak i	1,500	900 miles	Laser target, first H-I payload
Mid-1987	BTS-5	Bngineering Test Satellite # 5	Mitsubishi	N/A	Geosync.	Mobile Satcom with ships, planes
1/87	MOS-1	Marine Observation Satellite	NBC	1,650	545 miles	Carrying CCDs and other multispectral detectors
Barly 1988	CS-3A	Communications Satellite #3A	Mitsubishi	N/A	Geosync.	Third-generation, 6,000 voice channels plus K- and C-band transponders
Mid-1988	CS-3B	Communications Satellite #38	Mitsubishi	N/A	Geosync.	Sister to CS-3A
Mid-1989	GMS-4	Geosync. Meteorological Sat.	NEC	N/A	Geosync.	Weather spacecraft; H-I launch vehicle
Mid-1989	GMS-5	Geosync. Meteorological Sat.	NBC	N/A	Geosync.	<pre>\$185 million development cost; 3-axis stabilized; H-I launch vehicle</pre>
Mid-1990	BS-3A	Broadcast Satellite	NEC	N/A	Geosync.	Color TV3 channels
Mid-1991	BS-3B	Broadcast Satellite	NEC	N/A	Geosync.	Sister to BS-3A
N/A	ers-1	Earth Resources Satellite #1	NBC/Mitsubishi	3,000	N/A	Will carry synthetic aperture radar, visible and IR sensors
1/92	ets-6	Bngineering Test Satellite #6	Mitsubishi	N/A	N/A	First H-II payload
1994	N/A	Moon Probe	N/A	N/A	Inapplic.	H-II payload; seismic detection
Mid-1990s		Venus Probe	N/A	N/A	Inapplic.	H-II payload; magnetosphere probe

Geosync. = Geosynchronous orbit (approximately 22,700 miles above Earth's surface) N/A = Not available at press time Inapplic. = Inapplicable

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Source: AZTEK Associates

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Conference Schedule

1986

Semiconductor	October 20-22	Hotel Inter-Continental San Diego, California
Technical Computer	November 3-5	Silverado Country Club Napa, California
Asian Peripherals	November 5-7	Hotel Okura Tokyo, Japan
Semiconductor Users/ Semiconductor Application Markets	November 10	Sheraton Harbor Island San Diego, California
Electronic Publishing	November 17-18	Westin Copley Place Boston, Massachusetts
CAD/CAM EDA	December 4-5	Santa Clara Marriott Santa Clara, California

1987

Semiconductor Users/ Semiconductor Application Markets	February 4–6	Saddlebrook Resort Tampa, Florida
Copying and Duplicating	February 23-25	San Diego Hilton Resort San Diego, California
Electronic Printer	March 23-25	Silverado Country Club Napa, California
Japanese Semiconductor	April 13-14	The Miyako Kyoto, Japan
Telecommunications	April 13-15	Silverado Country Club Napa, California
CAD/CAM .	May 14–15	Hyatt Regency Monterey Monterey, California
Display Terminals	May 20-22	San Diego Hilton Resort San Diego, California
European Semiconductor	June 4-5	Palace Hotel Madrid, Spain
European Copying and Duplicating	June 25-26	The Ritz Hotel Lisbon, Portugal
Financial Services	August 17–18	Silverado Country Club Napa, California
Western European Printer	September 9-11	Palace Hotel Madrid, Spain
European Telecommunications	October 1-2	Monte Carlo, Monaco
Semiconductor	October 19-21	The Pointe Resort Phoenix, Arizona
Office Equipment Dealers	November 5-6	Hyatt Regency Monterey, California
Electronic Publishing	November 16-17	Stouffer Hotel Bedford, Massachusetts
CAD/CAM EDA	December 10-11	Santa Clara Marriott Santa Clara, California

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Product Offerings

Industry Services

Business Computer Systems CAD/CAM Computer Storage-Rigid Disks Computer Storage—Flexible Disks Computer Storage-Tape Drives Copying and Duplicating **Display Terminal Electronic Printer Electronic Publishing Electronic Typewriter** Electronic Whiteboard European Semiconductor* **European Telecommunications** Gallium Arsenide Graphics **Imaging Supplies** Japanese Semiconductor* Office Systems Personal Computer Personal Computer-Worldwide Shipments and Forecasts Robotics Semiconductor* Semiconductor Application Markets* Semiconductor Equipment and Materials* Semiconductor User Information* Software-Artificial Intelligence Software-Personal Computer Software-UNIX **Technical Computer Systems** Technical Computer Systems-Minisupercomputers Telecommunications Western European Printer

Executive and Financial Programs

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Corporate Alliance Program Coporate Technology Program Financial Services Program Strategic Executive Service

Newsletters

European PC Monitor First Copy Home Row I.C. ASIA I.C. USA

Focus Reports

The European PC Market 1985-1992 European PC Retail Pricing PC Distribution in Europe PC Software Markets in Europe PC Local Area Networking Markets in Europe The Education Market for PCs in Europe Japanese Corporations in the European PC Markets Home Markets for PCs in Europe Integrated Office Systems-The Market and Its Requirements European Market for Text Processing Image Processing in the Office Work Group Computing Translation Systems

Vendor Support

- The IBM 3270 Market: 1986 and Beyond
- Korean Semiconductor Industry Analysis
- Diskettes-The Market and Its Requirements

Directory Products

I.C. Start-Ups-1987

SPECCHECK--Competitive Copier Guide 2

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SPECCHECK—Competitive Electronic Typewriter Guide

SPECCHECK—Competitive Whiteboard Guide

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Future Products

- Industry Services
 - Manufacturing Automation Computer Storage—Optical Computer Storage—Subsystems
- Focus Reports

Japanese Printer Strategy Japanese Telecommunications Strategy Canon CX Laser—User Survey Digital Signal Processing PC-based Publishing Taiwan Semiconductor Industry Analysis China Semiconductor Industry Analysis PC Distribution Channels

• Directory Products SPECCHECK—Competitive Facsimile Guide SPECCHECK—Competitive Electronic Printer Guide

*On-line delivery option available

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: October-December 1986-28

NEC BOLDLY STEPS WHERE NO MAN HAS GONE BEFORE --PRODUCES A 6-MBYTE 3.5-INCH FLEXIBLE DISK DRIVE

SUMMARY

NEC Corporation's System Research Center has announced development of a radically new 3.5-inch flexible disk drive product. Today's standard capacities for this size of disk do not exceed the 2-Mbyte limit, but NEC believes that its new technology can provide an unformatted capacity of 6 Mbytes using currently available standard media. While NEC did not mention firm production plans, Dataquest believes that commercialization of the product could come as early as the third quarter of 1987.

Until now, only Toshiba has announced a high-capacity 3.5-inch flexible disk product, but its 4-Mbyte vertical recording technology depends on custom (and patented) barium ferrite media. One of 'the prime advantages of the NEC approach is the availability of large volumes of low-cost diskettes.

This newsletter looks at the NEC technology and reviews the highcapacity flexible disk market. With this development, the industry is forced once again to review the true capacity needs of the small computer user in order to determine the viability of high-capacity products in today's market. Dataquest has concluded that there is truly a need for products of this nature.

FLEXIBLE DISK TECHNOLOGY BACKGROUND

In 1975, when the OEM flexible disk drive business was beginning, the 8-inch diameter products offered 400- and 800-Kbyte capacities on a single side of a diskette (depending on whether FM or MFM recording techniques were used). Track density was 48 tracks per inch (TPI) and bit densities were 3,268 or 6,538 bits per inch (BPI). Data transfer rates of 31.25 Kbytes/second for single-density recording and 62.5 Kbytes/second for double density were attained. Two-sided diskettes doubled these capacities to 800 Kbytes and 1.6 Kbytes, respectively.

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The next major change in flexible disk technology came with the reduction in diameter to 5.25-inches. Using essentially the same TPI and BPI specifications as the first 8-inch products, capacities of 125 and 250 Kbytes per side were produced. Soon track densities were doubled to 96 TPI and recording densities increased to 9,646 BPI, with a resulting 1.6 Mbyte double-sided standard. Table 1 illustrates the historical movement of this technology.

. The natural progression to a smaller form factor dropped the diameter of flex diskettes to 3.5 inches and found them encased in a hard shell to protect the thin oxide film recording medium. Currently, the most popular technology is an 80 TPI and 8,717 BPI diskette, providing 1.0 Mbytes of storage on two sides. Capacities of 2.0 Mbytes have been achieved by pushing the track density to 135 TPI and the recording density to 17,434 BPI. It appears that this 2.0-Mbyte standard will gain wide popularity and will be the standard for several years.

To attain these high recording densities, a cobalt-doped iron oxide medium must be used. A coercivity level of 700 Oersteds is possible in commercially available diskettes today. It is this media that NEC intends to use in the new 6-Mbyte 3.5-inch diameter product.

Table 1

HISTORY OF FLEXIBLE DISK CAPACITY

	8-Inch	<u>Diameter</u>	5.25-Inch Diameter 3.5-inch Diameter					<u> </u>			
Coating	Oxide	Oxide	Oxide	Oxide	Thin Oxide	Thin Oxide	Thin Oxide	Thin Oxide	BaFe	CoPeO3	CoFeO3
Envelope	Soft	Soft	Soft	Soft	Soft	Hard	Hard		Hard	Hard	Hard
Capacity:											
Per Diskette, Mbytes	0.8	1.6	0.5	1.0	1.6	12.760	0.5	1.0	4.0	2.0	6.0
Per Surface, Mbytes	0.8	0.8	0.25	0.5	0.8	6.030	0.5	0.5	2.0	1.0	3.0
Per Track, Bytes	10,416	10,416	6,250	6,250	10,416	23,868	6,250	6,250	25,000	12,500	12,500
Recording Density (BPI)	6,536	6,618	5,877	5,922	9,646	21,925	0,187	8,717	35,000	17,434	17.400
Track Density (TPI)	48	48	48	96	96	333	135	135	135	135	406.5
Tracks/Surface	77	77	40	80	96	301	80	80	80	80	240
Data Rate, Kbytes/second	62.5	62.5	31.25	31.25	31.25	31.25	62.5	31.25	125	62.5	62.5
Rotational Speed, rpm	360	360	300	300	360	600	600	300	300	300	300
Pirst Ship Date	1975	1977	1980	1981	1984	1986	1982	1984	1987	1986	1987

Source: Dataquest October 1986

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NEC TECHNOLOGY DESCRIPTION

The NEC System Research Center has published papers describing the technology it has developed in order to record 6 Mbytes of data on currently available high-density media and 12 Mbytes on barium ferrite or metal media.

The key to the high-capacity capability of this announcement is increasing the track density to 406.4 TPI. Winchester rigid disk drives have long enjoyed track densities more than twice as compact as NEC's announcement, but the significant advancement in this news is the increase in track density on a very low-cost, removable, flexible disk drive.

Another key benefit of this announced technology is that diskettes recorded on lower-capacity, 1.0- or 2.0-Mbyte drives can be easily read by the new NEC drive. This feature assures upward compatibility with current products.

In order to attain these high track densities, three technologies were used:

- High-torque linear stepping motor
- Sector servo
- Modern control theory

The servo pattern is not yet announced, but NEC has stated that it divides each track into 32 sectors with an 83 bit/sector overhead due to servo data. On each seek, the head is moved in three-track increments, based on a table of electrical current phase data. Once the head is within three tracks of the target track, positive or negative movement is controlled with the aid of servo samples and a linear feedback control circuit. The servo circuitry is mounted on a separate card but can be integrated into custom LSI and included on the normal drive electronics board in the future.

According to NEC, the servo pattern is written by using a special board "on the host system," implying that the diskettes can be formatted in the field rather than requiring factory placement of servo signals.

The feedback controller consists of digital filters that control the secondary mode off-track errors to less than one-tenth of those normally found in conventional servo systems. By sampling off-track errors and controlling the balance of the motor while working out the tracking position of the disk, a single, low-cost, 8-bit microprocessor is ideally suited for the application.

The errors normally experienced in high track density, removable media products are off-track positioning errors due to:

- Disk centering errors
- Head expansion errors

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Media expansion errors

The NEC product is specified to be able to track a relative head position error of \pm 0.8 microns and \pm 0.6 micrometers for track errors. Using modern control theory, the head can chase a wandering track by moving a sine curve pattern as the diskette spins. The servo sampling rate is 32 times per revolution while the diskette spins 5 times per second.

The read/write head gap is 0.7 micrometers. There is no erase gap required because, with a head positioning error of ± 3 micrometers and a track pitch of 62.5 micrometers, no additional erasure area is required.

Detailed specifications of the NEC diskette drive are listed in Table 2.

Table 2

DRIVE SPECIFICATIONS

Capacity:	
Unformatted	6.0 Mbytes
Formatted	4.0 Mbytes
Data Transfer Rate:	500 Kbits/second
Access Times:	
Track-to-Track	1 msecs
Average Access	80 msecs
Acquisition Time	33 msecs
Average Latency	100 msecs
Rotational Speed:	300 rpm
Recording Density:	17,400 BPI
Track Density:	406.4 TPI
Cylinders:	240
Tracks:	480
Recording Method:	MFM
Height:	1.61 inches (41 mm)
Head Coil:	180 x 2 turns
Signal to Noise:	34.4dB
Overwrite:	27.5dB

Source: NEC Corporation

APPLICATIONS

There is reason to show some concern about the market viability of a new high-capacity flexible disk drive. To date, there have been no substantive success stories regarding this category of products. The following sections look at just two examples.

Iomega's Bernoulli Box

Iomega further developed some IBM technology for the Bernoulli Box, a high-capacity flexible file that uses custom media inside a rigid shell. OEM buyers could not position a 5- or 10-Mbyte flexible disk product in their product lines, especially in a form factor exceeding the 8-inch standard dimensions. Clever marketing saved Iomega from disaster and the Bernoulli Boxes found a home in retail distribution, selling to small businesses. The bulk of the units were purchased for backup purposes, but became popular system products because of their fast access and the easy removability of their media.

The total market for Iomega's products has been estimated at around 50,000 units per year. The company's sales have grown from \$51 million in 1984 to an estimated \$126 million in 1986. It is unclear whether new entrants in the high-capacity flexible drive market would erode Iomega's share or might broaden the base of users and increase Iomega's sales.

Now Iomega has produced a 5.25-inch, 20-Mbyte Bernoulli Box and is once again attempting to sell an OEM product. This time, the form factor and capacity are in step with the times and the brand name recognition gained from several years of supplying high-quality products and service just might make the company successful in the OEM market.

IBM'S PC AT

Our second example is none other than the International Business Machine Corporation. IBM announced a 1.6-Mbyte, 5.25-inch flexible drive as a standard feature of the PC AT. A 360-Kbyte drive was also provided in the basic configuration. Early reviews of the PC AT were positive about the ability to store more than a megabyte of data on a flexible disk, but now there is some doubt that anyone uses its extra capacity or even cares if it is there.

A major retail chain removes all 1.6-Mbyte drives from the AT computers installed for use in its headquarters and replaces them with a half-height 360-Kbyte drive. The reason given is that all software is distributed on 360-Kbyte diskettes and, internal to the corporation, all data that is moved from one PC to another is required to be on the lowercapacity media. With Winchesters installed in every PC and the easy availability of tape backup, they see absolutely no need for a flexible drive with high capacity, even though it can read data written by lowercapacity drives.

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Application Summary

NEC's 6-Mbyte 3.5-inch offering appears to have limited use in today's market if either of these two examples continues to hold true for other products. The key item for acceptance is the drive's ability to read the lower-capacity standard diskettes.

In summary, potential applications are:

- Winchester disk drive backup
- Random access to archived information
- New, low-cost high-capacity system disks

COMPETITION

The rival products in this arena consist of the currently nonstandard flexible disk drives with higher capacities than are normally offered on PC products.

Some of these products are actually available today, while others are yet to be formally announced. The offerings from DTC, Iomega, and Kodak are the only ones actually available for sale. The DTC and Kodak drives are listed in Table 2 under the 12.76-Mbyte column. All three of these vendors require that the recording medium be encased in a hard plastic shell for stability and protection of the flexible film. The Iomega Beta 20 is offered for \$550 in large OEM quantities while DTC and Kodak sell their drives at or slightly higher than the Iomega price for only half the capacity. All three products are 5.25-inch form factor and are intelligent drives with direct attachment to the SCSI bus.

Other soft-jacketed 5.25-inch diameter, high-capacity products will be announced at Fall COMDEX 1986. Since the diskettes used in these new drives are not shrouded in hard plastic, the new drives could potentially read diskettes onto which data has been stored by old-fashioned 360-Kbyte drives.

Toshiba is the only disk vendor that has actually shown a vertical recording flexible disk drive. Toshiba's 4-Mbyte 3.5-inch drive was exhibited at NCC in Las Vegas this year. Its special barium-ferrite medium requirement has caused most analysts to doubt the wide commercial success for this product. It does, however, have the strong point of being able to read conventional 1-Mbyte 3.5-inch diskettes. Deliveries could begin as early as mid-1987.

NEC, then, has the highest announced capacity 3.5-inch diameter flexible disk drive and offers backward compatibility with 1- or 2-Mbyte media. Pricing is not yet available for either the Toshiba or NEC drives.

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DATAQUEST ANALYSIS

The experience of the Dataquest Tokyo office indicates that data interchange is the most important consideration in a product of this nature. Thus, NEC is promoting standardization of its media and servo pattern as well as assuring that 1- and 2-Mbyte diskettes can be read on NEC's high-capacity unit. Other observations from our Japanese office point to strong acceptance of any removable product with the capacity of a rigid disk drive and the price of a flexible disk drive. The success of the Japanese word processor, with over a million units sold in 12 months, opens up a major opportunity for a small, high-capacity removable storage devices to store documents made of Chinese <u>kanji</u> characters and graphics.

One must remember that NEC has only made an announcement of a highcapacity 3.5-inch flexible disk drive and that it may never see the light of day. On the other hand, the trend toward high-capacity flexible storage products is accelerating and NEC's new technology will probably lead the pack if it can be brought to market.

The key to this entire segment of the industry is public acceptance. • A major OEM provider of small computer products must prove that a highcapacity flexible disk is both useful and desirable. If NEC can find that computer vendor and can force its product to be the standard, it will be an overnight success. By the way, isn't NEC one of the largest PC manufacturers in the world?

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Dave Norman Phil Devin

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Conference Schedule

1986

Semiconductor .	October 20-22	Hotel Inter-Continental San Diego, California
Technical Computer	November 3-5	Silverado Country Club Napa, California
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CAD/CAM EDA	December 10-11	- Santa Cla Santa Cla

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Product Offerings

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Business Computer Systems CAD/CAM Computer Storage-Rigid Disks

 Computer Storage—Flexible Disks Computer Storage-Tape Drives Copying and Duplicating **Display** Terminal **Electronic Printer** Electronic Publishing Electronic Typewriter Electronic Whiteboard European Semiconductor* European Telecommunications Gallium Arsenide Graphics **Imaging Supplies** Japanese Semiconductor* Office Systems Personal Computer-Worldwide Shipments and Forecasts Robotics Semiconductor* Semiconductor Application Markets⁴ Semiconductor Equipment and Materials* Semiconductor User Information* Software—Artificial Intelligence Software—Personal Computer Software—UNIX **Technical Computer Systems** Technical Computer Systems-**Minisupercomputers Telecommunications** Western European Printer

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Diskettes-The Market and Its Requirements

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SPECCHECK-Competitive Copier Guide

SPECCHECK-Competitive Electronic Typewriter Guide

SpecCheck—Competitive Whiteboard Guide

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SPECCHECK-Competitive **Facsimile** Guide SPECCHECK-Competitive **Electronic** Printer Guide

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 - Figure 1, IBM's New Proprinter, Page 1
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SAM Code: 1985-1986 Newsletters: July

RESEARCH

NEWSLETTER

IBM'S NEW PROPRINTER: A VIEW INSIDE

INTRODUCTION

IBM recently unveiled a series of significant printer announcements, including its first entry into the retail impact dot matrix market--the 4201 Proprinter. DATAQUEST believes that this rugged, lightweight, reliable entrant indicates IBM's commitment to being a serious participant in a market that has become dominated by foreign manufacturers.

Our first-hand look at the Proprinter, shown in Figure 1, revealed an impressive, advanced manufacturing-oriented design, and allowed DATAQUEST to analyze this exciting new product's semiconductor content.

Figure 1

IBM'S NEW PROPRINTER



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THE MARKET

The Proprinter is targeted for use with the entire range of IBM personal computers (listed in Table 1) and is designed with many unique features. On a price/performance basis, it is very competitive with other retail products, as illustrated in Table 2. DATAQUEST believes, in fact, that the Proprinter's suggested retail price has already been discounted to as low as \$475.

Table 3 reflects the strength of some of the established manufacturers in this marketplace. IBM will be competing in a market in which 64 percent of share was held by only four players in 1984, all of which were located offshore. This market was \$3,039 million in 1984, and is estimated at \$2,782 million in 1985. DATAQUEST believes that in dollar value, this market will continue to decline to \$2,479 million in 1989. However, we believe that relative unit growth will continue to grow, from 4.5 million units in 1985 to 6.3 million units in 1989.

Table 1

IBM PROPRINTER/SYSTEM COMBINATIONS

PCjr PC XT PC XT PC AT PC Portable 3270 PC PC XT/370 3270 PC/G 3270 PC/GX PC Parallel Interface RS-232-C Interface

Source: IBM Corporation DATAQUEST

Table 2

COMPETITIVE PRICE/PERFORMANCE COMPARISONS

<u>Vendor</u>	Model	Speed (cps)	<u>Price</u>
IBM	Proprinter	200/100/40	\$ 549
Epson	FX-80+	160/37	\$718*
Citizen	MSP20	200/50	\$649
Star	SR-10	200/50	\$649
Dataproducts	801X	180/90/30	\$649
Fujitsu	DotMax 9	180/25	\$695
Okidata	192	160/33	\$499

*FX-80+ price shown includes NLQ option at \$219. Base price is \$499.

Source: DATAQUEST

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Table 3

1984 IMPACT DOT MATRIX MARKET SHARE (Percent of Total)

Epson TEC Okidata Star

Total 64%

Source: DATAQUEST

PROPRINTER FEATURES/TECHNOLOGY

DATAQUEST considers the most impressive application-oriented feature of this printer to be its paper-handling system. The Proprinter offers both continuous forms handling and single-sheet/envelope feed capability. Continuous forms are driven by sprockets that engage the form before the print station. This feature, coupled with a flat platen bar and easy access to the form as soon as it exits the print area, permits document on-demand printing.

An innovative front-load paper path and a friction feed system combine to allow easy printing on single sheets (up to 11 inches wide) and envelopes (up to 9.5 inches wide). Either sheets or envelopes can be printed without removing the continuous forms. DATAQUEST believes that simple single-sheet and envelope feeding is a practical and necessary complement to multimode printers, and has too often been overlooked by suppliers. IBM's approach to multimode (simultaneous) forms handling should be well received by users.

Ease of Assembly

DATAQUEST believes that the Proprinter's most significant technology application is its advanced, manufacturing-oriented design. IBM is taking continual strides toward its goal of being a cost-effective, efficient, leading producer in all of its lines of business. In its 1984 annual report, the corporation states that "Becoming the industry's low-cost producer, distributor, seller and servicer is central to IBM's long-term strategy. To help meet our cost goals, we have pursued a program of plant modernization and expansion unparalleled in the industry. As a result, our overall manufacturing capacity has been substantially renewed and designed to support highly efficient production." The Proprinter contains fewer than 60 parts, one of which is the printed circuit board. The majority of the parts are created from molded plastics (appropriately selected for strength and temperature stability). The design objectives included a requirement for no screws, nuts, or bolts. Thus, assembly consists of basically snapping together all of the precision-fit subassemblies--and can be performed in less than five minutes. The only adjustments appear to be rotatable eccentrics that establish the final head carriage-to-platen alignment.

The net result of this design is a strong, lightweight, portable product that can be competitively manufactured at low cost--which is essential for competing with offshore manufacturers and for targeting the retail market. DATAQUEST estimates that the cost of manufacturing the Proprinter is between \$75 and \$125. Though it is probably near \$125 now, we expect it to drop with automation and the resulting economies of scale. We also believe that this printer could be easily manufactured by a robotized factory--a possibility that has been rumored but not yet announced by IBM. The Proprinter is currently produced at IBM's facility in Charlotte, North Carolina.

Maintenance

Because of the way the Proprinter is assembled, it allows for easy maintenance. This ease of maintenance and reliability is supported by IBM's service pricing and policy for the printer, which includes:

- A one-year warranty (carry-in exchange)
- A one-year service contract, priced as follows:
 - Customer carry-in, repair--\$30
 - Customer carry-in, exchange--\$30
 - On-site exchange, \$35-\$41

Semiconductor Analysis

In the Proprinter that we examined, there were a total of 83 semiconductors, 23 of which were integrated circuits using conventional DIP (dual-in-line) packages. Table 4 describes each integrated circuit, lists the other components on the board, and estimates the total dollar value of all the semiconductors used in the printer.

DATAQUEST estimates that the Proprinter's semiconductor components represent a total value of \$24.40. We derived this value by pricing each device at a single quantity through distribution and then discounting for appropriate volumes. We also estimated the value another way, using 1985 contract price information from DATAQUEST's Semiconductor User Information Service. In both instances, the overall single quantity pricing was discounted by approximately 60 to 65 percent--a reasonable assumption given the devices and their potential volumes.

Table 4

IBM PROPRINTER SEMICONDUCTOR CONTENT

Quantity	Device/Description
4	National 7407 - TTL Hex Buffer/Driver
1	National 7406 - TTL Hex Inverter Buffer
3	National LM339 - Linear Comparator
1	National 74C04 - CMOS Hex Inverter
1	National 74LS155 - TTL LS Decoder/Demultiplexer
2	National 74LS279 - TTL LS Latch
2	National 74LS174 - TTL LS Flip-Flop
2	National 74LS367 - TTL LS Buffer
1	National 74LS05 - TTL LS Inverter
1	National 74LS374 - TTL LS Flip-Flop
1	Signetics NE556 - Linear Timer
1	TI 74LS373 - TTL LS Latch
1	Toshiba TMM2016 - NMOS 16K Static RAM
1	AMD AM27128 = NMOS 128K EPROM
<u> </u>	Intel 8-bit MCU*
23	Total ICs
20	Power Transistors
37	Diodes
3	Low-Signal Transistors
60	Total Discrete
83	Total Semiconductors
\$24.40	Total Semiconductor Value
*There	were few identifying marks on this device. It

had a 1982 copyright date. DATAQUEST believes it is a ROM-less version of the 8039/40.

Source: DATAQUEST

Using an estimated \$125 manufacturing cost for the Proprinter, we estimate a semiconductor value-to-cost of manufacturing ratio of 20 percent. This ratio is also called an input/output (I/O) ratio. The I/O ratio determines the relationship between semiconductor value and the value of the equipment in which the devices are used.

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DATAQUEST also uses end-user values to determine input/output (I/O) ratios because they give a view of the market on a macro level. We believe that retail prices give a better impression of what the market will bear for particular equipment, and therefore give an indication of the semiconductor market associated with that equipment. Using the suggested retail price of \$549, we estimate an I/O ratio of 4.4 percent, reaching as high as 5.1 percent, with a discount on the Proprinter to a price as low as \$475.

DATAQUEST CONCLUSIONS

DATAQUEST believes that the new Proprinter and other announced products are early examples of IBM's applying its own technology to provide users with solutions to their hard copy applications. DATAQUEST anticipates that over the coming months, IBM will announce more peripheral products, which will help to leverage its design and manufacturing investments.

In DATAQUEST's opinion, these moves do not mean that IBM will shift exclusively to internal sources for printer products. We believe that IBM will participate in carefully selected market segments, and continue to purchase from external sources in other segments.

We believe that IBM is applying standard semiconductor technology to the Proprinter, and that its entrance into this marketplace will provide continued opportunities to semiconductor manufacturers.

(Market information about the printer industry has been provided by DATAQUEST's Electronic Printer Industry Service.)

Anthea C. Stratigos

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SAM Code: 1984-1985 Newsletters: July

RESEARCH

NEWSLETTER

NORTH AMERICAN SEMICONDUCTOR CONSUMPTION BY APPLICATION MARKET

Dataquest

INTRODUCTION

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Analyzing semiconductor consumption from an application market perspective is a task the semiconductor industry has long grappled with. In the past, analyzing semiconductor consumption by application market was fairly easy because the data processing and military industries were about the only major consumers of semiconductor devices. Watching the trends and technology in those two market segments gave a pretty good indication of what would transpire in the semiconductor industry.

Over the years the number of semiconductor applications has increased tremendously. And a closer and more accurate examination of semiconductor consumption by application market has become both increasingly difficult and increasingly necessary.

For these reasons, DATAQUEST has developed a new service--Semiconductor Application Markets (SAM)--to assist decision makers who must take a tactical or strategic approach in their analysis of the semiconductor market, from either an application, demand-side, or "end use" perspective.

This newsletter provides Semiconductor Industry Service (SIS) clients with a brief look at the results of SAM's research and analyses. In the future, detailed information about this aspect of the semiconductor market will be provided to clients of DATAQUEST'S SAM service.

METHODOLOGY

Market Segmentation

SAM breaks out electronic equipment into six application market segments. Segmenting the market is a matter open to a variety of interpretations. After considerable dialog with semiconductor

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manufacturers and an examination of many different segmentations, SAM has standardized the segmentation of electronic equipment into the following markets:

- Data processing
- Communications
- Industrial
- Consumer
- Military
- Transportation

Data processing comprises all equipment whose main function is flexible information processing. Included in this segment are all personal computers, regardless of price, distribution, or use in the office, education, or home environment. Within the communications market, DATAQUEST classifies telecommunications as a subsegment that consists of customer premises and public telecommunications equipment. Other communications electronics include radio, studio, and broadcast Industrial comprises all manufacturing-related equipment, equipment. including scientific, medical, and dedicated systems. The consumer segment comprises equipment that is designed primarily for home or personal use whose primary function is not flexible information Audio and video equipment and appliances are typical processing. examples of equipment that is classified in the consumer application Military equipment is primarily defense-oriented electronic market. equipment and is classified by major budget area. It does not include all electronic equipment procured by the government because such a breakout would double-count equipment that logically belongs in other market segments. Finally, transportation consists mainly of automotive and light truck electronics. This designation leaves room to analyze other markets, such as off-highway equipment, that are large users of semiconductors.

Research

SAM analyzes semiconductor consumption by:

- Tracking the electronic equipment revenues (by application market) of major manufacturers and relating the information to historical semiconductor consumption
- Gathering proprietary data through personal interviews with procurement, contract, or materials managers regarding their merchant market semiconductor procurement and captive production and the use of the devices within their corporation or company

- Analyzing the semiconductor content of individual pieces or types of electronic equipment
- Developing input/output ratios that express the relationship between the value of semiconductors and the value of the electronic equipment in which the semiconductors are used
- Forecasting the markets for more than 200 individual types of electronic equipment, each of which is classified within one of the six application market segments
- Forecasting semiconductor consumption using input/output ratios and the electronic equipment forecast
- Analyzing semiconductor manufacturers' shipments in all semiconductor product and technology areas by application market (this bottom-up analysis acts as a check on the top-down approach just described)

ANALYSIS

Table 1 shows the forecast for North American electronic equipment shipments, which we define as equipment produced and sold by a company that is based within the region--regardless of where production occurs. For example, if Company X is located in New Jersey and has production facilities in Arizona and Singapore, DATAQUEST classifies all that company's shipments as North American. Some market analyses define shipments as "shipments to a particular region." SAM classifies that as consumption by a particular region.

Table 1

NORTH AMERICAN ELECTRONIC EQUIPMENT SHIPMENTS (Millions of Dollars)

				CA	GR
	<u>1983</u>	<u>1984</u>	<u>1989</u>	1983-1984	<u>1984-</u> 1989
Data Processing	\$ 64,187	\$ 82,537	\$179,147	28.6%	16.8%
Communications	23,331	27,939	58,987	19.8%	16.1%
Industrial	28,048	31,980	64,843	14.0%	15.2% "
Consumer	12,768	13,589	20,601	6.4%	8.7%
Military	37,300	42,295	79,200	13.4%	13.4%
Transportation	5,547	7,441	13,812	34.1%	13.2%
Total	\$171,181	\$205,781	\$416,59 0	20.2%	15.1%

Source: DATAQUEST June 1985

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As shown in Table 1, we believe that data processing and communications will continue to be the fastest-growing electronic equipment market segments, followed closely by industrial. Transportation, which experienced a tremendous surge of growth between 1983 and 1984, is expected to slow its growth considerably over the next five years. We believe that consumer products will continue to be increasingly manufactured offshore by foreign producers and we expect the segment to experience the slowest growth among all the electronic market segments.

Table 2 presents our forecast for total semiconductor consumption by application market. All segments experienced growth of at least 30 percent between 1983 and 1984 because of the tremendous growth in the semiconductor market during that time. Besides a surge in overall demand that affected unit shipments, there was a huge imbalance between that demand and supply. This positively affected prices, keeping them firmer than normal, and facilitated the enormous growth experienced in semiconductor dollar shipments. We believe that growth between 1984 and 1989 will continue to be much more moderate in all application market segments, with data processing and transportation growing fastest with five-year compound annual growth rates (CAGRs) of approximately 11 percent and consumer growing slowest with a CAGR of 6 percent.

Table 2

NORTH AMERICAN SEMICONDUCTOR CONSUMPTION (Millions of Dollars)

				CA	GR
	<u>1983</u>	<u>1984</u>	<u>1989</u>	1983-1984	<u>1984-1989</u>
Data Processing	\$ 4,9 95	\$ 8,326	\$14,356	66.7%	11.5%
Communications	1,803	2,612	3,912	44.9%	8.4%
Industrial	1,584	2,238	3,428	41.3%	8.9%
Consumer	807	1,093	1,461	35.4%	6.0%
Military	1,301	1,825	2,556	40.2%	7.0%
Transportation	606	796	1,344	31.4%	11.0%
Total	\$11,096	\$16,890	\$27,057	52.28	9.98

Source: DATAQUEST June 1985

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It must be remembered that this forecast, having been generated by electronic equipment estimates, logically refers to both captive and merchant semiconductor consumption. Many electronic equipment manufacturers have captive production capabilities, which are reflected in the electronic equipment estimates.

To better understand the merchant semiconductor market in relation to each application market, DATAQUEST reviewed the captive production of various manufacturers that are large players in their individual application market segments. This information was totaled for each segment and the aggregate estimates were applied to the total semiconductor forecast to derive merchant market estimates, which are shown in Figure 1.

Weighting the total market for captive production reveals some clear differences in application market estimates. In 1984, for example, the data processing segment, which utilizes the greatest captive production, consumed 44.0 percent of the merchant semiconductor market, in contrast to 49.3 percent of the entire market. Similarly, in communications, which is also heavily weighted with captive production, there was a drop from 15.5 percent of the total market to 14.6 percent of the merchant market. The remaining market segments slightly gain in share as adjustments are made to account for merchant versus captive semiconductor consumption.







Source: DATAQUEST July 1985

DATAQUEST CONCLUSIONS

Although certain shifts in market share percentages may occur between 1984 and 1989, all of the application market segments will grow in dollars. We believe that considerable opportunities will exist in the future in all application market segments despite the severity of the semiconductor industry's present market conditions. While the industry's downturn certainly reflects softness in certain electronic markets, we believe that overall demand from an electronic equipment market perspective has stayed rather consistent. We believe that other factors, including the commonly cited ones of inventory readjustment and over capacity, appear to have more of an influence on the severity of today's market.

Anthea C. Stratigos

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SAM Code: 1985-1986 Newsletters: August

RESEARCH

NEWSLETTER

PERSONAL COMPUTER-BASED CAD/CAM--MIRACLE OR MIRAGE?

As the CAD/CAM war for the minds and dollars of the world's engineers rages on, personal computer (PC)-based CAD/CAM systems threaten to breach the traditional battle line boundaries. A key question in the minds of vendors, buyers, and market forecasters alike, is whether or not the personal computer is a short-lived phenomenon that will eventually give way to the more powerful engineering workstations. Although DATAQUEST believes that standalone workstations will continue to gain market share as costs fall, we also predict that personal computers (specifically the IBM PC AT) will be a major force within the CAD/CAM industry. (See Figure 1.) This newsletter discusses the interesting dilemma that these lower-cost PC-based CAD/CAM systems present to the market, as well as some intriguing implementation alternatives.

Figure 1



CAD/CAM WORKSTATION SHIPMENTS

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LOW COST -- THE REAL ISSUE

While many PC CAD system purchase justifications contain the over-used and abused item for access to other business applications (e.g., spreadsheets and word processing), DATAQUEST believes that the real issue is cost. Given a choice however, we believe that most engineers and technicians would opt for a 32-bit, virtual computing architecture with high-performance (1K x 1K resolution with pan and zoom) graphics. This fact is further validated by our most recent end-user survey in which we asked users at more than 3,000 CAD/CAM installations what their cost and feature requirements would be in order to place one workstation on every engineer's desk. The most frequent responses are listed in Table 1.

While there currently are no systems in the marketplace that meet these parameters at the \$10,000 price level, we expect that this type of architecture will be quite common by the end of 1986. Given the rapid decline in workstation component prices (listed in Table 2) along with the increasingly competitive nature of the market, DATAQUEST believes that the average price of a 32-bit workstation will drop an average of 26 percent per year from its current level of \$20,000 to approximately \$6,000 by 1988, as illustrated in Figure 2.

Table 1

END-USER SURVEY RESPONSE FOR IDEAL WORKSTATION CONFIGURATION (Most Frequent Responses)

Cost: \$10,000 Minimum Disk Requirement: 50 MB Screen Resolution: 1,024 x 1,024 Color Required: 60% yes, 40% no Minimum Memory Requirement: 1 MB

Source: DATAQUEST

Table 2

Component		<u>1983</u>		<u>1984</u>		<u>1985</u>		<u>1986</u>		<u>1987</u>		<u>1988</u>	1983-68 <u>Cagr</u>
Memory													
64K	\$	3.75	\$	3.11	\$	1.03	\$	0.91	\$	0.87	\$	0.82	(26%)
256K	\$	50.00	- \$	17.55	\$	3.73	\$	2.52	\$	2.17	\$	1.76	(49%)
1M		N/A		N/A	\$	162.50	\$	52.00	\$	18,86	\$	9.81	N/A
32-bit MPU	\$	400.00	\$	200.00	\$	175.00	\$	125.00	\$	82.00	\$	63.00	(31\$)
1MB Main Memory	\$	480.00	\$	398.08	\$	119.36	\$	80.64	\$	69.44	\$	56.32	(354)
128% Image Memory	\$	60.00	8	49.76	5	14.92	8	10.08	\$	8.68	\$	7.04	(35%)
Monochrome Display	\$	388.00	\$	366.00	\$	346.00	\$	326.00	\$	308.00	\$	290.00	(61)
Color Display	\$1	,157.00	\$1	,099.00	- \$1	.044.00	Ś	992.00	\$	952.00	\$	923.00	(45)
50 MB Winchester	\$1	,300.00	\$1		Ś	850.00	Ś	800.00	\$	700.00	\$	650.00	(13%)
LAN Connection	\$1	,160.00	\$1	,225.00	\$1	,070.00	\$	935.00	\$	840.00	\$	760.00	(88)
Avg. Monochrome Cost Avg. Color Cost	\$3	,788.00	\$3	,238.84	\$2	,575.00	\$2	,276.72	\$2	,008.12	\$1	,826.36	(14%)
(256 colors)	\$4	,977.00	\$4	,320.16	\$3	,377.72	\$3	,013.28	\$2	,712.88	\$2	,508.64	(13%)

WORKSTATION COMPONENT AVERAGE PRICES (Estimated Prices in \$US in OEM Quantities)

N/A = Not Available

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Source: DATAQUEST

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Figure 2

AVERAGE ENGINEERING WORKSTATION SELLING PRICE FOR A FIXED CONFIGURATION



*Configuration includes IMb main memory, SOMb disk, 1K × 1K monochrome display, 18Mb virtual address space, LAN connection

Source: DATAQUEST

Small vs. Large Companies

When one begins to contemplate the penetration potential of low-cost systems, it is important to consider not only the total market size, but where the market exists as well. A common misconception about the market for low-cost systems is that smaller companies (100 employees or less) form the vast majority of possible unit sales. In the United States, this is not the case. As Table 3 illustrates, 48 percent of the 2.8 million engineers and draftsmen work in large establishments with 1,000 employees or more, and only 17 percent work in establishments with 100 or less employees. Although DATAQUEST acknowledges that larger establishments have a higher incidence of installed CAD/CAM capability than smaller establishments, the number of workstations per engineer is still very low (approximately 1 workstation for every 20 engineers).

Given this understanding of where the market exists underscores the following key points:

- The fact that larger establishments already possess some CAD/CAM capability obviates the need for data base compatibility when selling low-cost or PC-based systems.
- Due to the relative amount of risk, the smaller establishments view cost as the number one buying criteria, whereas larger establishments tend to place greater importance on system functionality.
- Because of their cost sensitivity, smaller establishments view CAD/CAM expenditures as a choice between either buying or not buying a system, while larger establishments view CAD/CAM expenditures from a standpoint of how much CAD/CAM they can buy with a given amount of money.

Table 3

U.S. ENGINEERS AND DRAFTSMEN BY ESTABLISHMENT SIZE

Company Size (No. of Employees)	Number of Engineers and Draftsmen	Percent <u>of Total</u>		
100	482,361	17%		
100 to 1,000	993,097	35%		
1,000	1,361,962	48%		
Total	2,837,420	100%		

Source: U.S. Dept. of Labor, Bureau of Labor Statistics DATAQUEST

The Educational Market

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By virtue of their lower cost and lower productivity requirements, low-cost CAD/CAM systems are a natural fit for the educational market. Sales of CAD/CAM systems to the educational and other low-productivity markets could represent a significant portion of the future CAD/CAM market, especially when considering the following facts compiled by the DATAQUEST Software Industry Service:

- By the end of 1984, approximately 1 million personal computers had been shipped to the U.S. school environment. This is expected to increase to 7.8 million by 1989.
- In 1984, 44 percent of all worldwide shipments of personal computers went to the school environment.
- In 1984, the school environment purchased \$209 million worth of PC software. Nearly half of the PC software revenue went for scientific and technical applications including CAD/CAM.

The Players

Currently, the low-cost CAD/CAM market is dominated by a number of young start-up companies that specialize in offering PC-based CAD/CAM systems. Figure 3 reflects our 1984 market share ranking of these companies in terms of units. DATAQUEST estimates that there are now well over 100 companies who offer some type of PC-based CAD/CAM software. We expect that number to double by the end of this year.

Another interesting development is that the large turnkey CAD/CAM companies have begun to throw their hats into the low-cost CAD/CAM arena. Computervision, Daisy, Applicon, and Racal-Redac all started shipping PC-based CAD/CAM systems during the last few months. DATAQUEST expects the rest of the traditional turnkeys to announce some type of low-cost CAD/CAM system later this year.

Surprisingly, Computervision shipped nearly 200 units of its IBM PC-based Personal Designer systems during the last eight weeks of 1984 without any formal announcement of the product. This clearly demonstrates the tremendous need for this type of product, even within the installed base of companies that also use larger, mainframe-based CAD/CAM systems.

Another-vendor related issue is the question of who is likely to dominate in the low-cost marketplace. From a hardware point of view, the IBM PC is clearly today's leader. IBM's market leadership position does not appear to be waning; most of the CAD/CAM vendors we talked to acknowledged that they will offer at least one IBM PC AT-based solution. DATAQUEST expects that low-cost engineering workstations such as the DN 300 from Apollo Computer and the Sun 2/50 will also be very competitive hardware solutions as their prices continue to fall.

Figure 3



1984 PC-BASED CAD/CAM UNIT MARKET SHARE

Source: DATAQUEST

From a software standpoint, there are two battlegrounds forming, based on types of distribution channels. The dealer channel is currently dominated by the new start-ups such as AutoDesk, Chessel-Robocom, and PCAD, while the direct sales channel appears to be the territory of the larger turnkey vendors. DATAQUEST believes that these two sales channels require completely different types of sales and marketing strategies; and therefore we think the likelihood of one vendor dominating the total market is rather remote. However, it is reasonable to assume that the turnkey companies, with their large and relatively well-trained sales forces, will continue to dominate the direct distribution channel, while the newer start-ups will continue to capitalize on their early lead via the dealer channel.

CURRENT PROBLEMS

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Despite the tremendous promise the low-cost CAD/CAM market holds, there currently are a number of technical hurdles that need to be overcome in order to realize the total market potential. These problems include:

- Poor graphics performance
- Non-virtual computing
- Limited storage
- Limited communications

Poor Graphics Performance

The absence of high-resolution (1K x 1K) graphics, coupled with the inability to effectively pan and zoom across a drawing, seriously limits the productivity of PC-based systems. Ironically enough, the type of users most frequently associated with PC-based CAD (e.g., architects and small engineering firms) usually create the densest drawings and therefore have the greatest difficulty achieving acceptable levels of productivity. The pan and zoom problem is especially troubling to many engineers because their eyes can scan a manually created drawing in microseconds whereas the PC renderings often take minutes to generate new views of a drawing. This artificial constraint usually causes a great deal of frustration and can result in total abandonment of CAD/CAM by the engineer. DATAQUEST believes, however, that an acceptable fix in the form of a board-level, add-on solution is on the way, and should be publicly available by June of this year.

Non-Virtual Computing

Even though the Intel 80286 used within the IBM PC AT supports virtual addressing in a protected mode, neither DOS nor Xenix utilize this facility. As a result of this non-virtual environment, CAD/CAM application programmers continually have to make compromises between functionality and performance. The PC environment is not unlike the 16-bit older-generation CAD/CAM systems (e.g., Digital Equipment's PDP-11, Data General's Eclipse), to which the CAD/CAM industry has so fervently bid farewell over the last few years. Ironically, now that the CAD/CAM vendors have sweated and slaved to move their systems into the 32-bit, virtual world, the PC beckons them to return to the days of yore when 16-bit systems were fashionable and response time was measured in the length of coffee breaks taken between keystrokes. In any event, it doesn't appear to be very likely that the turnkey CAD/CAM vendors will try to shoehorn their systems down to the PC. Rather, we believe that they will either purchase companies or packages that already run on the PC or develop new programs from scratch.

Limited Storage

The current PC configurations do not fully address the size limitations of storing CAD/CAM drawings and programs. Ten megabytes of hard disk is woefully inadequate when one considers that an average drawing consumes around 1 MB of storage. Forty megabytes of hard disk, the maximum allowable on the IBM PC AT, is closer to the amount required in most production applications, but that, too, could quickly be used up when one starts adding Xenix operating systems and the necessary application programs. In any case, access to larger amounts of hard disk storage is needed, either locally within the workstation or via a communication network. 2.

Limited Communications

The lack of an effective means of sharing peripherals and data within a network of PCs is still a limiting factor. Although there are now a number of networks available for PCs (IBM's included), most of them pale in comparison with Apollo's Domain LAN. The Apollo LAN allows a virtually effortless ability to share peripherals, programs, and data, and contains numerous options for communicating with other manufacturers' machines such as Digital Equipment's and IBM's. Although a similar end can be achieved with a PC, the user is usually left with the tasks of doing the integration himself by patching together the necessary hardware and software pieces. This is difficult, and therefore not done very often. We believe that the CAD/CAM vendors will probably have to get into the PC communications act in a big way in order to solve these integration problems and avoid the messy user alternative.

IMPLEMENTATION ALTERNATIVES

While DATAQUEST believes that the PC will unquestionably play a major role within the CAD/CAM market, there are a number of implementation alternatives available other than the generic IBM PC approach. These alternatives include:

- Waiting until prices fall on 32-bit workstations
- Building a low-cost workstation
- Converting the PC to a virtual workstation

The Waiting Game

The waiting game is certainly the least expensive alternative from a development standpoint, but it could become very costly in terms of market share. Even when the more powerful 32-bit workstations arrive at the lower price points, DATAQUEST expects that users will demand some type of PC interface that will allow the casual user (e.g., an engineering manager) to view drawings created on the CAD/CAM system.

"Build-It-Yourself"

Building its own low-cost workstation is the strategy that Intergraph has adopted for addressing this marketplace. The Interpro 32 combines 32-bit virtual computing under a UNIX environment with the ability to run PC programs under MS-DOS. Coupled with its unbelievable \$20,000 price tag, we expect this product to be a big winner in the low-cost arena. The only missing piece in the Interpro 32 is that it currently does not run any of Intergraph's CAD/CAM software locally. DATAQUEST expects, however, that Intergraph will eventually support its software on the Interpro 32.

PC Conversion

Another rather interesting alternative for solving the low-cost puzzle is to transform the PC into a 32-bit, virtual computer. OPUS Systems, a start-up in Los Altos, California, has developed a board set that plugs into the IBM PC and allows users to run full 32-bit, virtual UNIX applications. The process of porting large CAD/CAM programs to the PC environment is greatly enhanced with this product. In addition to Futurenet Corporation, which has already implemented a PC-based CAD/CAM system using the OPUS board set, DATAQUEST expects that a number of other CAD/CAM vendors are likely to take advantage of this low-cost alternative.

DATAQUEST ANALYSIS

DATAQUEST believes that the PC will have the following effects on the different types of companies within the CAD/CAM market:

Traditional Turnkey Companies

Since the turnkeys have evolved from the era of \$100,000 workstations, they are not overly elated about the prospects of selling \$10,000 CAD/CAM systems. Nevertheless, the aggressively priced IBM PC AT, coupled with the smaller start-ups such as AutoDesk, T&W, and PCAD moving into the turnkey's hallowed installed bases, signals that the low-cost race has officially begun. When considering that the larger engineering and manufacturing establishments contain the greatest unit potential, the turnkeys are likely to be the major benifactors since their large, direct sales forces are the most expeditious way of reaching this group.

The major challenges for the turnkeys in the PC marketplace as we see them will be:

- Training their existing sales forces to sell low-cost systems effectively
- Differentiating low-cost, PC-based products from their other more expensive solutions

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PC-based CAD Vendors

Although the smaller PC-based CAD vendors were first out of the starting block, staying ahead of the pack will be difficult. Provided that the larger turnkey companies supply good interfaces in and out of their larger systems, it will be very difficult for the PC-based vendors to penetrate the turnkeys' installed bases and new sites that require an end-to-end CAD/CAM solution. The PC-based vendors do have a significant lead, however, in establishing a dealer network. This dealer network should increase the effectiveness of the PC-based vendors to reach the smaller, and more geographically dispersed establishments in comparison with the direct sales methods of the turnkey vendors.

We believe that the major challenges facing the PC-based vendors will be:

- Holding off the charge of the turnkey vendors
- Retaining and expanding their dealer networks
- Providing interfaces to and from other CAD/CAM systems

Workstation Suppliers

The major market for the workstation companies exists as OEM suppliers to the CAD/CAM vendors. Consequently, the PC AT and other forthcoming products will have a profound effect on their financial well being. We expect that the major challenges the PC will present to the workstation vendors will be:

- Addressing the low-cost market with some type of PC-compatible solution
- Retaining the loyalty of their existing OEMs

The PC CAD/CAM issue adds a whole new level of complexity to a marketplace that already suffers from an overabundance of confusion. With hundreds of CAD/CAM companies and products all vying for the engineers' desks, one wonders how sellers and buyers can break through the noise and install useful CAD/CAM solutions. One thing that seems certain however, is that the days of the \$100,000 CAD/CAM workstation are numbered.

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Anthea C. Stratigos David Burdick SAM Code: 1985-1986 Newsletters: August

RESEARCH NEWSLETTER

THE 22ND DESIGN AUTOMATION CONFERENCE: THE INDUSTRY SHAKES, RATTLES, AND ROLLS IN LAS VEGAS

Dataquest

INTRODUCTION

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Amid a backdrop of corporate shakeouts and a troubled economy, an anxious ECAD market rolled out its new product offerings at the 22nd Design Automation Conference (DAC) on June 23 through 26. Flashy Las Vegas seemed an almost contradictory location for a relatively serious-minded technical conference and tradeshow. Imagine hundreds of electrical engineers scurrying past roulette and blackjack tables to attend technical sessions such as "Synthesis of Logic Structure from Behavioral Descriptions" and "Mixed-Mode and Switch Level Simulation." Yet, by conference end, it seemed only Las Vegas could match the energy and excitement of the ECAD market itself.

Several new product announcements, including significant entries from major corporate players, lent the tradeshow an electric atmosphere. As any gambler knows, when the stakes get high, as they are today in the \$789 million electronic CAD market, competition gets fierce and the number of new players begins to dwindle. Predictably, not as many start-ups were represented as at previous shows. And, at times, the dialogue resembled advertising hype more than high technology.

What is happening seems clear: With increasing degrees of design automation, the ECAD players have become more marketing-oriented and less engineering-driven. As the design functionality offered by vendors becomes more similar and more a function of software, spec sheets are being replaced by rhetoric.

This newsletter discusses some of the industry-wide issues raised at the DAC, issues that will have a profound effect on this growing electronic equipment market.

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SYSTEMS-LEVEL DESIGN

DATAOUEST believes that the theme of this year's DAC was systems-level design integration. Vendors' product lines have necessarily expanded or migrated beyond earlier product offerings to address full-design functionality. EDA or front-end design companies are adding physical layout technology to their product lines. Many traditional layout companies have announced front-end capability. Both types of companies are now offering test, simulation, and compilation.

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DATAQUEST believes, however, that as part of seeking to provide total design solutions, these vendors need to address the major challenges posed by the installed user base: How to integrate within their own specific product line, as well as provide communication and integration with outside vendors' products or a user's own in-house developed software.

NICHEMANSHIP

Also present in number at the DAC were the so-called "niche" companies offering isolated or discrete functionality rather than full systems-level design functionality. These niche companies are able to play one of two roles: either identifying and trailblazing new niche markets, or addressing voids in current ECAD companies' products with their own offerings. Their specific application products include tools addressing the following areas:

- Application accelerators
- Test
- 🌒 🐘 Analysis
- Simulation
- Project management
- Communications
- Data base management

DATAQUEST believes that, as the process of migration continues among the systems-level vendors, windows are increasingly opened for these niche companies. As these smaller players possess a high degree of flexibility, responsiveness, and specialized expertise, they are uniquely able to anticipate and respond to the market's direction. In certain cases, niche company products actually complement existing major ECAD company products. For example, as major ECAD companies begin to approach the analog market, these niche companies are already offering analog design, test, and compilation tools.

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INTEGRATION

Besides the unique product offerings of the niche companies, DATAQUEST believes that other healthy trends evidenced at the DAC were:

- The inclusion of alternate, third-party supplied products and methodologies
- Alliances based on complementary technologies
- The relative "openness" of hardware and software to include or complement other systems and solutions

These trends all spell integration in the larger sense. By integration, we mean tying together applications within each of the design cycle phases to provide a cohesive design solution. Integrated test and simulation product announcements clearly demonstrate the level of sophistication of the current design tools.

DATAQUEST believes that the integration of microprocessor development systems, computer-aided software engineering, logic analyzers, and automatic test equipment represent new directions which the industry must now take. Vendors must begin presenting the buyer with a clearly comprehensible product line, one that makes sense rather than one that merely occupies shelf space. Only in this manner can vendors hope to truly integrate their products to meet users' total design needs.

DATAQUEST ANALYSIS

The 22nd Design Automation Conference once again outdid the previous years' shows, with 6,200 people attending the exhibits and conferences (3,800 paid attendees versus 2,400 vendors and free passes). The interest level in developing and improving the electronic product design process underscored the end user's need for comprehensive and cohesive solutions.

Like any high-technology industry, product introduction rates, vendor learning curves, and product line mixes experience growth similar to the industry itself. Although electronic CAD/CAM as an industry is not so young, the vendor's current focus on general design automation tends to reposition the industry into the early growth stages of an industry life cycle. Illustrated by the products at the DAC and the growth of the ECAD market itself, the industry is maturing beyond a simple focus on product features to a focus on the benefits of new design automation solutions.

DATAQUEST identifies several issues relating to the long-term success of the ECAD market and the companies that comprise it, and to the advancement of the electronic product design process.

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Integrity

With so much emphasis on features, benefits, intangibles, rumored performance, and hype-filled glossies, one has to wonder how a new company, or at least one with a good product, gets its message across without getting lost in the shuffle. There is no question in our minds that the marketing- versus engineering-orientation of the ECAD vendors is here to stay. We believe that is inevitable. However, we also believe that the marketing focus must concentrate on long-term customer relationships. To do this, DATAQUEST believes that it is critical for vendors to not only focus on what their message is, but also on living up to that message. As the industry matures to a marketing orientation, we believe that companies must concentrate on the following:

- Differentiate between announcements, introductions, and delivery
- Define product specifications and target market strategies from the beginning
- Recognize internal strengths and weaknesses as well as the competitors' strengths and weaknesses
- Sell internal strengths, not the competitors' weaknesses
- Be willing to perform comprehensive benchmarks
- Develop product solutions and benefits that match the user's problems and needs

We believe that integrity is critical to the long-term success of both companies and the industry. This is due to the high degree of competition and the speed with which the industry changes. Integrity refers to integration of internal product lines as well as to a company's public and corporate image. Without it, buyers are left to a random decision-making process. As competition and change continue to accelerate, we believe that the sophisticated engineer will seek out those vendors that demonstrate sound product strategies, benefits, and features.

Marketing

With the growth of the industry, responsibility for product definition and marketing strategy shifts from a solo engineering performance to one directed by marketing and perhaps shared with engineering. It is marketing's responsibility to differentiate the product from those offered by the competition and to separate facts from fantasy. It is clear that marketing's role is twofold:

- Perform classical marketing functions
- Ensure that technology does not have to sell itself, by itself

As the degree of automation and integration increases, companies must take a pro-active role in educating, marketing, selling, and supporting their products. We believe that those that do not take an active lead will not only succumb to competitive pressures, they will also confuse and clutter the industry.

Flexibility

Where did all the traditional turnkey companies go? Although at the conference in force, the traditional turnkey companies (i.e., Applicon,
Calma, and Computervision) are late in providing the front-end and full systems-level design capabilities offered by companies such as Daisy, Mentor, and Valid.

Perhaps established and high-technology are mutually exclusive terms, and that if a company maintains pace with ever-changing technology it cannot also be large and bureaucratic. We do not believe that this is entirely true, as one very large company (Tektronix) introduced its products at the DAC with all of the focus, integrity, and functionality of any of its younger competitors. Managing growth is the obvious challenge. However, the possibility exists that even the young stars of today's market will become entrenched in their own politics and miss moving-target market opportunities.

We believe that the focus must be on providing solutions to, rather than products for, the design automation problem. To achieve this focus, vendors must be flexible enough to react quickly to changing design methodologies, as well as to the changing technologies of the products themselves.

Barriers to Entry

Given that vendors must be flexible with a strong marketing orientation, they must also protect their market positions and installed bases. Developing or capitalizing on barriers to entry is a short-lived luxury with tremendous protection payoffs. Recognizing that barriers to entry can take many forms, DATAQUEST believes that these barriers are undergoing a transition.

The number of vendors at this year's DAC increased to 76 from 40 the previous year. Not only did the number of vendors increase, but the type and scope of these companies changed. Companies with a strong hold in a particular ECAD application segment are experiencing competitive pressures from what seemed to be outsiders. The barriers to entry are being broken down. One example is printed circuit board CAD applications and the ever-increasing types and numbers of companies offering them.

If a company's barriers to entry are short- rather than long-lived, it can expect steady and increasing competitive pressures. We believe that this situation is an excellent opportunity for the company to form strategic alliances with which to balance its features and barriers to entry. However, strategic alliances that offer advantages which competitors can easily obtain are, in our opinion, short-lived. They merely maintain status quo rather than gaining an edge. This distinction is important because it focuses on the barrier as a means to an end rather than as the end itself.

SUMMARY

The 22nd DAC proved to be a good show in terms of attendance, interest level, and new product announcements. This question remains, however: To what degree will the electronic CAD/CAM market be affected by the doom and gloom of the computer and semiconductor industries? We believe that the following applies, regardless of the financial status of the market:

- Companies must develop and manage barriers to entry
- Marketing must take a pro-active role in directing the company
- Companies must manage their public images, maintaining a balance between advertising strategies and deliverables
- Companies with measureable productivity tools in general will survive through a financially unstable period

DATAQUEST believes that Darwin's theory is in effect: only the strong will survive. It's in the cards.

(The majority of this newsletter was originally published by DATAQUEST's CAD/CAM Industry Service and is reprinted with its permission.)

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Anthea C. Stratigos Tony Spadarella

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RESEARCH NEWSLETTER

THE SMART CARD REVISITED

INTRODUCTION

In June 1984, DATAQUEST analyzed the potential smart card market from a U.S. market perspective. At that time we discussed the dynamics of the market and looked at its potential as it applied to the semiconductor market. One year later, the smart card market is continuing to develop as we had anticipated, with several interesting events having occurred in the interim.

This newsletter examines the trends that will continue to affect the smart card market, which, if realized, will represent a major volume application for semiconductors.

BATTELLE'S MEMORY CARD CONFERENCE

The smart card was avidly discussed on May 8 and 9, 1985, during Battelle Columbus Laboratories' conference entitled, "Memory Card Issues, Activities, and Opportunities." Leaders in the industry gathered to discuss the pros, cons, setbacks, and gains facing the smart card. There is still tremendous interest in the technology, which was evidenced by continued growth in the size of the conference; this year more than one hundred individuals attended the conference.

DATAQUEST noted, however, that the semiconductor industry was underrepresented at the conference. Aside from an excellent presentation from Motorola, which actively participates in this market, and an attendee from National Semiconductor, which we believe is also examining the market, there was a significant lack of participation by IC manufacturers. Given the conference's proximity to Silicon Valley, and the potential smart card market, we believe that domestic manufacturers should have taken a more visible position.

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It is understandable why IC manufacturers have historically shied away from the smart card market. Several years ago a tremendous hype and excitement surrounded the technology, but research and analysis revealed that the smart card was an idea whose time had not yet come. Device manufacturers pulled back resources, saying that the market still had too many "ifs." They awaited further developments and at that time were correct in their interpretation of the market.

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In the last several years, however, the smart card market and technology have made great strides. Clearly, semiconductor manufacturers, having studied the market once, are skeptical about getting involved. Industry players are not sure that the market is here. There has been enough activity recently to indicate, however, that waiting to commit resources until the market further develops may mean that it will be too late to participate, and benefit, when growth comes. Historical analyses and findings cannot be applied to today's decisions about this market.

The smart card is an excellent example of everyone waiting for everyone else to get there first--meanwhile, the market continues to struggle forward. The tone of the conference was very upbeat. Speakers provided excellent updates on their companies' activities and their exhibits demonstrated "live" smart cards in simulated retail environments. An example was an impressive display given by Micro Card Technologies, Inc., a Dallas, Texas-based subsidiary of France's Bull. Each attendee was given a personalized card upon entrance to the conference, for use in airline ticketing and shopping demonstrations.

Smart Card Applications

One thing that we still believe, and were pleased to have confirmed by industry leaders during Battelle's conference, is that the smart card market will continue to evolve through largely non-financial applications. Packaging and size limitations that are a function of an ISO standard credit card, and the scrutiny necessary to approve use in a large-scale financial application, are not as severe in non-financial or industrial uses of the technology.

We also continue to believe that any commitment that does come from the financial community will occur in niche-oriented, customer-specific programs.

The spectrum of participants at the conference lends itself to the scope of applications for which smart cards can be used. Companies represented included:

- **6** -Bally Systems Citicorp, Diner's Club
- Bell Communications Research • U.S. Department of Defense

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- BellSouth Corporation
- Eastman Kodak Co.
- Citibank • Ericsson Info. Systems

- Eureka Federal Savings
- First Interstate Bank
- IBM
- Lawrence Livermore Labs
- Lucky Stores
- 3M

- NCR
- Pacific Bell
- Philadelphia Nat'l. Bank
- Shell Oil Company
- Standard Oil Co. of Indiana
- Visa International

On the smart card side, there were two companies that presented excellent, non-financial solutions utilizing "smart card" technology. The first is Datakey, Inc., located in Burnsville, Minnesota. Its products, the Data Keys and Data Tag, are molded of thermoplastic and are shaped like typical keys and "dog tags." Uninhibited by the packaging constraints of a standard credit card, the products contain ICs and have been utilized in a myriad of applications, including:

- Kidney dialysis
- Process control
- Vehicle fleet fuel management
- Security

The second company, IHMS, is a smart card engineering firm located in Corte Madera, California. This firm didn't pursue the financial industry and found that cost effectiveness in today's market could be found in health care applications. Its system is designed for Health Maintenance Organization (HMO) environments and provides solutions for tracking:

- Membership identification
- Audit trailing (patient history)
- Telephone authorization

IHMS has also been involved in using its system for automotive warranty cards, and process and inventory control applications.

The MasterCard Test

DATAQUEST believes that the most significant development in this market is the test announced by MasterCard International. The U.S. financial community has always taken a very conservative view of the smart card, and without the same type of market forces as those experienced in France, mass use of the smart card as a "credit card" has always seemed unlikely. The test is one of the first serious looks at the technology from the financial community for financial application, and if the results are positive, it may be the push the market needs. The test involves two major players in the market. The first is Casio Microcard Corporation, which was established last year in New York as a subsidiary of Casio Computer Co., Ltd., of Japan. Micro Card Technologies, Inc. (Bull's subsidiary), is the other major player involved in the test. The two subsidiaries were established for the purpose of developing and marketing the smart card for the U.S. market. Each player will be supplying some 50,000 cards for use in one of two MasterCard test sites--Florida, or Washington, D.C. ¥

The test is slated to last for a one-year period during which several issues will be evaluated including:

- Card authentication
- Cardholder verification (Personal identification number (PIN) verification will be used in the initial phase, with the possible employment of biometrics to follow.)
- Individual authorization parameters
- Transaction processing
- Transaction authentication (Is the transaction valid?)

While the cards are being tested in the market, they will also be examined in controlled test environments so that evaluators can have a better understanding of the card's physical and security strengths and weaknesses. MasterCard has also contracted with an independent researcher to survey and analyze the attitudes and responses of consumers, merchants, and bankers toward the technology.

The goals of the project are fourfold:

- To eliminate fraudulent transactions
- To reduce communications costs
- To increase control over credit abuse
- To provide a foundation for new card services

DATAQUEST believes that the test will begin sometime during the fall of this year. If it is successful, we believe that MasterCard will approach its board, sometime in early 1986, to obtain a mandate to begin issuing smart cards in late 1986.

DATAQUEST also believes that the emergence of the Japanese in the U.S. smart card market (and their involvement in a major test by the financial community) is very significant. We believe that at present as many as five Japanese manufacturers are committed to some type of memory card product. The Japanese electronics community has done serious research and development regardless of where this technology's market appears to be going. According to one Battelle speaker, the Japanese apparently have an inherent belief in the market and are not as concerned with their short-term return on investment. It was also said that Japan's positioning in this area may put it in a commanding role when the market takes off. In the case of Casio, the precedent it has set with its credit card calculator and radio has given credibility to the idea of incorporating solid state electronics in plastic the size of a credit card.

Smart Card Technology

At the conference we were interested to learn the various chip configurations that manufacturers are using in their smart cards. These companies include:

- Micro Card Technologies
 - Single-chip solution using a Motorola 8-bit MCU with 8K EPROM (the device also contains 12.8K bits of ROM and 288 bits of RAM)
- Datakey
 - Data Key: Single-chip solution using a General Instrument 1,400-bit EEPROM
 - Processor Key: Single-chip solution using an SEEQ 16K EEPROM

Data Tag: Two-chip solution using an 8-bit MPU (from a domestic manufacturer; company name is proprietary to Datakey) and a SEEQ 64K EEPROM

- IHMS
 - Two-chip solution utilizing a Fujitsu 8-bit MPU, the second chip is a 64K EPROM, which we believe is also a Fujitsu device.
- Casio Microcard
 - Two-chip solution utilizing an NEC 8-bit MPU with an NEC 64K EPROM

Single quantity prices for a variety of smart cards range from \$9.00 to \$250.00, depending on the card, its chip configuration, and the application for which the card is used. Manufacturers also noted that the cost of semiconductors accounted for approximately 20 to 75 percent of the cost of the card, again depending on the configuration and application. DATAQUEST believes that all smart card manufacturers are

developing some variety of a single-chip solution in their product lines, and we continue to expect a single-chip orientation in most smart card designs.

DATAQUEST CONCLUSION

DATAQUEST believes that the smart card market will continue to evolve as an industry in transition for some time. Nonetheless we believe that it is a potential market with tremendous opportunity. We believe this market deserves continued interest and commitment from all players who are in line to benefit--card users, plastic card manufacturers, smart card manufacturers, and semiconductor manufacturers.

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Anthea C. Stratigos

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RESEARCH NEWSLETTER

NCC 1985: REFLECTIONS OF AN INDUSTRY

INTRODUCTION

Despite an estimated 80,000 attendees, the mood at the 1985 National Computer Conference (NCC), held last month in Chicago, was indicative of the widespread industry slump. Nineteen percent fewer companies exhibited this year compared with last year's show, despite an increase in participants from the Far East. Among notable absentees were Apple, Compag, Digital Equipment, Hewlett-Packard, Lotus, MCI, Micom, Microsoft, Prime, Texas Instruments, and Wang Laboratories.

With NCC no longer appearing to be the setting for major new product announcements, the exhibits concentrated on rounding out existing product lines and offering multiple solutions featuring compatible or complementary products. This newsletter is a compilation of information from other DATAQUEST technology services attending the show.

EXHIBITORS

Anderson Jacobson

This data communications supplier announced several new modems as well as network control products. One of the modems was the AJ 4081, a 4,800-bps, four-wire, leased-line modem meeting the CCITT V.27 standard. This modem has point-to-point or multipoint capabilities and lists for \$1,495. The AJ 9611 is a 9600-bps, four-wire, leased-line modem; it includes a four-port time-division multiplexer (TDM) and is priced at \$2,245. Also announced was the AJ 1411, a 14.4-Kbps modem employing trellis coding with a six-port TDM; it is priced at \$5,495.

Anderson Jacobson's network control products included the AJ MDTS network control system for monitoring up to 32 modems from a central site.

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AT&T Information Systems

AT&T-IS did not announce any new products at NCC. However, DATAQUEST observed that for the first time since divestiture, it displayed a wellrounded, well-defined product line. These products included STARLAN, the PC networking scheme; Information Systems Network (ISN), a packetswitching system for local and wide area networking; the Premises Distribution System (PDS), a complete premises wiring plan; the 6300 PC; the UNIX PC; and the 3B computer family.

3Com Corporation

3Com, a leading local area network (LAN) company, introduced a larger-capacity version of its 3Server storage server. The new version, 3Server70, has 70 megabytes of storage, versus 36 megabytes on the original 3Server. Up to five add-on expansion units can be linked to a 3Server70, each with an additional 70 megabytes, totaling 420 megabytes for a fully extended 3Server70. The price of the 3Server70 is \$8,995; the 3Server sells for \$7,995.

Charles River Data Systems

CRD introduced its 32-bit supermicrocomputer, the Universe 32. This is the first 68020 system that incorporates a standard bus, runs an operating system, and supports a local area network. CRD began shipping the Universe 32 in August.

CRD also introduced its new Universe 2400, a VME-based 32-bit supermicrocomputer engineered for harsh environments. The system was announced in April of this year and was shown for the first time at NCC. It is a UNIX-based system built around the Motorola 68000 microprocessor.

Corvus Systems

Corvus, manufacturer of the Omninet local area network, announced its new product, the Cheetah, a high-performance multitasking graphics workstation aimed at the OEM and VAR markets. This is Corvus' first attempt to enter the technical workstation market. The Cheetah is a UNIX-based professional workstation utilizing the 68010 processor and targeted toward the engineering professional. Corvus is positioning its product in the low-end CAD/CAM UNIX marketplace.

Corvus Systems and Onyx Inc. completed their merger at the end of July. The new company will be called Corvus Systems, Inc.

Cromemco

Cromemco demonstrated its System 100, System 300, and System 400. The System 100 and System 300 were announced in July 1984 and shown at that year's NCC. The system 400 was announced in January 1985. All three systems presently incorporate the 68010 processor. The System 100 - and System 300 are high-performance, 32-bit computers that run under UNIX V operating systems.

Digital Communications Associates (DCA)

DCA announced a new communications link for personal computers to IBM Systems/34, /36, and /38. The new product, called the Smart Alec, allows the IBM PC, PC XT, and PC AT to emulate IBM 5251 Model 11, 5291, or 5292 Model 1 terminals for direct attachment to IBM mainframes or remote attachment through modems to an IBM 5294 workstation controller or an IBM 5251 Model 12.

DCA also displayed its recently announced IRMA FASTLINK line of high-speed, dial-up modems, which are capable of throughput rates of as high as 10,000 bps on the public switched telephone network. These modems were designed and manufactured by Telebit Corporation, of Cupertino, California, and are also sold directly by Telebit under the name TRAILBLAZER. A new joint venture company--DCA/Telebit--has been formed to produce and market the products.

Encore

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Encore demonstrated three of its products: the Multimax, a 32-bit multiprocessor computer system combining up to 20 microprocessors; the HostStation 100, a 19-inch alphagraphic display product that was introduced internationally at the Hannover Fair; and the HostStation 500, a 32-bit workstation upgrade for the HostStation 100. The HostStation 500 will be shipped sometime in the third quarter of 1985. Encore's products are designed around the National Semiconductor 32032, with floating-point arithmetic capabilities and large physical and virtual addressing capabilities.

Excelan

Excelan, a LAN company that focuses on backplane host-to-host LAN interfaces, displayed its recently announced personal computer LAN interface. The PC interface includes the EXOS 205 front-end processor board and TCP/IP (Transmission Control Products/Internet Protocol) software for either Xenix (on the PC AT) or PC-DOS.

Flexible Computer Corporation

Flexible demonstrated its first product, the FLEX/32, a multicomputing system that supports various computers working on one or more tasks together or independently. The FLEX/32 is a parallel processing system for real-time, aerospace, industrial automation, and research applications. In its basic configuration, the FLEX/32 can support up to 20 32-bit superminicomputers based on the 32032 processor, each with 1 Mbyte of memory and a VME interface.

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Hayes Microcomputer Products

Hayes announced support for two protocols for personal computer communications. It will now support the X.25 protocol, the standard approved by the CCITT. The X.25 protocol will become crucial as personal computer communications become synchronous. For asynchronous communications, Hayes will adapt the X.PC protocol. Hayes' support of the X.PC protocol is based on its compatibility with international standards, its nonproprietary nature, and its ability to support advanced personal computer applications such as electronic banking and multiple sessions between a host and a personal computer. Also featured in Hayes' booth were the Transet 1000, a multifunction print and communications buffer, and the Smartmodem 2400.

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IBM Corporation

IBM displayed a wide variety of product lines in its booth, including semiconductor manufacturing and industrial automation equipment. As with many other vendors, IBM dedicated a fair portion of its booth to these "complementary products."

IBM demonstrated the PC Network to show that the company can "link it all together," with a CRT pictorial showing the cabling system, PC Network, and token ring passing all working together. In the communications area, there were three demonstrations: IBM and ROLM, IBM and SBS, and the IBM SNA. The IBM and ROLM presentations focused on the interconnection of IBM and ROLM equipment as announced by IBM on June 18. In DATAQUEST'S opinion, this interconnection still does not seem to be completely worked out. The IBM and SBS demonstration made no mention of MCI, although IBM has agreed to sell SBS to MCI as a portion of its investment in MCI.

Keyword

In addition to its line of disk conversion software, Keyword showed the 7000 series, which is designed to allow the transfer of standard ASCII files between any incompatible devices for which conversion software is available. Keyword boasts that it offers SNA and DISOSS interfaces by simply converting to the word processing software supported by the IBM host.

The Keyword concept for both conversions and communications may have a significant impact on future product buying decisions. Departments with differing requirements are likely to choose incompatible equipment, yet the necessity to exchange documents will remain. The Keyword concept offers a needed freedom of choice to buyers with different applications who are unlikely to agree on a single hardware or software solution.

Motorola

Motorola showed a networking system called Office LAN that links Four-Phase 6300 Office Information Systems together. Using Ethernet, the LAN standard developed by Xerox, and the XNS protocol, information can be transferred between CPUs at rates of up to 10 Mbps. Other Ethernetcompatible systems can be used in the network, and Motorola plans to expand Office LAN to its 2000, 4000, and 5000 product lines.

Another SNA communication link was introduced as a 32-bit supermicrocomputer, part of the 2000 family; it can also operate in bisynchronous (BSC) networks. Pricing is about \$20,000 including a 52-Mbyte Winchester disk drive; up to 12 workstations can be supported.

NEC Information Systems

The new product at NEC's booth was its local area network, ViaNet, a twisted-pair wire, Omninet-based LAN for the NEC Advanced Personal Computer. The ViaNet uses software from ViaNetix, of Boulder, Colorado. ViaNet software has three hardware requirements: two or more workstations or minicomputers running MS-DOS (PC-DOS) or UNIX; a network interface card for each machine; and an appropriate transmission bus--coaxial cable, twisted-pair wire, or fiber-optic cable. ViaNetix also supplies software to Tandy for its new ViaNet running on ARCnet hardware.

Pyramid Computers

Pyramid made a significant announcement with its model 98x Isoprocessor, a UNIX-based system to be sold for two-thirds the price of a VAX 8600. The 98X uses two fully symmetrical RISC-based processors. Because it has two CPUs, the system can run multiple jobs simultaneously 1.75 times faster than the company's previous, single-CPU system. Pyramid has shipped approximately 250 98X systems to 150 customers. Pyramid's client base includes AT&T, Bell Operations, Cray Research, Hewlett-Packard, Intel, NASA, NCR, Raytheon, TRW, the U.S. Army, and the U.S. Navy.

A wide range of scientific and commercial applications are available from Pyramid. With approximately one-third of its operations now dedicated to commercial applications, Pyramid intends to focus more on the commercial marketplace.

SCI Systems, Inc.

SCI Systems announced an addition to its product line of UNIX-based systems, the SCI 2000, a high-performance multiprocessor. The SCI 2000 is designed around Intel's 80286 microprocessor and 80287 coprocessor. The SCI can be upgraded when production quantities of the 80386 become available.

Sequent Computer Systems

announced and demonstrated its Balance Sequent 8000, а high-performance, general-purpose, parallel computer that runs 2 to 12 tightly coupled National Semiconductor 32032 microprocessors. As a the Balance 8000 is a true 32-bit system. When initially result, introduced in September 1984, the system used the 32016 microprocessor. Sequent says that each CPU provides computing power roughly equivalent to that of a VAX 11/750 supermini.

Sord Computer Corporation

Sord introduced three computer systems for the OEM and VAR markets. The three systems offer a wide variety of plug-in cards and expansion options at competitive prices; they are aimed at the scientific and business communities.

The UNIBOX, announced in May of this year, is designed around the 68010 microprocessor (which can later be upgraded to the 68020) and a 32-bit VME bus.

The Sord M86 is a powerful dual-processor system that is designed around both the 68000 and 280A microprocessors.

The Sord M68MX is built around the 68000 processor, which provides fast response for number crunching and general business use.

Sord, a Japanese manufacturer, is engaged in a successful effort to expand the geographical scope of its operatons. Sord is making a major effort to penetrate the U.S. market, with sales offices located in New York, Los Angeles, and Chicago. A few of Sord's customers are Citicorp, the <u>Far Eastern Economic Review</u>, Ford, Gamaha, General Motors, Gulf Polytechnic, and Holdens Ltd.

<u>Stratus</u>

Stratus demonstrated the XA400 (Extended Architecture), part of the Stratus/32 product line. The XA400 and the XA600 are recognized as the leading computers for the on-line transaction processing (OLTP) marketplace.

Stratus covers a wide spectrum of applications such as financing, manufacturing, factory information networking, order entry, data collection, retail and distribution, and a variety of service applications.

Tandy Corporation

Tandy announced a delay in the availability of ViaNet, its new local area network for Tandy personal computers. Tandy stated that the network has been tested and is ready for market but that the company needs time to train its staff and develop support programs. The new product is based on ARCnet hardware and incorporates software from ViaNetix.

Timeplex

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Timeplex featured its line of T-1 and multiplexer products, including the Series 3 Microplexer statistical multiplexers, the Microplexer X.25 packet assembler/disassembler (PAD), the Link/l Facilities Management System, and the Prophet network management system. Packet-switching and T-1 products are among the leading products in the rapidly expanding U.S. data communications market.

Universal Data Systems (UDS)

Universal Data Systems, a part of Motorola Information Systems Group, introduced the UDS 202SD, a 1,200-bps, half-duplex, asynchronous or synchronous modem for use on dial-up lines. Also featured was a new 14.4-Kbps modem that complies with the new CCITT V.33 standard.

<u>Votan</u>

This Fremont, California, voice-recognition company exhibited several applications of voice-recognition systems it has developed. Major applications are foreseen in information processing, office automation, telecommunications, instrumentation, and control.

Xerox Corporation

Xerox's booth conveyed a sense of cohesiveness that DATAQUEST had not sensed from Xerox previously. This was due in part to the company's statement of direction in April, which indicated that the company will focus on document processing. Xerox displayed a wide variety of products, including several new personal computers, laser printers, and word processing systems, all operating on the Ethernet LAN.

The model 4045 laser printer operates at 10 ppm, with an optimum capacity of 5,000 pages per month. It can support up to four Xerox workstations and will support some PC graphics software packages. The model 6085, an advanced desktop professional workstation, can be used for graphics applications and supports PC software as well as advanced software from Xerox. The system features windowing, a mouse, and a choice of various bit-map screens.

DATAQUEST'S ANALYSIS

The 1985 NCC will be remembered as a rather uneventful exhibit, mirroring the difficulties of the data processing industry. The telecommunications industry, with a variety of local area network and modem introductions, emerged as a segment that is apparently not as severely affected by the present market. Yet even in telecommunications, as with other vendors at the show, the emphasis was not on new product introductions but, rather, on an effort to round out, enhance, or expand existing product lines.

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John Brew

RESEARCH Newsletter

SAM Code: 1985-1986 Newsletters: September

THE IBM PC AT: A VIEW INSIDE

Dataquest

Despite heated competition in a tough marketplace, the IBM PC AT and its lookalikes have weathered the 1985 storm rather well. This month, DATAQUEST'S Semiconductor Application Markets analysts probed the IBM AT and analyzed the machine's IC content.

MARKET OVERVIEW

Of the three segments analyzed by DATAQUEST'S Personal Computer Industry Service (PCIS), the one in which the AT is classified has maintained the strongest growth in 1985. The less than \$1,000 group, which typifies the low-end game and home environment, has been continually subjected to the volatility of the consumer marketplace and has been hardest hit this year. The \$1,000 through \$5,000 segment (in which the IBM XT is now classified) has experienced steady growth overall. This segment, however, is facing continued pressure from its high-end counterparts, which are offering higher-performance machines at smaller cost differentials.

According to PCIS, the \$5,000 through \$10,000 segment has maintained a healthy market over the past year, with expected worldwide consumption of approximately 1.6 million units in 1985. PCIS estimates the segment will have continued growth through 1986 with nearly 2.1 million units sold--a 29.5 percent increase over 1985. The AT and AT-compatibles will dominate this sector with just over 40 percent of the market; DATAQUEST estimates that worldwide consumption of these computers will amount to 643,000 units in 1985.

Use in the business sector is driving growth in the AT market. The potential to operate in a multiuser and multitask environment offers cost-effective solutions with a system that performs at higher speeds than its market counterparts. The AT's memory capacity and disk storage have also combined to enhance the system's overall capabilities. The typical average selling price of the AT is \$6,500, but discounted machines have been offered for as low as \$5,400 to \$6,000.

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At present a first wave of manufacturers is participating in the market. Besides IBM, the major players include Compaq, Kaypro, Texas Instruments, Zenith, NCR, and TeleVideo. These companies have a head start in the market and are benefiting from initial market growth. New announcements are heard frequently, and many other players anticipate joining the market to form the second wave of industry participants. Too many players, however, could rapidly saturate this promising market.

There are benefits from riding on the coattails of more mature counterparts. We believe that the newer entrants have had more time to provide cost-effective design solutions to the system, including reducing chip count and board size.

INTEGRATED CIRCUIT CONTENT

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The AT that we examined contained 251 integrated circuits, amounting to an estimated cost of \$457.24. We believe that this IC cost has dropped dramatically, by as much as 25 to 30 percent, since the AT was first announced. DATAQUEST derives estimated component content by contacting sales offices and distributors, comparing single-quantity prices, and assuming an average large-quantity discount. We supplement this information with the research and analysis of our semiconductor product analysts and pricing/trend information from our Semiconductor User Information Service.

DATAQUEST included three boards in our analysis. The main system board contained 125 components valued at \$289.69. The display board contained 66 ICs valued at \$35.02, and the disk controller board had 60 devices valued at \$132.53. Table 1 reflects the overall AT IC content, by product area, quantity, and aggregate value. Table 2 lists the device manufacturers whose chips were prevalent on the boards.

Overall, there were 178 standard logic devices, 38 of which were from the ALS product family. The ALS devices were heavily concentrated on the main board but used less elsewhere in the system. We were also interested to note that ASIC devices accounted for just over 10 percent of the system IC cost. We believe that the AT is one of IBM's first uses of PLA devices to reduce logic component quantities in its PC family.

We believe that there is further opportunity to reduce the TTL "glue" devices that are still used throughout the system. We aggregated the device count and assumed averages of gates per package for both mediumand small-scale devices. We estimated 8 gates per small device and 25 gates per medium device. Accordingly, the 178 devices amounted to approximately 2,971 gates, which we evaluated at two- to five-tenths of a cent per gate, or approximately \$7.43; i.e., the associated cost for gate arrays, compared to the combined logic device costs found on the system's three boards. One caveat in this analysis is that it merely indicates the cost for the gates utilized, without accounting for the actual size (and cost) of the device(s) that would have to be implemented. The AT system logic that would be implemented on a gate array is pin intensive, requiring larger (more expensive) devices than a logic gate count would indicate. Low gate utilization combined with pin-intensive system partitioning would make a gate array solution substantially more expensive than the \$7.43 figure indicates.

DATAQUEST pelieves that there are cost-effective gate array solutions being developed. We believe that Chips and Technologies, a Milpitasbased start-up, is developing a chip set for the PC AT and other 80286-based systems. The chip set integrates much of the TTL and some of the peripherals surrounding the system processor. We anticipate availability of this set sometime in the early fall.

DATAQUEST CONCLUSIONS

The severity of today's semiconductor market conditions is certainly visible in the AT, where IC costs have dropped significantly in a system whose ASP has remained rather constant. The projected market size of AT and AT-compatible systems, however, still indicates that with more than \$450.00 worth of ICs each, these systems will provide a substantial market for device manufacturers for some time to come.

Anthea C. Stratigos

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ESTIMATED IC CONTENT IBM PC AT

Main System Board	<u>Quantity</u>	<u>Cost</u>
Standard Logic Small Scale Medium Scale	36 _ <u>36</u>	
	72	\$ 21.45
Micro Devices (80286-6 based)	9	91.14
Memory (predominantly 128K DRAMs "stack packs") ASIC	41 3	168.70 <u>8.40</u>
Main System Board Total	125	\$289.69
Display Board		
Standard Logic Small Scale Medium Scale	24 <u>32</u> 56	\$ 14.85
CRT Controller Memory (16K DRAMs) ASIC	1 8 1	3.17 12.00 5.00
Display Board Total	66	\$ 35.02
Disk Controller Board		
Standard Logic Small Scale Medium Scale	27 <u>23</u> 50	\$ 12.40
Microperipherals Memory (16K SRAMs) ASIC	5 2 3	84.53 2.80 32.80
Disk Controller Board Total	60	\$132.53
Total Estimated IC Content, IBM PC AT	251	\$4 57.24

Source: DATAQUEST

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Table 2

COMPONENT MANUFACTURERS IBM PC AT

Main System Board

Manufacturer

Standard Logic Texas Instruments Fairchild

Intel

Micros

Memory

.

Mostek Texas Instruments

Monolithic Memories

ASIC

Display Board

Micros

Memory

ASIC

Standard Logic

Texas Instruments Fairchild National Semiconductor

Motorola

Mostek

IBM

Disk Controller Board

Standard Logic	Texas Instruments
Micros	Western Digital Intel
Memory	Synertek
ASIC	Western Digital AMD



October-December

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RESEARCH

BULLETIN

VISA ANNOUNCEMENT TAKES THE SMART CARD ANOTHER LEAP FORWARD

Esen M Dataquest

Visa International announced on September 30 a concept for a new smart card that contains an IC and incorporates display and keypad technology.

According to Visa, the prototype, which is the size of a typical plastic credit card, takes smart card technology one step further than previous cards by using a single card for a variety of accounts, such as money fund and checking accounts, as well as credit transactions. A particular button on the key pad will access the given account to which it pertains; at that point, a common PIN (personal identification number) used for all accounts on the card can be activated for self-authorization without contact with a terminal.

Visa believes that the card is technically feasible and less costly than its counterparts, which must interact with a terminal for authorization. It believes that self-authorization can be accomplished without breaching the security needed for use of a card in financial transactions.

DATAQUEST believes that both Toshiba and International Microelectronic Products have been involved in the development and testing of this prototype. At this point, we believe that the card will use a semicustom single-chip approach incorporating microcontroller and EPROM technologies. We believe that EEPROM may also be under consideration.

Visa intends to begin testing the card in approximately 18 months. If successful, Visa believes that the card will initially be used for specialized, perhaps upscale, customer accounts. But the plan is to eventually have everyone using this card, which the company terms "the card of the future."

There are approximately 84 to 85 million Visa cardholders in the United States today, 2 million of which hold "gold" cards. Visa believes that 5 to 10 percent of all Visa cardholders will, in the future, carry "gold" cards. If successful, the accompanying unit base for this technology is tremendous and presents a great opportunity for the parties involved.

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DATAQUEST believes that this announcement is significant because it marks another step by a leading financial institution toward using the smart card as a credit card alternative in financial applications. Thus far, the financial community has acted conservatively toward smart cards, leaving proof of this technologies' viability and acceptance up to its industrial counterparts; several successful nonfinancial applications currently exist.

Now that Visa has joined ranks with MasterCard (slated to begin a year-long test this month), the smart card could not have a better audience to prove itself. Both institutions have noted that if tests and feasibility studies are successful, they fully intend to use smart cards in broad-base applications. This is the type of opportunity that the smart card needs to realize the benefits (and volume) that have been touted for so long. The technology has its chance, and its audience; within the next year or two we shall see whether the smart card will have a secure place in the North American market.

Anthea C. Stratigos

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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: October

STATISTICAL MULTIPLEXER MARKETS AFFECTED BY INDUSTRY SLOWDOWN

Dataquest

SUMMARY

In the past, the U.S. statistical multiplexer (statmux) markets have weathered economic storms without experiencing significant slowdowns in growth and have achieved growth above the CAGR for the industry. In 1985, however, statmux growth will not be as significant as in the past, due to declining demand for computers, office automation offerings, computer company alternatives, and decreased capital expenditure during the first six months of the year.

DATAQUEST expects statistical multiplexer growth to be soft in 1985, with a moderate recovery beginning in the fourth quarter, and beginning to reach acceptable levels in 1986. We believe that, following 1986, the statmux industry will not enjoy the growth levels previously attained by the industry. However, statmux manufacturers will enjoy various levels of success as specific products and markets provide revenue opportunities.

DATAQUEST expects the U.S. economy to grow by slightly more than 3 percent in 1985; less than half the 1984 growth rate. The Semiconductor Industry Association's revised book-to-bill ratios indicate continued deep declines in the the chip industry. The unprecedented market situation is forcing the companies to pay closer attention to their business operations. Numerous computer, data communications, and chip companies have announced lower than expected revenues and profits. We expect personnel layoffs and workplace reductions to continue throughout the remainder of 1985 as companies respond to the softness.

ECONOMIC TRENDS

Although the index of leading indicators turned down in March, leading economists still expect the economy to continue to expand. The prime rate, 9.5 percent, is at its lowest in five years. Unemployment levels remain unchanged at approximately 7.3 percent.

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Capital expenditures for data communications products remain spotty, depending on the user's corporate requirements. Although corporations appear to have budget increases of about 15 percent compared to last year, the increases will now be allocated to many departments requiring products and services to support 1985 requirements. Corporations appear to have the capital funds available to spend, but are maintaining a wait-and-see attitude before they allocate funds for expenditure. As these funds are held back, orders are delayed or cancelled, thereby affecting order entry and backlog.

STATMUX FORECAST

DATAQUEST's forecast for the statmux market is shown in Figure 1 and Figure 2. We expect moderate growth in the mid-range, strong growth in the high-end, and flatness in the low-end segment. The long-term view (1985 through 1989) has changed from our previous forecast (1984 through 1988). This change is a result of further defining our multiplexer segments, and analyzing many of the alternative products and services that could impact statmux shipments and revenues.

Low-End Segment

The low-end market has begun to experience severe price pressures and an influx of competitive entrants. As new entrants enter this segment, they use lower prices and increased distributor discounting to gain market presence.

DATAQUEST expects flat sales in 1985 compared with 1984. Although unit shipments may be up in 1985 and 1986, we estimate that average sales prices (ASPs) will continue to decline, thus affecting total revenues in this segment. Price cutting has occurred but not yet to the level which we are seeing with modems. Companies from the Far East are not major players in this segment yet, but may be ready to enter the low-end market in 1986.

DATAQUEST believes that several factors will affect the long-term growth of this segment. One factor is the shift within the minicomputer companies to become more vertically integrated with product solutions for their customers. Digital Equipment Corporation and Hewlett-Packard are achieving substantial sales of their own statmux products. Computer companies are developing more intelligent, distributed functionality to the users. The recent Digital Equipment Corporation MicroVax II product places the power of a Digital Equipment Corporation 11/780 VAX on the desk for \$20,000. The MicroVax technology allows it to become a communications node on an office network; it has the ability to communicate with a host at speeds of up to 56 Kbps on a remote link. IBM's System/36 allows up to four PCs to connect to a low-cost minicomputer that offers file server capability along with a communications link.

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Leased line backlogs continue to affect low-end and mid-range products. Product orders are pushed out or cancelled as customers await the installation of long distance communications. This is particularly true for Dataphone Digital System (DDS) facilities, thus creating demand for dial-up modems, especially the 2400s.

Micom continues to maintain its leadership position in this segment but not without experiencing order softness through the first six months. Gaining positions are Codex, Racal-Milgo, and Paradyne. ComDesign has increased its share position through its extensive distribution and OEM agreements and a highly successful telemarketing program.

DATAQUEST foresees emphasis being directed to low-cost manufacturing, margin discounts, and product features in order to expand product coverage and revenue generation. We anticipate additional entrants in 1985, which will continue to chip away at the user base. We also expect to see statmux functionality appear in new product areas such as the modem, with the integrated multiplexer currently being offered by Codex, Paradyne, and others. The statmux functions will also be integrated into terminals and computers.

The low-end market could experience a long-term impact from the RBOC local area data transport (LADT) offerings, which have been filed by the RBOCs over the past year. The LADT is oriented for the low-speed asynchronous terminal user who will need connections either within a local access and transport area (LATA) or within a geographic region. The use of X.25 (a standard interface for accessing packet-switched networks) and the protocol conversion within the packet switch central office node could offer an attractive low-cost service to users who have smaller volumes of data transmissions.

Mid-Range Segment

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DATAQUEST defines this segment as systems with from 2 to 32 channels. This segment is known for its product features and functions that offer the user enhanced product capabilities in the multiple protocol network enviornment. A significant feature offered by many of these companies is the dual trunk and alternate routing. These mid-range products also provide switching and contention functions for the smaller minicomputer users who need these functions without the cost of a data PBX.

Datacommunications networks never remain the same, thus growing to meet user requirements as the company's data base access needs increase. Two significant products (from Micom and IBM) entered this segment within the past six months, which we believe could impact some of the traditional mid-range players. The first occurred when Micom introduced its 32-channel unit, which can upgrade the user to 32 channels from the present limitation of 16 channels in a single unit. Another aspect of this product is the use of the firmware cartridge for protocol software changes. We expect to see this cartridge, which is also used by Case and Network Products, to appear in other statmux products due to the ease of software changes.

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The second entry is the IBM 3710 product, which could impact some statmuxes that support up to 32 channels. The 3710 was in beta test and is now available for normal shipment. This multi-68000 protocol-based product may become widely accepted by the SNA shops as MIS executives evaluate its capabilities within the 3725 remote networks.

DATAQUEST estimates that Timeplex is the mid-range segment leader, with its highly successful M and SM series Microplexers (see Figure 4). Timeplex also introduced the Series III, which comprises new models of the Microplexer products that support multiple trunks and protocols at a lower price.

Companies that are making strong progress in this segment include Tellabs, which has signed substantial marketing agreements with ATTIS to supply products to ATTIS for resale, and Racal-Milgo, with its Omnimux products.

It is interesting to note the success the three major modem companies are having with statmux revenues. Codex trails Micom in the low-end segment, Case (Paradyne and Rixon) trails Infotron in the high-end, and Racal-Milgo is pushing Tellabs for second in the mid-range. These companies have an enormous modem customer base in which to offer new products. DATAQUEST will present our 1984 Revenue Scorecard, which will present the success modem-based companies are having by offering statmux products.

High-End Segment

Companies continue to migrate to this segment. Penril's recent acquisition of Network Products reflects the interest manufacturers have in this high-end segment, where profits and revenues are higher than in other segments.

The high-end systems are better for multiprotocol and speed requirements, especially for 56-Kbps Dataphone Digital Systems (DDS). The recent 56-Kbps tariff reductions are allowing corporations to replace multiple, parallel, lower-speed modems with the faster 14.4 and 19.2 modems, along with 56 Kbps. These high-end systems also provide the network technicians with the network performance and usage information from all the node sites. These new modems allow replacement of older, smaller statmuxes, but lets them be reused within the network to create the optimum network design for the user.

These systems incorporate processing capability and intelligence that enables them to minimize downtime and ease switchover to alternate links. Systems like the Infotron 990 provide standard features, including tandem switching and alternate reconfiguration, and terminal switching and contention.

Additional networking functions offered by these high-end systems include X.25 gateways to public and private packet-switch networks, multiple protocol support, and protocol emulation.

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Infotron continues to maintain its leadership position with revenues of \$27 million from its networking processors (see Figure 5). Taking a strong second place is Case, which acquired Rixon to gain a strong foothold in the United States. In addition to selling direct, Case has a license with Paradyne, which generated over \$8 million of Case's U.S. revenues for the DCX 850 product.

DCA continues to gain revenue share with its 355 product. The 355 is now offered by Ameritech as a CPE product and is achieving revenues for this RBOC. DATAQUEST is not aware of any other RBOC that is offering this high-end product as a CPE offering.

Doelz is a new entrant, which we identified last year as a threat. DATAQUEST estimates that Doelz achieved approximately \$1 million in revenues in 1984 with orders from TRW and the Chicago Public Library. We expect Doelz to gain market share in 1985.

The high-end segment is not without competition from other segments with concentrator-type products. We believe that IBM 3725 shipments will continue to remain ahead of plan through mid-1985. NCR and Amdahl have alternatives that can support multiple 56-Kbps trunks. Private packet networks continue to expand to serve connectivity needs for individual companies.

TDM GROWTH

DATAQUEST does not monitor the Time Division Multiplexer market as a defined segment, but we are aware of continued TDM activity with respect to 56-Kbps link connections. Companies such as Infotron, Timeplex, GDC, and Amdahl are among a handful of companies still offering a TDM product. We estimate that the revenues from these 56-Kbps products totaled \$18 million in 1984.

CONCLUSION

The U.S. statmux market is soft as of mid-year 1985, and indications are that this market condition will continue through year-end. While most data communications markets are outperforming computer and telecommunications markets, the statmux segment is suffering from the proliferation of products on the market and the effects of competing technologies. The low-end segment of the statmux market is especially subject to price discounting and competitive product pressure. Statmux products in this area are undergoing various product integrations with modems and distributed computer architecture.

We expect companies to move toward the high-end segment where profits are higher and system functionality will offer the user value-added features. The high-end systems experience less competitive discounting except for volume dollar discounts, and tend to drag along additional

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components and software charges. The recent acquisition of Network Products by Penril is an example of one company positioning itself in several segments, in this case, the high-end segment with the Network Products components offering.

We expect prices to continue to drop in some areas, which will have a direct impact on revenues and profits. DATAQUEST believes that companies must become better managed as this softness continues. Companies must focus on their markets and costs, and must be cognizant of the user migration to higher speeds.

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John Brew William C. Kanupke

Figure 1

ESTIMATED U.S. REVENUE, STATISTICAL MULTIPLEXER MARKET (Millions of Dollars)



Figure 2

ESTIMATED U.S. SHIPMENTS, STATISTICAL MULTIPLEXER MARKET (Thousands of Units)



\$130.4 MILLION

Figure 4

ESTIMATED 1984 U.S. REVENUE MARKET SHARES FOR MID-RANGE STATISTICAL MULTIPLEXERS (If-Sold, End-User Values)





ESTIMATED 1984 U.S. REVENUE MARKET SHARES FOR HIGH-END STATISTICAL MULTIPLEXERS (If-Sold, End-User Values)



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RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: October

NIELSEN COMPUTER PRODUCTS UPDATE

INTRODUCTION

This newsletter is the first in a series of monthly reports on retail sales of personal computer-related products as reported by the Nielsen Computer Products Index (NCPI)--a service of the A.C. Nielsen Company. Despite recent slowdowns, the data processing industry still accounts for nearly 40 percent of all electronic equipment revenues in North America; products in the NCPI represent a cross section of the data processing segment. DATAQUEST will highlight the extensive Nielsen survey results each month, recognizing the importance of the computer-related hardware to the semiconductor industry. The most recent data available are for August 1985.

ABOUT THE NCPI

The NCPI is a comprehensive monthly report of projected information gathered from a statistically sound sample of retail computer specialty stores. The NCPI measures computer product sales at the consumer transaction point in the distribution channel. The data are gathered through personal visits by Nielsen auditors, who visit computer specialty stores on the last day of each month to count inventory and tabulate all sales receipts. Both chain (e.g., ComputerLand and Businessland) and independent computer stores are represented, with the exception of Radio Shack and IBM product centers. While the NCPI is not a comprehensive survey of the market through all distribution channels, it is an invaluable tool for determining competitive issues, examining sales trends (in dollars and units), and checking inventory levels (in units) for computer-related products at the retail level.

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The following six products, representing a cross section of the data processing industry, will be reported on each month:

- Central processing units
- Modems

Printers

Monitors

•

Storage devices

Add-on boards

The central processing unit (CPU) is simply the computer without the keyboard, monitor, and other accessories. The following information for each of these equipment types will be compared with the data from the previous month:

- Dollar sales
- Unit sales
- Unit retail inventory

The NCPI encompasses the complete personal computer lines of Apple, AT&T, Compaq, Hewlett-Packard, Kaypro, IBM, and Texas Instruments, among others. As the monthly reports accumulate, we will begin to examine historical trends. The most recent data, comparing August 1985 with July 1985, are presented in Table 1. Table 2 shows the changes from June to July.

Table 1

AUGUST RETAIL NCPI RESULTS

Product Category	Dollars Purchased (Millions)	Percent <u>Change</u> *	Units Purchased (Thousands)	Percent <u>Change</u> *	Retail Inventory <u>(Thousands)</u>	Percent <u>Change</u> *
CPUs	\$230.0	7.08	101.3	9.4%	120.6	(9.7%)
Printers	58.5	2.98	80.9	6.9%	120.4	(5.5%)
Nonitors	20.2	(1.2%)	71.0	15.6%	101.9	(7.0%)
Add-on Boards	28.7	5.9%	105.5	11.6%	222.2	(6.0%)
Storage Devices	28.4	4.88	47.9	13.5%	91.0	(4.0%)
Nodens	<u> </u>	(8.9%)	19.9	(3.3\$)	36.2	(6.5%)
Total	\$373.9	5.2%	426.6	10.24	692.2	(6.5%)

*Percent change from previous month

Note: Columns may not add to totals because of rounding.

Source: DATAQUEST A.C. Nielsen October 1985

Table 2

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	JULI	RETAIL I	WCPI RESULT	9		
Product Category	Dollars Purchased (Millions)	Percent <u>Change</u> *	Units Purchased (Thousands)	Percent <u>Change</u> *	Retail Inventory (Thousands)	Percent <u>Change</u> *
ĊPUs	\$215.0	1.1\$	92.6	0.1%	133.6	(4.9%)
Printers	56.9	(1.2%)	75.7	(2.0%)	127.4	1.0%
Monitors	20.4	(1.7%)	61.4	(7.4%)	109.5	(7,4%)
Add-on Boards	27.1	(1.34)	94.6	(1.0%)	236.2	(1.6%)
Storage Devices	27.0	(1.3%)	42.2	(2.0%)	94.8	(2.5%)
Nodems	9.1	10.14	20.6	9.7*	38.7	(10.6%)
Total	\$355.4	0.4%	387.1	(1.6%)	740.3	(3.3%)

*Percent change from previous month

Note: Columns may not add to totals because of rounding.

Source: DATAQUEST A.C. Nielsen October 1985

DATAQUEST CONCLUSIONS

While the total number of CPUs sold in August rose slightly to 101,300 units, this is still substantially below the May 1985 figure of 116,579. June and July have traditionally been slow months for personal computer sales, and this held true for 1985. The increase in CPU units sold in August was the result of numerous factors.

The return to school prompts the sale of many personal computers, especially at the university level; August 1985 was as strong as any month last year in terms of home computer sales. IBM's announcement that there would be no PC2 this year certainly influenced purchasing decisions that had been delayed in expectation of a new personal computer. Also, an agreement among Lotus, Intel, and Microsoft on expanded memory specifications signaled a greater stability in the IBM-compatible marketplace, which will help relieve the plug-compatible world of the constant threat of technical or proprietary obsolescence. Thus, software and peripherals developers, PC users, buyers, and sellers, and those who have been intending to buy, can now feel much safer in any PC purchase/support decision they make knowing that there is a new level of stability and safety in the marketplace.

Lower prices for many models, as well as the introduction of the Atari ST, also contributed to the increased sales of CPUs. The upcoming Christmas season will be crucial for computer manufacturers as a barrage of advertisements and price cuts hit the marketplace, along with the introduction of new products (such as Commodore's Amiga). As evidenced from Table 1, retailers are slicing all product inventory levels in preparation for adjusting to holiday trends. Telsen () Dataquest

SAM Code: 1985-1986 Newsletters: November

RESEARCH

NEWSLETTER

DATAQUEST FORECASTS REBOUND FOR BUSINESS COMPUTERS IN NEXT TWO YEARS

INTRODUCTION

The latest DATAQUEST forecast for the business computer systems industry reflects the worldwide market weakness in 1985 but projects a rebound beginning in 1986 and strengthening through 1987. This newsletter reviews the forecast and the reasons for the expected upturn during the next two years.

FORECAST

Table 1 illustrates the current DATAQUEST historical figures and forecast for the worldwide multiuser business computer industry. The following definitions were used in compiling this forecast:

- Annual Shipments are the number of individual systems (which may include more than one tightly coupled CPU) shipped by U.S. manufacturers to end users, distributors, dealers, and other third-party resellers during a calendar year.
- Average Selling Price refers to the list price of an average hardware configuration. (This number is more meaningful for each individual segment than for the industry as a whole.) It does not include applications software, maintenance, services, or add-on peripherals.
- Total End-User If-Sold Market represents the dollar volume of the shipments to end users at the end-user price. This number reflects both revenues to manufacturers and margins to intermediate distribution channels. Leases and rentals are converted to an equivalent sales figure for inclusion in the total.

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Retirements from Installed Base are the systems that are either scrapped, returned to the manufacturer, or otherwise ineligible for add-on revenues. ţ.

Year-End Installed Base is the cumulative shipments through the end of the year, minus cumulative retirements.

The following key points are illustrated by this table:

- Market growth from 1984 to 1985 is projected to be 6.8 percent, after a growth rate of 16.5 percent from 1983 to 1984.
- Retirements are expected to grow from approximately 10 percent of shipments in 1984 to more than 20 percent of shipments in 1989.
- The average system price will decline steadily over the forecast period, as the number of low-priced work group and small department systems grows much faster than the shipments of more expensive business unit and corporate resource computers.

Figures 1 and 2 break down the overall industry forecast by market segment and show the growth in end-user, if-sold market, and in units shipped, respectively, for each segment. The following conclusions are apparent from these figures:

- Growth rates are highest for the work group systems, which is the newest market segment, and decline with each subsequent segment through corporate resource, which is the most mature segment.
- While the number of corporate resource system units is small, the end-user if-sold market for these systems is almost half the entire 1984 worldwide market.

ANALYSIS

Factors Contributing to the 1985 Slump

The well-publicized slump in the worldwide computer market during 1985 is the result of a number of factors that happened to converge this year. The most important of these factors are:

- The strength in the dollar, causing systems sold by U.S.-based manufacturers to be noncompetitive in price
- The weakness in the manufacturing sector of the economy, which has traditionally been a heavy purchaser of business computer systems
- The desire to integrate personal computers with each other and with larger systems, which has been frustrated by:
 - A lack of shippable products that fully satisfy user requirements
 - A lack of experience in the market with linkage products, making it difficult to assess the organizational and economic implications of choosing one approach (e.g., local area networks) versus another (e.g., micro-to-mainframe links)
 - Complexity in the installation, integration, and use of linkage products
- The desire by many corporations to exert control over the use
 and purchase of personal computers by centralizing the total systems planning and acquisition responsibilities to the MIS department, thus lengthening the sales cycle
- A reluctance to install 308X systems from IBM due to the perception that the new 3090 products will shorten the market life of the older line

Outlook for the Future

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DATAQUEST believes that all of these factors will have a temporary effect on the market and that sales will turn up again as the economic conditions change and as more linkage products are available. Specific influences that will push the market back up in 1986 and 1987 include:

- New work group systems announced by major vendors in 1985, such as the IBM System/36 and the Digital Equipment Corporation MicroVAX II, that will have a full year's shipments in 1986
- Quantity shipments in 1986 of new high-end corporate resource systems, such as the IBM 3090, Honeywell DPS 90, and Burroughs A 15, that were announced in 1985
- Probability of new corporate resource and departmental systems offerings from IBM that will resolve existing confusion in its product lines
- Shipments of announced and anticipated products (from IBM, Digital Equipment, Hewlett-Packard, Data General, Wang, and others) that more fully integrate personal computers with departmental systems
- More familiarity with the issues of departmental computing by central MIS groups, leading them to move ahead in implementing networks of PCs, departmental/work group systems, and high-end business unit or corporate resource computers

- Availability of more mature networking products that are easier to understand, easier to use, less expensive, faster, and more flexible
- Weakening of the U.S. dollar abroad

The underlying demand for more computing power has not diminished. As Figure 3 shows, while the business computer systems market has experienced a compound annual growth rate of 21.9 percent from 1980 to 1984 in dollar terms, the installed base of compute power as measured in millions of instructions per second (MIPS) grew at a compound annual rate of 90.1 percent during the same period. Far from reducing the need for larger systems, the proliferation of personal computers has typically increased the load on multiuser systems due to:

- Increased data communications
- Increased demand for data sharing
- Increased number of computer users and a heightened awareness of what a computer can do for them

An additional source of growing demand for computer power is the increasing sophistication of software packages. The more "intelligence," capability, and flexibility designed into software, the more hardware resources are typically consumed to perform these complex tasks. Thus, new systems or upgrades to existing systems are needed to run these packages. This will be especially true as the following start to come on stream:

- Artificial intelligence systems
- Integrated voice, data, graphics, and images
- More truly user-friendly system interfaces
- Concurrent task processing similar to "windowing" on personal computers that allows instantaneous switching between functions regardless of whether they have been completed

DATAQUEST believes that the net effect of these developments will be to unblock the growing pent-up demand for computing capabilities. And, because the increased use of communications to link computers together increases the work load on the systems, this demand is expected to keep growing for the rest of the decade.

DATAQUEST CONCLUSIONS

The good news is that the slump will not last forever; in fact, 1986 should look much brighter than 1985. But the bad news is that growth rates will never again reach their previous heights. The number of

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vendors in the industry will decrease consistent with a decline in the growth rate. The successful vendors will be those that have implemented strategies based on the following realities:

- IBM is the primary competitor in all segments and all markets.
- Very few companies will be able to compete with IBM across the board; thus, selecting the right niche and positioning will be crucial.
- Companies focusing on small businesses will succeed only if they
 offer the verticalized products (primarily software
 applications) and marketing programs necessary to attract these
 niche markets.
- Companies focusing on medium to large businesses will succeed to the extent they provide communications to PCs and to other multiuser systems that are:
 - Easy to configure, install, and use
 - Transparent to the user and user programs
 - Compatible with major industry standards
 - Flexible
 - Capable of sharing data, not just moving it

The vendors that survive the current slowdown will not only have learned these important lessons, they will also have learned how to manage themselves more prudently. Most will emerge leaner, more focused, and generally stronger than before. The wild days of unrestrained growth may be over, but the computer industry will remain a vital force in the worldwide economy.

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John Brew Gwen Peterson

Table 1

WORLDWIDE MULTIUSER BUSINESS COMPUTER INDUSTRY ACTUAL AND FORECAST SHIPMENTS AND REVENUES

	**********	• • • • • • • • • • • •	-Actual				• • • • • • • • • • • • •	Estimated	*********		CAGR	CAGR
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1980-84	198 5 · 89
	•••••	•••••••	•••••				••••••••••				*****	
Annual Shipments											•	
in Thousands of Units	101.0	133.3	183.3	255.5	340.5	419.5	516.9	643.1	813.3	1023.9	35.5X	25.0%
Average Selling Price												
in \$ Thousand <mark>s per Unit</mark>	\$137.2	\$126.2	\$119.2	\$102.9	\$89.9	\$78.0	\$69.8	\$62.4	\$54.7	\$48.4	-10.0%	-11.2%
Total End-User If+Sold												
Market in \$ Billions	\$13.9	\$16.8	\$21.6	\$26.3	\$30.6	\$32.7	\$36.1	\$40.1	\$44.5	\$49.6	21.9%	11.0%
Market Growth												
Percentage change over												
previous year	26.5%	21.4%	29.9%	20.3%	16.5%	6.8%	10.3%	11,2%	10.9%	11.4%		
Retirements from				•								
Installed Base												
in Thousands of Units	6.8	11.8	\$7.3	22.5	33.2	54.1	80.2	111.5	166.1	237,6	48.9%	44.7%
Year-Ending Installed Asso												
in Thousands of Units	426.9	548.4	714.4	947.5	1254.8	1620.1	2056.8	2588.4	3235.5	4021.8	30.9%	25.5%
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Source: DATAQUEST August 1985

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Figure 1



WORLDWIDE MULTIUSER BUSINESS COMPUTER SYSTEMS FORECAST SEGMENT SIZE BY END-USER, IF-SOLD MARKET

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WORLDWIDE MULTIUSER BUSINESS COMPUTER SYSTEMS FORECAST SEGMENT SIZE BY UNITS SHIPPED



Source: DATAQUEST August 1985

Figure 3

WORLDWIDE MULTIUSER BUSINESS COMPUTER SYSTEMS GROWTH IN INSTALLED COMPUTING POWER , (Millions of Instructions Per Second)



Source: DATAQUEST August 1985

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SAM Code: 1985-1986 Newsletters: November

RESEARCH

NEWSLETTER

A NEW STABILITY IN THE MS-DOS PC MARKET AND AN EXCLUSIVE PREVIEW OF 1986 PCs

Dataquest

INTRODUCTION

In the last six months, the personal computer industry has been bombarded constantly by negative rumors and reports. Financial and industry analysts, the trade and general press, and even the nightly television news shows have told and retold the story of the meteoric rise and tragic fall of the personal computer market.

In the midst of all this bad news, DATAQUEST believes that a very important distinction must be drawn between the <u>industry</u> and the <u>market</u>. While there is no denying that growth and sales rates are declining and many manufacturers, distributors, and retailers are in deep trouble, we consider these to be strictly <u>industry</u> phenomena caused by an enormous oversupply of products and participants. DATAQUEST believes that the industry must and will shrink. Of the more than 350 PC manufacturers and marketers in the world today, we believe that only 75 to 100 will still exist in 1988.

On the other hand, the <u>market</u> (i.e., everything pertaining to users and applications, both present and future) is in a holding pattern caused by confusion (too many products and players) and fear of obsolescence and/or incompatibility. But we believe that the market can and will continue to grow once that confusion and fear are overcome. Although market growth will obviously be much slower than in the past, we still expect it to be substantially faster than in most other major industries. We believe that the keys to overcoming the users' anxieties are:

- Reliable, stable, alternative sources of PC hardware and software products. PC suppliers must wean users from their perceptions that IBM is the only safe bet.
- A strong, uniform, industry-wide standard with enough "big-name" support to allow users a way to avoid obsolescence and incompatibility.

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Recently, two major events occurred that should begin to solve these problems and help restore stability to the market. These were IBM's statement that there is no "PC 2" in 1985 and the Lotus/Intel/Microsoft Expanded Memory Specification.

THE END OF THE RUMORS

The mysterious IBM "PC 2," having run rampant through the rumor mills for a year, was officially announced to be nonexistent on July 18. In an uncharacteristic move, IBM stated that "irresponsible speculation about a <u>nonexistent</u> IBM product was hurting the industry. We will not introduce any new personal computers this year." How should the industry interpret this voluntary IBM statement?

- Is it simply a semantic argument (e.g., there is no "PC 2" since IBM has never used that term except for the old PC XT)?
- Perhaps it really <u>is</u> the truth. (Is the term "PC 2" simply a collective concoction of the press and analyst communities?)
- Or is it simply a face-saving way of postponing or cancelling a real-but-as-yet-unannounced product?

DATAQUEST believes both the first and the last explanations to be true in light of the tough situations and poor market conditions that IBM and other manufacturers are currently facing. Among these are:

- Widespread "knowledge" of the "PC 2" among users and potential buyers is delaying purchase decisions and damaging sales of not only competitors, but even of IBM's PCs and XTs. We believe that the "PC 2" is one of the primary reasons for consumers' fears and confusion and, therefore, a factor in this year's delayed demand and market slowdown. (In fact, various end-user surveys have shown the "PC 2" to hold as high as 20 percent of the intention to buy.)
- The "PCjr Syndrome": The rumored "PC 2" probably would have been a modular, low-cost, high-volume, 286-based replacement for the PC and XT, but with a lower-than-AT CCP factor (capacity, configuration, performance). However, an intentionally limited, "junior version" of the AT obviously brings up some bad memories for IBM.
- Given the above scenario, the existing AT would require a very difficult repositioning upward as a technical, multiuser system, since 95 percent of the ATs currently installed are used as nothing more than fast, general-purpose, standalone PCs with larger memory. In most users' minds, the AT is <u>already</u> the "PC 2." It would appear to be far easier for IBM to allow the AT to evolve downward and come in with a new, top-of-the-line, 386-based product (the "PC 3"?).

The Competitors' "PC 2s": Existing PC AT clones such as the ITT Xtra XP and the Kaypro 286i are all improvements over the original, most are single-user oriented, and some are already street-priced only slightly higher than where the rumored IBM "PC 2" would have been list-priced--approximately \$3,000 to \$3,500.

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Clearly, until these and other issues are overcome, any further IBM CPU introductions will have to wait. Thus, the "PC 2" (or 3), the true portable ("Clamshell"), and the jr's replacement (a version of Japan's PC JX?) are now not expected until the first half of 1986. Even though there are many reports of various IBM 286-based systems being beta-tested, it is certainly possible that whatever was the "PC 2" has actually been scrapped in favor of a leapfrog strategy to a 386-based system. In any case, IBM's statements should bring a temporary sigh of relief to suppliers and users alike.

THE BEGINNING OF A NEW STANDARD

Compounding IBM's above-mentioned situation, the Lotus/Intel Expanded Memory Specification was unveiled in April to the IBM PC architecture community as <u>the</u> method of bypassing the artificial limit of 640 Kbytes of RAM. Despite immediate arguments from AST Research, Quadram, and others, Intel's Above Board memory card was quickly established as a quasi-standard way to expand any PC-, XT-, or AT-compatible machine up to 8 Mbytes, in many cases obviating the need for a new "PC 2" (which would have to offer less RAM than the AT's 3 Mbytes). Lotus Development's Symphony vl.l and 1-2-3 v2.0 would be among the first major software packages to run on it.

Last week, the hallowed Microsoft banner was added to the previous collaboration to create the Lotus/Intel/Microsoft Expanded Memory Specification, revision 3.2 (the LIM expanded memory standard). Microsoft announced full support for the standard and promised its integration into all future systems software including windowing, multitasking, multiuser, and networking products. Intel has begun aggressive advertising and marketing campaigns for the increasingly versatile Above Board, and claims to have signed more than 1,500 dealers in the U.S. market. Lotus' Symphony vl.1 is now shipping and 1-2-3 v2.0 is promised very soon. Additional software support has been announced by Ashton-Tate for Framework and by Sorcim/IUS for SuperCalc 3, among many others.

In a record four months, the LIM expanded memory standard has been quickly established and is expected to have significant industry-wide impacts. There are enough big names rallying behind it that it should be able to provide a new level of safety and stability for manufacturers and users as an additional source to IBM. This appears to be the bandwagon to jump on in order to hedge one's bets against IBM's dominance in the PC world. (If Digital Research decides to support the LIM standard with Concurrent DOS and/or GEM, this bandwagon might just become a sure bet!)

DATAQUEST ANALYSIS

DATAQUEST believes that at the end of 1984, the MS-DOS/8088+8086 architecture installed base and market presence were nearly as big as IBM's. MS-DOS manufacturers held 44 percent of the worldwide installed base of 4.5 million MS-DOS/PC-DOS machines. Now, with the addition of the LIM expanded memory standard, enhanced graphics adapters, windowing environments, increased usage of 8087 coprocessors, and the arrival of plentiful, relatively low-cost, 286-based PC AT clones, we expect that the IBM-compatible architecture might now be as strong and safe as IBM's own PC product line.

Regardless of what IBM might do in the future, those manufacturers who can manage to meet or beat the competition in terms of pricing, promotion, and distribution (still a very tall order, indeed) can expect to survive with the existing architectures for the next few years. Where clone companies once trembled at the thought of IBM moving toward increasingly proprietary hardware and software, they can now afford to let go of Big Blue's coattails and look forward to an independent life on their own. IBM's constant threat of technical or proprietary obsolescence is no longer a killer weapon to the plug-compatible world--the LIM expanded memory standard and other advances have given it a new lease on life.

For these same reasons, we believe that software and peripherals developers, PC users, buyers, sellers, and those who have been intending to buy, can now feel much safer in any PC purchase/support decision they make today knowing that there is a new level of stability and safety in the marketplace.

IBM and Microsoft recently added to this stability by announcing an agreement to work more closely in developing systems software for IBM personal computers. The only systems products specifically discussed were PC DOS and MS DOS (disk operating system, a control program that performs the basic housekeeping tasks in a computer). PC DOS is IBM's proprietary version of Microsoft's MS DOS.

The two companies will fully share information about future systems products and use a formal joint development methodology. They will also share jointly developed technology on a nonexclusive basis (each company may sell to its respective customer base).

The agreement allows Microsoft to play a larger strategic role in IBM's systems product line, including the updating of DOS software for new uses such as networking. The agreement is unique for IBM, which does not have this kind of long-term relationship with any other company.

What Does It Mean?

IBM has committed itself to PC DOS, which will remain an open architecture. MS DOS and PC DOS will not take divergent paths, and makers of PCs who use MS DOS can be assured of compatibility. IBM will use Intel processors through the 80386 for the PC line. Microsoft will remain the world's leading supplier of personal computer operating systems, and IBM believes that it can base its PC strategy on Microsoft's ability to deliver.

The industry has a clear message about direction and technology in PCs and should acquire an air of stability.

What Should Users Look For?

In the near term, we expect some joint announcements on networking, establishing another much needed standard. There is a distinct possibility that Microsoft Windows will become the standard PC environment. Current user concerns focus on networking and communications, multitasking, and a better user interface. Windows solves two of these, multitasking and the user interface.

IBM will now set the direction for the development of PC DOS. If user demand should build to a significant point for Xenix applications on the AT, we expect IBM to take the lead in conjunction with Microsoft.

Why Did IBM Do It?

It is easy to overanalyze IBM. The situation appears to be that two business partners who have prospered from working together are now working to improve their relationship.

At a more practical level, MS DOS was never designed to be a multitasking networked product working in a 32-bit architecture, and that is exactly where IBM and Microsoft want to take it. The task is complex and difficult and must be coordinated at all levels.

Why Did Microsoft Do It?

As the number one provider of both single-user and multiuser operating systems, Microsoft does not want its direction to be different from IBM's. Two overlapping but similar products will only confuse the market. Microsoft (in the persona of Bill Gates) has a strong viewpoint about where systems and user interface development should go and has worked a long time to be in a position to be a major influence on that direction.

CONCLUSIONS

The IBM-Microsoft agreement came just days after the Lotus/ Intel/Microsoft Expanded Memory Specification was announced. The new agreement substantially supports the thesis that the IBM-compatible architecture is now as safe and stable as IBM itself. The new standards extend the product lines of <u>all</u> MS-DOS/808x systems and they will continue to be the workhorses of the PC market at least through the late 1980s.

1986 PREVIEW

The new level of standardization also dictates the next steps in the evolution of MS-DOS/808x machines. Specifically, we expect the following to occur within the next six to nine months:

- Price cutting even greater than the normal 20 percent per year. (By now, 100 percent IBM PC compatibility is relatively easy; in fact, it's very nearly a commodity when buying a Phoenix Software BIOS kit. The resulting lack of differentiation will leave price competition as the only weapon.)
 - This year, major players such as IBM and Compaq must move fast to close the growing gap between their \$2,000 basic configurations and the \$1,100 to \$1,500 systems from Tandy, Epson, Sanyo, Leading Edge, Commodore, and a plethora of no-name PC-compatibles from the Far East.
 - Next year, several major electronics manufacturers from Taiwan and Korea will bring to the U.S. market full PC-clone working systems for \$750 to \$900 retail list price. These systems will consist of CPU, keyboard, 256 Kbytes or more of RAM, 12-inch monochrome CRT, graphics, parallel and serial ports, two flexible disk drives, MS DOS 2.1 or 3.0, BASIC, and bundled productivity software.
- Drastic cost cutting (the "Apple //c-ization" of the IBM PC architecture).
 - Apple shrank the II+'s chip count from 109 to 39 in the //e and to only 41 chips for the much more complex //c.
 - We expect someone to do the same for the IBM PC XT utilizing the latest in custom VLSI, CMOS circuitry, and gate arrays.
 - The resulting decrease in size, weight, cost, labor, and power consumption, and the concomitant increase in quality and reliability are absolutely vital to competing successfully in this increasingly vicious market. (Indeed, this type of design is what many observers expected the phantom IBM PC 2 to look like.)

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- Further shakeout during 1986 and 1987
- As the generic \$1,000 MS-DOS/808x PC clones become less differentiated and more of a commodity, competition will increase to a fever pitch and trigger further rounds of layoffs, bankruptcies, acquisitions, and mergers.
- Many of today's U.S. PC manufacturers will become nothing more than OEMs or private label distributors for offshore manufacturers.
- Modular PCs for modular marketing
 - As the smaller firms scramble for niches in various vertical markets, the larger firms are beginning to follow. However, they will quickly discover that no single vertical market will satisfy their volume requirements, and multiple verticals will become the rage.
 - The varying requirements of each submarket will force the large vendors to develop modular PCs to sell into the various vertical market modules.
 - A basic PC's turnkey "personality" will be modified or customized to each target market using add-on cards and devices and perhaps ROM cartridges.
 - Expect the first modular PC to appear sometime around mid-1986.

DATAQUEST will present a more complete preview of 1988 PC models in an upcoming newsletter.

(Portions of this newsletter were first published by DATAQUEST'S Software Industry Service (SWIS) and Personal Computer Industry Service (PCIS) and are reprinted with the permission of those services.)

> John Brew Kenneth T. Lim Paul Cubbage



RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: November

NIELSEN COMPUTER PRODUCTS UPDATE

INTRODUCTION

This newsletter is the second in a series of monthly reports on retail sales of personal computer-related products as reported by the Nielsen Computer Products Index (NCPI) --a service of the A.C. Nielsen Company. Despite recent slowdowns, the data processing industry still accounts for nearly 40 percent of all electronic equipment revenues in North America; products in the NCPI represent a cross section of the data processing segment. DATAQUEST will highlight the extensive Nielsen survey results each month, recognizing the importance of the computerrelated hardware to the semiconductor industry. The most recent data available are for September 1985.

ABOUT THE NCPI

The NCPI is a comprehensive monthly report of projected information gathered from a statistically sound sample of retail computer specialty stores. The NCPI measures computer product sales at the consumer transaction point in the distribution channel. The data are gathered through personal visits by Nielsen auditors, who visit computer specialty stores on the last day of each month to count inventory and tabulate all sales receipts. Both chain (e.g., ComputerLand and Businessland) and independent computer stores are represented, with the exception of Radio Shack and IBM product centers. While the NCPI is not a comprehensive survey of the market through all distribution channels, it is an invaluable tool for determining competitive issues, examining sales trends (in dollars and units), and checking inventory levels (in units) for computer-related products at the retail level.

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The following six products, representing a cross section of the data processing industry, will be reported on each month:

Modems

- Central processing units
- Printers
 Add-on boards
- Monitors
 Monitors
 Storage devices

The central processing unit (CPU) is simply the computer without the keyboard, monitor, and other accessories. The following information for each of these equipment types will be compared with the data from the previous month:

- Dollar sales
- Unit sales
- Unit retail inventory

The NCPI encompasses the complete personal computer lines of Apple, AT&T, Compaq, Hewlett-Packard, Kaypro, IBM, and Texas Instruments, among others. As the monthly reports accumulate, we will begin to examine historical trends. The most recent data, comparing September 1985 with August 1985, are presented in Table 1. Table 2 shows the changes from July to August.

Table 1

Product Category	Dollars Purchased <u>(Millions)</u>	Percent <u>Change</u> *	Units Purchased <u>(Thousands)</u>	Percent <u>Change</u> *	Retail Inventory (Thousands)	Percent <u>Change</u> *
CPUs	\$213.7	(7.14)	\$ 93.3	(7.9%)	\$118.7	(0.7%)
Printers	53. 3	(8.9%)	75.5	(6.7%)	118.0	(2.0%)
Monitors	20.6	(8.4%)	65.5	(7.8%)	101.6	2.0%
Add-on Boards	27.9	(2.5%)	102.8	(2.6%)	213.9	(3.7%)
Storage Devices	32.0	7.78	50.0	4.28	85.7	0.6%
Nodems	7.7	(6.7%)	17.4	(12.7%)	<u>33. 3</u>	(7.94)
Total	\$355.2	(5.9%)	\$404.5	(5.2%)	\$671.2	(1.7%)

SEPTEMBER RETAIL NCPI RESULTS

*Percent change from previous month

Note: Columns may not add to totals because of rounding.

Source: DATAQUEST A.C. Nielsen November 1985 i, c

Table 2

Product <u>Category</u>	Dollars Purchased (Millions)	Percent <u>Change</u> *	Onits Purchased <u>(Thousands)</u>	Percent <u>Change</u> *	Retail Inventory <u>(Thousands)</u>	Percent <u>Change</u> *
CPUs	\$230.0	7.04	\$101.3	9.54	\$119.5	(9.7%)
Printers	58-5	3.10	80.9	6.9%	120.4	(5.5%)
Monitors	22.4	10.14	71.0	15.64	99.5	(7.3%)
Add-on Boards	28.7	5.78	105.5	11.5%	222.2	(6.0%)
Storage Devices	29.7	10.14	47.9	13.6%	85.1	(3.3%)
Nodezs		(9.48)		(3.2%)	36.2	(6.6%)
Total	\$377.6	6.3*	\$426.7	10.24	\$682.9	(6.5%)

AUGUST RETAIL NCPI RESULTS

*Percent change from previous month

Note: Columns may not add to totals because of rounding.

Source: DATAQUEST A.C. Nielsen November 1985

CONCLUSIONS

Although the number of CPUs purchased fell in September from August, unit sales were still slightly ahead of June and July. DATAQUEST's Personal Computer Industry Service forecasts a relatively strong upcoming quarter for CPU sales due to a greater stability in the market, attractive price reductions for the holiday season, and increased consumer spending power. We expect 40 percent of all computer purchases for 1985 to occur in the last quarter of the year.

Inventories continued to be trimmed, as retailers are hoping to avoid a recurrence of last year's problem of excess holiday merchandise, which was carried in inventory until as late as March of this year.

. John Brew

RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: November

1986 SEMICONDUCTOR APPLICATION MARKET OUTLOOK

INTRODUCTION

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> With 1985's North American semiconductor consumption nearing a close at nearly 32 percent below last year's record high, it is timely to begin an industry outlook for 1986. As 1986 approaches, the industry is still reeling from what the last two years have brought--extremes at either end of the spectrum. Today, we believe that the worst has passed. Having weathered the storm, the industry will pick up the pieces and move into 1986, a year that we believe will represent modest growth. DATAQUEST's 1986 growth estimates for North American semiconductor consumption are up approximately 9.8 percent. This newsletter summarizes our outlook for 1986 from an application market perspective.

AN APPLICATION MARKET VIEW

By the time final statistics evolve, they will paint a dismal picture of 1985. In addition to a tremendous decline in consumption, North American capacity utilization will hover somewhere in the low 50 percent range. Thus far, nearly 20,000 industry employees worldwide have lost their jobs. DATAQUEST believes that the industry's emergence from this slump will center on three concepts--all playing equal roles to foster stable growth:

- Design technology
- Manufacturing technology
- Marketing technology

To date, marketing technology, or an application market perspective, has been less crucial than the other areas. Traditionally, customers have been centered in the data processing and military communities, and being on the leading edge has always spurred the "technology push" that has driven industry growth. Today, however, with increasing competition

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and semiconductor pervasiveness, design and manufacturing technologies have become givens--they are bottom-line keys to survival. An equal emphasis must now be put on the third concept--marketing technology.

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What are Buyers Saying?

When incorporating what we call marketing technology into a semiconductor market analysis, interesting results emerge. At the center of this perspective is knowing the pulse rate of the demand side of the industry's business. What have the key buyers been saying? What are their estimates for 1986 procurement?

DATAQUEST recently spoke with 15 major electronics manufacturers whose 1985 semiconductor purchases will amount to approximately \$3.5 billion. We believe that success in 1986 will be found among the device manufacturers who adequately address the issues that were most often raised in DATAQUEST's conversations with these buyers. Several recurring themes emerged. They include:

- A definite move toward variations of just-in-time delivery schemes
- Inventory control
- Reducing supplier bases in order to foster long-term, quality relationships that are dedicated to working jointly to accommodate new, flexible manufacturing processes
- Confusion in dealing with the continuing emergence of ASICs, specifically:
 - Understanding the issues involved in replacing standard parts with ASIC technology
 - Working with start-ups (which are usually ASIC houses that offer unique benefits), but at a time when the emphasis is on reducing suppliers
- Long-term availability of parts and vendor support
- Quality versus price decisions
- Overseas procurement

We believe that the above issues, many of which have long-term implications, must be jointly addressed by the decision makers who buy and sell devices. In our opinion, mutually beneficial solutions to issues such as these will typify future business successes.

Other interesting points came from our research, among which were user projections of:

- An average procurement decline of 32 percent from 1984 to 1985
- An average procurement growth estimate of 12 percent from 1985 to 1986

Only two companies projected slight declines in their 1986 procurement. This was due to 1985's significant price erosion and not to a decline in their projected unit demand.

In addition to excess inventory (which for the most part has been worked off) and overprojected equipment sales, two other reasons were frequently mentioned as having direct effects on 1985's drop in procurement:

- Business divestiture and general reevaluation of corporate strategy
- Streamlining and automating manufacturing processes

Electronic Equipment Forecast

DATAQUEST's electronic equipment forecast accompanies the projections and concerns from the user community to illustrate 1986 market potential. In Table 1, the estimated 1985 through 1989 compound annual growth rate reflects healthy growth in almost all sectors. We expect strongest growth in the communications market sector, followed by the industrial sector. Data processing, by far the largest segment, is also expected to have positive although somewhat slower growth throughout the period.

Table 2 reflects DATAQUEST's estimates for 1984 through 1986 North American semiconductor consumption by application market. We expect the data processing and communications semiconductor markets to resume share as modest market resiliency returns in 1986. We believe that the automotive (within transportation) and military segments, both of which remained relatively stable and less susceptible to price pressure during the recession, will stabilize in 1986 after gaining share in 1985.

DATAQUEST's technology services have identified many fast-growing equipment markets that present significant opportunity in the long term. Table 3 comprises a listing of each type of equipment, their major manufacturers, and DATAQUEST's long-term market forecast for each.

Table 1

ESTIMATED NORTH AMERICAN ELECTRONIC EQUIPMENT FORECAST (Billions of Dollars)

	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1989</u>	CAGR (1985-1989)
Data Processing	\$ 78.9	\$ 91.0	\$102.0	\$143.8	12.1%
Communications	27.9	32.8	37.8	58.9	15.8%
Industrial	32.0	36.6	41.8	64.8	15.4%
Consumer	13.6	14.5	15.6	20.6	9.1%
Military	43.6	48.7	54.6	79.9	13,1%
Transportation	7.4	8.5	9.6	13.8	12.8%
Total	\$203.4	\$232.1	\$261.4	\$381.8	13.3%

Table 2

ESTIMATED NORTH AMERICAN MERCHANT MARKET SEMICONDUCTOR CONSUMPTION BY NORTH AMERICAN MARKET

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	<u>1984</u>	<u>1985</u>	<u>1986</u>
Data Processing	42.1%	37.5%	39.6%
Communications	15.5%	13.9%	14.7%
Industrial	16.2%	16.5%	16.0%
Consumer	8.0%	7.9%	7.48
Military	12.9%	15.5%	14.3%
Transportation	5.2%	8.7%	7.98

Source: DATAQUEST November 1985 ۲ ۱

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Table 3

	2016	Cast _		
Equipment Type	1985	1989	CAGR	<u>Major Manufacturers</u>
PCs*				
\$1 to \$999	3,256	6,165	171	IBM, Apple, Commodore
\$1,000 to \$5,000	20,257	39,562	18%	
\$5,000 to \$10,000	9,711	19,950	201	
Printers				
Ink Jet	257	904	371	IBM, Xerox, Hewlett-Packard
Thermal Transfer	151	908	571	IBM, Xerox, Hewlett-Packard
Local Area Networks	953	2,475	278	Network Systems Corp., Ungermann-Bass, Sytek
Integrated Voice/ Data Workstations	220	1,101	498	Northern Telecom, Thomson CSF, Rolm
Cellular Mobile Radio				
Telephones	176	378	21 🕯	ATET, Motorola,
Base Station Equipment	370	864	24%	GE/Northern Telecom
Robot Systems	557	1,419	261	GMP, Cincinnati Milacron, ASEA
Sub-4-Inch Rigid Disk Drives	107	\$73	698	Rodine, Miniscribe, LaPine

KEY NORTH AMERICAN ELECTRONIC EQUIPMENT MARKETS (Millions of Dollars)

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*PCs represent worldwide forecasts.

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Source: DATAQUEST November: 1985

DATAQUEST ANALYSIS

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When combining a discussion of merchant market procurement and electronic equipment forecasts, trends emerge that center on an application market perspective.

- DATAQUEST believes that the industry is moving toward a concept of tailored service, which has taken place in many other industries and comes in many forms:
 - A close association with "the little guy"
 - An emphasis on customer service

- A niche market orientation
- Product differentiation and/or specialization
- The industry is experiencing what GM's Alfred P. Sloan, Jr., called a CLASS AMASS AMASS-CLASS commercial market evolution. In the semiconductor industry, this comprises a move from concentrated efforts in the data processing and military markets through the last 15 or 20 years of the "jelly bean" era, on to what is now appearing as a niche market, ASIC orientation in the pervasive use of devices.
- The industry's next market surge will likely occur in the same manner as all other preceding "boom years"--with an unforeseen technology that ends up with individual users and takes semiconductor pervasiveness another leap forward, such as:
 - Calculators
 - Digital watches
 - Video games

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- Personal computers
- DATAQUEST believes that device manufacturers should emphasize
 having a diversified portfolio of customers across different industries. Stability and growth can often be found in smaller pieces of the pie as noted in Table 2, which shows 1985 market share gains in the military and transportation markets.
- Emphasis must, to a certain extent, lie in understanding why customers buy a company's products. Today's industry leaders are insisting on knowing why they won a design-in, what their technology provided, and what problems it solved. They are then further examining the market to learn who else might need the solution and how they can enhance their products for this new subset of players.

We believe that a new set of trends and issues will continue to emerge as the industry further experiences market and service transitions. DATAQUEST believes, however, that at the heart of many of these changes will lie an application market perspective. We believe that significant opportunity can be found in many growth markets, and ultimately, with the tremendous range of customers found in today's electronic equipment manufacturers.

Anthea C. Stratigos

RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters

DATAQUEST'S INDUSTRIAL AUTOMATION CONFERENCE STRESSES "AUTOMATION MEANS BUSINESS"

SUMMARY

Dataquest

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> DATAQUEST'S Robotics Industry Service (RIS) sponsored its first annual Industrial Automation Conference on October 28 and 29 at the Chicago Hyatt Regency. The event attracted more than 100 attendees and the mood was refreshingly candid, with participants honestly discussing the challenges and opportunities for the future.

> The conference theme was "Automation Means Business"--the business and strategic issues surrounding the automation industry. In support of this theme, well-known industry speakers discussed current changes within the industry in terms of the control and communication challenges; business, operations, and automation strategies; supplier evolution; and the strategic directions and alternatives available in the future.

> This newsletter summarizes the topics discussed at the Industrial Automation Conference. Notebooks containing all the conference material were distributed to the conference attendees and will be sent to subscribers who could not attend the conference. Clients who want to read specific speeches should contact their RIS binder holder or conference attendee.

STATE OF THE INDUSTRY

DATAQUEST presented its estimates on both the robotics market and its relationship to the total automation market. Figure 1 shows our estimate of the 1985 U.S. manufacturing automation market.

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Total Manufacturing Automation Market: \$13,530 million

Source: DATAQUEST

Speaker Highlights

- Mary Ellen Saxby, RIS Senior Industry Analyst, DATAQUEST.
 "Automation is in the introduction phase of its life cycle-characterized by technical problems, inadequate distribution,
 and customer reluctance to change. . . When we recognize
 automation as a process, rather than a set of products, the
 components will work together and adhere to standards. Costs
 will decrease and performance will increase."
- Stephen R. Purdy, RIS Associate Director, DATAQUEST. "Systems integrators are rapidly becoming the backbone of automation implementation for the industrialized world... End users must have a unified corporate plan with emphasis not only on the technical, but on the strategic as well."
- J. Tracy O'Rourke, President and Chief Operating Officer, Allen-Bradley. "I think the key elements in CIM going forward in a very aggressive fashion will revolve around sensors, reusable software, and communications. . . . If you do not apply the leading-edge technology at the highest quality at the lowest cost, somebody in the world will, and you will be out of business."

- Wayne Hanna, Chairman of the MAP Users Group. "The user community has recognized its responsibility to clearly define its requirements while focusing industry direction and priorities... Uniform industry testing must be performed to ensure vendor products conform to the standards."
- Briday Prasad, Manager of Technical and Industrial Control Systems, Ford Motor Company. "The best automation or best mechanization is the one that removes the need of the process itself in the first place. Manufacturing productivity should start in product design offices, using DFA (Design for Assembly)."
- James Toreson, President and Chief Executive Officer, Xebec. "Engineers in this country hate manufacturing. They think it is for second- and third-rate people; in fact, in general we have those kinds of people in the factory. Corporations must upgrade the role of manufacturing engineers and support the efforts of universities to train a skilled work force."
- Paul Mercer, P.E. Manager of Flexible Automation Processes, Boeing Commercial Airplane Company. "The process complexity of the aerospace industry brings a unique set of challenges, often requiring specialized, custom solutions. Price is not the issue--reliability is."
- Susan Powell, Process Development Manager, Advanced Micro Devices. "If another salesman from Detroit tries to sell me robots to solve my labor problems, I'll throw him out of my office. I don't have labor problems. I'm interested in quality and performance."
- Alan Kantrow, Pn.D., Associate Editor, <u>Harvard Business Review</u>.
 "You can produce the best darn equipment in the world, put it in your plant, and use it as a very expensive coatrack if you haven't built the organizational infrastructure to use it well."

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Barbara Sanders of General Motors gave a comprehensive overview of the automation technologies that will be necessary to produce the automobile of tomorrow. Her speech addressed the transformation in General Motors' approach to manufacturing: from the method of sequential steps from design through manufacturing, to an integrated product planning and manufacturing process. This innovation is taking place not only in the factories, but also in the office organization and in the products themselves.

C.B. Chan of the Singapore Economic Board presented the reasons why companies consider off-shore manufacturing as a viable alternative. He also discussed the unique problems Singapore faces, and how his nation is pursuing automation with a vigorous and progressive commitment in order to meet those challenges.

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Dr. Alan Kantrow encouraged us to think beyond the technological challenges to perhaps even a greater challenge--that of the management agenda. He said that the United States is experiencing changes that we have never before encountered. He stated that our treatment of manufacturing automation is outdated. In his view, we are using antiguated methods of accounting and purchasing for today's capital purchasing. He further suggested that the real work of manufacturing is not the movement of material through operations, but is instead the flow of information and the ability of an organization to learn in an ongoing fashion and respond to constantly changing market needs and conditions. £

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End-User Panel

A panel discussion was held with participants from AMD, Boeing, Ford, IBM, and Xebec discussing their respective business, operations, and automation strategies. The panel members revealed their opinions and concerns about the issues facing their industries. Several themes emerged as a result:

- CIM is still an unfulfilled goal, and at present an alphabet soup of technologies that will take quite a while to integrate.
- FMS is overrated--in fact, very few flexible manufacturing facilities today will ever be reused for another product line.
- America must upgrade the level of manufacturing education and provide incentives for today's graduates to consider manufacturing as a career choice.
- Automation equipment must have a higher level of reliability.
 What is the mean time between failure of your equipment?
- Manufacturing productivity does not start on the manufacturing floor; 70 percent of the product cost is determined in the design phase.
- You must influence the product design through early involvement by manufacturing personnel. Design for manufacturing efficiency.
- Emphasis on direct labor savings is many times not the issue. More important is QUALITY.
- There is a need for more experienced systems engineers who can apply process technology.

Automation Supplier Evolution

Keith Krach of GMF Robotics discussed the importance of transnational alliances. He outlined the business motives of the two parent corporations to enter the robotics industry, but stressed that the relationship between General Motors and Fanuc has been successful due to mutual trust and the assumption of perpetuity on both sides. Krach said, "The Fanuc/GMF relationship was, and is, one of true partnership."

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In his speech titled "The Global Marketing Challenge," Richard Rinehart of ASEA Robotics analyzed the challenges and opportunities of worldwide marketing coverage. His premise was that most companies that intend to be market leaders will require a global marketing plan. He defined a number of strategies, such as cost leadership, engineering leadership, and niche marketing, and he outlined the risk areas associated with the various strategy mixes.

Throughout the conference, the importance of systems integration was mentioned by end users and vendors alike. Peter Keller of Keller Technology Corporation brought the discussion into focus stating, "The industry hype has decreased and it's time to do the work." He described the barriers that prevent available products from reaching end users, and emphasized that before the pace to integrate can be accelerated, there must be a greater number of qualified systems integrators and experienced end users in place. He also gave advice to both users and vendors for selecting and working most effectively with systems integrators.

Jerry Saveriano of Vektronics reinforced the idea that the robotics industry continues to spur automation efforts, and that even though robots are a small portion of the automation market, they are the flexible link to other automation equipment that drives the total industry.

FUTURE CONFERENCES

Our next Industrial Automation Conference is planned for October 1986. Once again we expect to have a good attendance, so we encourage participants to make their reservations early to assure themselves a place at the conference.

The Industrial Automation Group is sponsoring a focus conference on December 9 and 10 in Palo Alto, California. The conference theme is "The Age of Productivity . . . Design Alternatives become Solutions." If you are interested in attending, please contact Sandy Bertino at DATAQUEST, (408) 971-9000, extension 245.

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John Brew Steve Purdy

RESEARCH NEWSLETTER

SAM Code: 1985-1986 Newsletters: December

TRENDS IN MILITARY ICs: SEMINAR HIGHLIGHTS

INTRODUCTION

Dataquest

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> DATAQUEST'S Semiconductor User Information Service recently sponsored a one-day seminar entitled Military IC Trends. Held on November 15, 1985, in Anaheim, California, the seminar offered a unique update on this ever-changing semiconductor application market.

> The focus of the seminar was toward a procurement audience and other decision makers in the defense electronics industry, such as system designers, materials managers, and engineers. Semiconductor manufacturers interested in this market also attended the seminar. Approximately 100 people attended. Seven speakers, predominantly from the IC manufacturing community, provided insight into this market. Highlights of the seminar follow.

MILITARY SEMICONDUCTOR OUTLOOK

Mal Baca, Director of Strategic Planning, ZEUS West, Inc., began the day with a military market overview. He stated that the military accounted for as much as 70 percent of the semiconductor market in the 1960s, as compared with a projected 10 percent of the semiconductor market in the late 1980s. MPU memory and logic technologies are expected to gain share as the market experiences a compound annual growth rate (CAGR) of 17.4 percent from 1983 to 1991. Mr. Baca also cited DATAQUEST statistics projecting a \$1.3 billion military semiconductor market in 1985. Major market participants include:

- Advanced Micro Devices, Inc.
- Analog Devices, Inc.
- Fairchild Camera & Instrument Corp.
- Harris Semiconductor Corp.

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- Intel Corp.
- International Rectifier Corp.
- Monolithic Memories, Inc.
- Motorola, Inc.
- National Semiconductor Corp.
- RCA, Solid State Division
- Signetics Corp.
- Texas Instruments, Inc.
- Unitrode Corp.

These were led by Texas Instruments, Motorola, and National, respectively. To date, the top 50 U.S. defense contractors, listed in Table 1, control 80 percent of DOD funding and military-grade electronics. These same manufacturers control 25 percent of research and development, test and evaluation funding, and the top military semiconductor customers.

Mr. Baca discussed defense contracting activity within U.S. geographic regions. He believes that the sunbelt region between Texas and Florida will be the fastest-growing area for defense contract activity in the future because of such benefits as lower labor costs and government-sponsored tax shelters associated with these regions. Major programs include:

- Aegis
 SSN-688
- Trident LHD-1
- DDG-51 AV-8B
- F-14 F-15
- F-16 F/A-18
- AH-64 H-60
- B-1B
- MX Patriot
- SLCM/GLCM
 ARM
- M-l Tank
 DIVAD

He said that the major application areas within the military sector are communications, missiles, and avionics. Other application areas such as space, naval, and ordnance make up a much smaller portion of the total.

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Table 1

TOP U.S. DEFENSE ELECTRONICS CONTRACTORS

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Rating	Company Name	<u>Rating</u>	<u>Company Name</u>
1	Bughes Aircraft	26	Sanders Associates
2	Lockheed	27	Motorola
3	Raytheon	28	Eaton
4	Litton Industries	29	Burroughs
5	Honeywell	30	North American Philips
6	Rockwell International	31	E-Systems
7	General Electric	32	Allied/Bendix Aerospace
8	Sperry	33	Loral
9	RCA	34	United Technologies/Norden
10	Texas Instruments		Systems
11	Westinghouse Electric	35	Gould
12	IBM	36	Control Data Corporation
13	ITT	37	AVCO
14	General Dynamics	38	AT&T
15	Martin Marietta	39	Computer Sciences Corporation
16	Ford Motor Co./Ford	40	Varian Associates
	Aerospace & Communications	41	Perkin-Elmer
17	McDonnell Douglas	42	Hewlett-Packard
18	Boeing Aerospace	43	Fairchild Industries
19	Singer	44	Hazeltine
20	Northrop	45	Goodyear Aerospace
21	GTE	46	AAI
22	Harris	47	Logicon
23	Teledyne	48	Watkins-Johnson
24	Grumman	49	Interstate Electronics
25	LTV	50	Bell Aerospace Textron

Source: Defense Electronics 2EUS West, Inc. DATAQUEST

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Mr. Baca cited many major market issues for the late 1980s. They include:

- Accelerated technological obsolescence and shorter life cycles of future technologies
- Standardization of emerging technologies, including standardization of ASICs
- Changes in packaging technologies
- Testing for VLSI

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 Lack of vendor visibility to new programs during the planning phase

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To the last point, Mr. Baca added that manufacturers could no longer keep semiconductor suppliers in a reactive mode and said he believes that open relationships would characterize the market in the future.

Lastly, Mr. Baca mentioned that the role of distribution would increase slightly to account for approximately 27 percent of the military market. He listed the major semiconductor distributors as Arrow, Hallmark, Hamilton, Keirulff, Pioneer/Harvey, Schweber, Wyle, and 2EUS.

TECHNOLOGIES FOR THE FUTURE

Gallium Arsenide

Michael Pawlik, Director of Foundry Marketing, GigaBit Logic, spoke of the future role of gallium arsenide (GaAs) in the military semiconductor market.

The technology itself has gained tremendous popularity in the industry and in the press. Start-up companies are continually emerging, and major manufacturers (captive and merchant) are devoting tremendous dollars to GaAs research and development. Mr. Pawlik characterized GaAs as a "racehorse for a new era" in comparison to silicon, which will always be recognized as a mainstream force and which he classified as a "workhorse for decades."

Mr. Pawlik believes that GaAs will accelerate the information revolution with such technological benefits as:

- Speed
- Power
- Radiation tolerance

He also cited several factors that apply to gallium arsenide's long-term market growth. They include:

- Speed greater than two times that of silicon
- Material improvement (The recent emergence of suppliers, now totaling over 15, has given this issue momentum.)
- Yield improvement
- Convergence to standard families
- Ten significant merchant suppliers worldwide
- Second-source agreements
- Acceptance by system OEMs (original equipment manufacturers)

The technology's major application markets center around data processing, communications, industrial, and military. Key equipment markets include:

- Supercomputers (scientific)
- Mainframe computers (business)
- Aigh-speed instrumentation
 - Communications test sets
 - VLSI testers
 - Logic analyzers
 - Digital oscilloscopes
- Communications systems in:
 - Microwave
 - Coaxial line -
 - Fiber optics
 - Radio
- Military and space
 - Satellite communication
 - Encryption/decryption

CMOS

Ronald Marfil, National Semiconductor Corporation's Military Marketing Director, gave a presentation on the attributes of CMOS technology in military electronic applications. Typical military systems demanded greater and greater performance, complexity, have and reliability without allowing for increases in space or power availability. CMOS, according to Mr. Marfil, has provided a means to an end since component users must arrive at the fastest, smallest, least-power-consuming, highest-reliability, and lowest-cost system possible.

Mr. Marfil said that bipolar logic shipments will remain a 2 to 1 leader over CMOS. He believes, however, that companies must look at CMOS logic projections along with projections for their CMOS MPU, memory, and linear counterparts. Thus, he believes that CMOS will play a major role in the military market.

CMOS works beautifully in a myriad of application areas. With respect to military applications, certain attributes make CMOS a natural fit. They include:

- Reduction in thermal problems
- Demand for battery-operated systems
- Demand for portability
- Limited power supplies

In short, CMOS works well within military temperature ranges because its low-power/low-heat dissipation properties give it increased reliability in size-restricted applications. CMOS is also achieving speeds formerly achievable only by its bipolar counterparts. CMOS will likely play a role--although not displacing ECL and GaAs, which have niches--in equipment and applications that require the attributes competitively offered by CMOS technology.

Surface-Mounted Packaging

Robert Reynolds, Manager of Texas Instruments' Chip Carrier Business Development, examined packaging issues facing the military semiconductor user community.

Mr. Reynolds said that, overall, military end system requirements are increasing and are less cost driven than commercial counterparts. This ultimately affects the technology used for military applications and which must meet the following system attributes desired by the DOD:

- More digital technology
- Lighter weight
- Smaller platforms
- Improved reliability
- Improved survivability
- Increased maintainability
- Lower power
- Reduced life-cycle cost

Packaging choice/availability becomes a function of many of these attributes since density has become a prevalent issue. Mr. Reynolds believes that surface mount offers a compromise between the historical use of hybrid circuits and the predominant use of custom VLSI, which is expensive, requires high volume for cost efficiency, and must have long lead times for development.

Reynolds explained surface-mountable packages for dense Mr. requirements and surface-mount assembly considerations. He described typical savings with SMT compared to DIP in certain programs. Savings included volume reductions of between 4 to 1 and 8 to 1 and weight reductions of between 2 to 1 and 5 to 1. He also said that in the future, emphasis on quality will have to be built in because test and inspection will become increasingly difficult. He summarized by stating that leadless ceramic chip carriers have arrived as an industry standard. Pricing will continue to decline as volumes increase, and lead times will remain short. Mr. Reynolds believes that flat packs will continue to decline and will fall off when unit volume falls behind profitable levels. Lastly, Mr. Reynolds stated that PCB technology will continue to evolve and respond to SMT needs.

Microprocessors

Dennis Kundsin, Marketing Director, Fairchild Camera & Instrument Corporation, discussed the use of microprocessors for military applications.

Mr. Kundsin began his talk by explaining that the primary use of military microprocessors is within embedded computers. These computers do not resemble a stereotypical computer, which is usually accompanied by a slate of peripherals such as keyboard or mass storage devices. Instead, embedded computers (somewhat modularized or "black-boxed") come in the form of, for example, aeronautic subsystems similar to an engine control device in an automobile.

At present, military embedded computer development is experiencing an explosion in software costs and rapid technological change. The response by the military has been:

- A movement toward standardization at both the assembly language and hardware levels--A major factor affecting the design of new products for the military market
- VHSIC--The development of high-performance semiconductor-based products

Included in the discussion was an overview of MIL-STD 1750A, which has become a de facto standard and is very widely used beyond its initial naval aeronautics base in air, land, and ship-based computers. Mr. Kundsin also discussed ADA, a Pascal-like language for embedded computers. He believes that the two standards have addressed the problems mentioned above. He concluded with the following observations on the standards:

- They are well conceived and stable.
- They are increasingly used by the military.
- They will be used imminently in the commercial sector.

- They will be implemented in an increasing number of products.
- They must be understood by the user in order to cope with the standards' impact on cost and program planning.

ASICs

No discussion of emerging technology for any application market is complete without mention of ASICs and their use in meeting end-user needs. Ronald Kasper, Vice President of Worldwide Sales, VLSI Technology, Inc. (VTI), expertly summarized the issues and advantages surrounding the implementation of ASIC semiconductor technology.

Mr. Kasper cited the major challenge of increasing electronic content in end-system applications with concurrent requirements to decrease size, cost, and weight while increasing system reliability. He also mentioned present user obstacles, which include:

- Different application needs between military and commercial ICs with respect to temperature ranges, rad hardening, and packaging
- Declining influence with today's mainstream semiconductor manufacturers
- Military user production runs equivalent to prototype runs in the commercial market

Mr. Kasper explained application benefits and considerations between programmable logic, gate array, cell-based, and hand-crafted design technologies including cost and design time tradeoffs. He stated the following advantages of using ASICs in military applications:

- Lower cost
- More reliability and security
- System upgrade at a fraction of cost
- Redundancy upgrade at system level
- Reduced system size
- System upgrade without software modification
- Wide spectrum of choice
- Strong market growth
- Allowance for end-product optimization

Military IC Standards

IC standards were mentioned throughout the day. One standard, MIL-STD-883, Revision C, was the subject of Arney Stensrud's presentation. Manager of Military Marketing at Motorola, Inc., Mr. Stensrud explained the ramifications associated with this standard, which was initially dated August 25, 1983, and took three subsequent revisions to resolve. The ramifications include:

- Significant administrative costs in documentation
- Significant changes in procurement
- Higher prices
- Higher minimum order quantities
- Longer lead times

Long-term impact is still expected. Mr. Stensrud summarized his presentation with the following conclusions:

- MIL-STD-883C/DESC drawings will become the dominant process product.
- MIL-M-38510/JAN will decline as a percent of the future military IC market.
- SCD military ICs will decline in use because of DOD resistance.
- Military IC manufacturers will pursue DESC drawing registration to provide standard registration.
- OEM prime contractors will convert SCD to standard DESC drawing/883C products.

DATAQUEST CONCLUSIONS

The tough requirements associated with designing military systems and procuring military ICs make this a market where much buyer/seller communication is essential. This market will continue to offer opportunity to the semiconductor community and will account for an average of 13 percent of the overall U.S. semiconductor market in the future. We believe that seminars such as this one sponsored by our sister service offer ample opportunity to bring the two communities together. We also believe that this type of interaction will typify future semiconductor procurement decisions.

Anthea Stratigos
RESEARCH NEWSLETTER

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COMPACT DISK PLAYERS: A SOUND MARKET

INTRODUCTION

Dataquest

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> Optical storage has long been hailed as the technology of the future for numerous applications. Finally one product, the compact disk (CD) player, is gaining mass appeal with consumers. CD players are becoming the darling of the audio world, providing a boon to the consumer electronics market and paving the way for other optoelectronic products.

> DATAQUEST'S Semiconductor Application Markets analysts have examined the major players and dynamics of the CD market and have evaluated the semiconductor content and market for these popular machines. As indicated in Figure 1, we believe that this year's worldwide CD market will reach \$836 million, a 249 percent increase over 1984. We estimate that this represents a \$146 million semiconductor opportunity for 1985 alone.

Figure 1

ESTIMATED WORLDWIDE COMPACT DISK PLAYER PRODUCTION



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BACKGROUND

Developed jointly by Philips, of the Netherlands, and Sony Corporation, of Japan, compact disk players were the first commercially available digital audio systems offering far greater sound reproduction than conventional analog systems. The first CD systems appeared on Japan's domestic market in October 1982. CD players were introduced to Europe in February 1983 and to North America later in the same year. CD players quickly caught the consumer's attention because of their compact size, easy handling, and superior sound reproduction. However, initial sales were slow because of the CD player's high retail price compared with that of its analog counterpart.

COMPACT DISK PLAYER PRODUCTION

CD player production is dominated by Japanese companies, with the exception of Philips and a few smaller European manufacturers. Table 1 lists the major manufacturers, which we believe account for more than 90 percent of the total CD player production.

Table 1

MAJOR COMPACT DISK PLAYER MANUFACTURERS

Japanese Manufacturers

Akai Hitachi JVC Matsushita (Panasonic, Technics, Quasar) NEC Nippon Columbia Nippon Gakki (Yamaha) Pioneer Sanyo (Fisher) Sharp Sony Toshiba Trio-Kenwood European Manufacturers

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Akai* Grundig Mission Philips (Marantz) Pioneer* Revox Sony*

*Planned production

Source: DATAQUEST December 1985 Japanese companies are the most aggressive in terms of increasing production capacity. Sony, the acknowledged leader, plans to boost capacity 40 percent to 140,000 units per month by the end of this year. Others, like Matsushita and Sanyo, plan to double their capacity to 100,000 units per month. As shown in Table 2, CD player production is expected to reach 3.7 million units this year, with nearly 90 percent originating in Japan.

Because of the large demand for CD players, and to avoid the heavy import tariffs (19 percent) placed on these goods going into the European market, Japanese manufacturers are setting up production facilities in Europe. Sony, for example, in a joint venture with CBS, of the United States, has announced plans to manufacture in Europe, thus exempting its products from this levy. Other international ventures include Philips' manufacturing CD players in Poland and China, JVC's joint agreement in China, and Sanyo's opening a production plant in Korea.

No major manufacturers are producing CD players in the United States, although software (or disk) production activity is great. Du Pont and Philips recently announced a joint venture in North Carolina, joining Sony/CBS (in Indiana), and 3M (in Wisconsin) in disk production.

Table 2

ESTIMATED PRODUCTION OF COMPACT DISK PLAYERS

	Actual		Porecast		
	<u>1983</u>	<u>1984</u>	1985	1986	<u>1987</u>
Japan					
Volume (R units)	290	769	3,315	4,950	5,905
Production Value (\$M)	\$138	\$212	\$ 680	\$891	\$915
Europe					
Volume (K units)	80	210	380	640	1,400
Production Value (\$M)	\$50	\$95	\$101	\$141	\$266

Source: DATAQUEST Electronics Industry Association Japan December 1985

COMPACT DISK PLAYER CONSUMPTION

The United States, not suprisingly, is the major importer of CD players from Japan. Americans purchased some 320,000 players from Japan in 1984. In the first half of 1985, the figure was over 500,000. By year-end, more than 1.2 million CD players will have been imported from Japan. Table 3 shows our estimates of consumption by major regional markets.

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Three applications--home, portable, and car audio--have emerged for CD players, each with varied market dynamics. In the home environment, unlike VCRs (of which the Japanese will produce 30 million this year), the audio market is relatively mature. We believe that, today, nearly 75 percent of CD purchases are for replacement of existing (analog) systems. Portable models are rapidly gaining popularity, but with only a few product introductions so far, volumes are still lower than in the home market.

An exciting, and potentially large, market for CD players is the automobile industry. Despite some early skepticism concerning technical problems, such as heat and vibration (which can hinder CD player performance), many manufacturers are offering them as an option in their higher-priced automobiles. Japanese automobile makers expect to sell more than 100,000 cars with CD players in 1986.

Table 3

	Actual		Forecast		
•	<u>1983</u>	1984	<u>1985</u>	<u>1986</u>	<u>1987</u>
Japan					
Volume (K units)	180	325	1,030	1,650	2,050
ASP in Japan (Dollars)	\$540	\$348	\$249	\$203	\$170
Burope					
Volume (K units)	125	295	1,010	1,775	2,250
ASP in Europe (Dollars)	\$707	\$509	\$378	\$296	\$235
United States					
Volume (K units)	40	320	1,275	2,150	3,190
ASP in U.S. (Dollars)	\$780	\$520	\$327	\$240	\$198

CONSUMPTION OF COMPACT DISK PLAYERS

ASP = Average Selling Price

Source: DATAQUEST Electronics Industry Association Japan December 1985 81

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Most U.S. automobile manufacturers are currently considering CD players as an option in 1986 models. With numerous car CD players on the market (Alpine, Ritachi, Kenwood, Pioneer, and Sony), CD players with AM/FM stereo should be a common option by 1987.

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SEMICONDUCTOR CONTENT

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We have examined a medium-scale CD player and its components and have estimated the semiconductor value as shown in Table 4. The component values, based on contract-volume prices, result in an input/output ratio (semiconductor value as a percentage of equipment average selling price) of 17.5 percent.

Table 4

ESTIMATED SEMICONDUCTOR CONTENT OF A COMPACT DISK PLAYER

Components	<u>Quantity</u>	<u>Cost</u>	
Integrated Circuits			
Standard Logic (SSI/MSI)	13		
Microcontroller (8-bit)	1		
D/A Converter (12-bit)	1		
Digital Filter	1		
Signal Conditioner	1		
Servo Control Unit	_1		
Subtotal	18	\$31.24	
Optoelectronic			
Laser Diode	1		
Optical Sensor	1		
LED Lamp -	<u> </u>		
Subtotal	3	\$22.32	
Discrete Components	<u>25</u>	\$ 3.75	
Total	46	\$57.31	
Semiconductor Value \$57.3	<u>1</u>	17.59	
Ketali value – \$327	- VIA/J -		

Source: DATAQUEST December 1985 In an effort to reduce componet costs and improve quality, new chips designed specifically for the CD player are now appearing on the market. Recent examples are an LSI chip (YM-3805) introduced by Nippon Gakki, which combines the signal processing and servo circuits, and a Matsushita digital filter LSI chip (MN 6618). Other developments include improved lagers, which are used to read the optical disk, an area where costs will be further reduced.

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CD_TECHNOLOGY AS A CATALYST

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Consumer acceptance of CD players could help push the development of other optoelectronic products. CD-ROM technology is virtually the same as that found in audio CD players, with the exception of more stringent error correcting demands for data applications. Potential applications for CD technolgy include the following:

- Computer data storage
- Videodisks
- Publishing
- Road map directories in automobile dashboards
- Medical records
- Laser smart cards

The potential applications for CD technology represent numerous attractive markets, and they all could gain widespread use by the consumer, in part, because of the enthusiastic acceptance of CD players.

DATAQUEST. CONCLUSIONS

As more and more manufacturers expand CD capacity and output, we expect prices to continue to fall while profit margins remain thin. Cutting component cost will become necessary for survival, given the fierce competition in the CD player market.

Perhaps even more important is the advantage the Japanese manufacturers are gaining in optical technology. With the potential widespread use of CD-ROMS as data storage devices for computers, and because of the shared technology with CD players, another large market is being captured by the Japanese even before it is widely recognized by the industry.

John Brew

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