Electronic Money & the Semiconductor Industry

The "Hot" Market for the New Millenium

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Citicorp

The Situation Today: Sense of Scale

- Operating the world's phone system involves (best guess) over 500 billion financial transactions a year
  - > Massive accounting and billing system
  - > Does it really create customer value?
- U.S. Economy involves around 250 billion small cash payments a year
- U.S. Banking system moves the equivalent of the U.S. GDP each day across its systems and networks

Already many "experiments" starting to take place in the market involving various payment systems — "online" and "offline"

- Mondex
- Visa/Microsoft
- DigiCash
- Etc., etc., etc.
- SmartCash
- CyberCash
- FSTC Electronic Cheque

Most thinking about electronic money and electronic payment systems focuses on individuals/company to company. . .

However,

the full potential of the information and knowledge revolution
cannot be achieved unless money is an integral part of the process and structure of the information economy

Let's elaborate!

Money here is defined as currency issued by the appropriate national authority, e.g., Federal Reserve of the USA

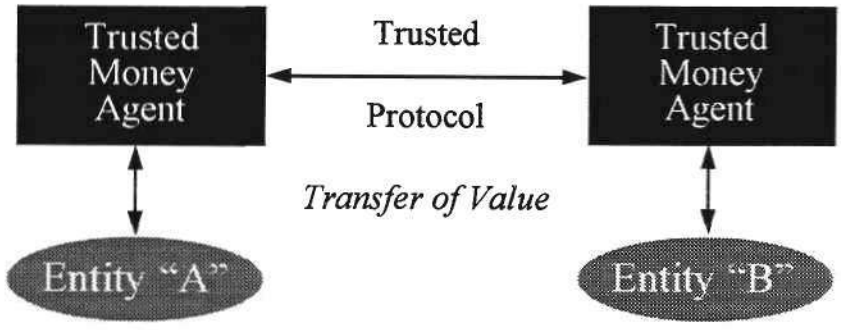
It is not

- > "tokens"
- > company money
- > ersatz money
- > barter money
- > etc.

Electronic Money: Repository or Purse

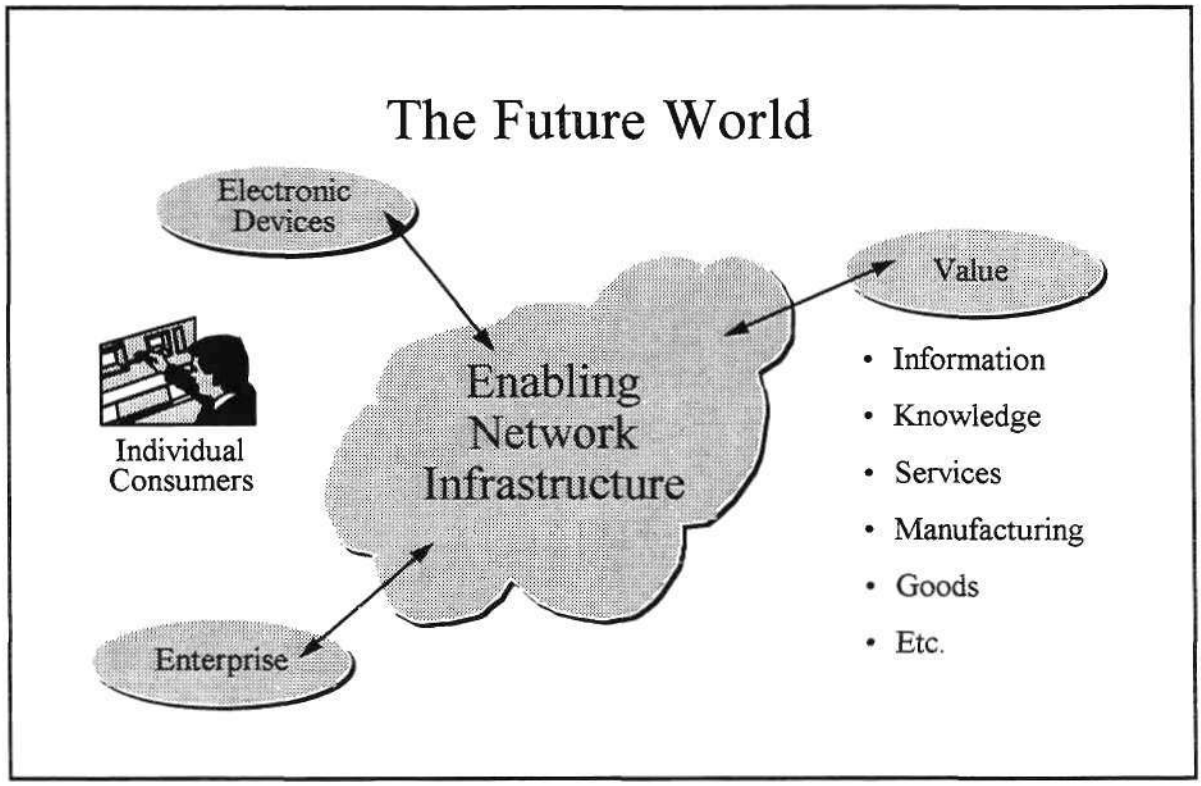
semiconductor device

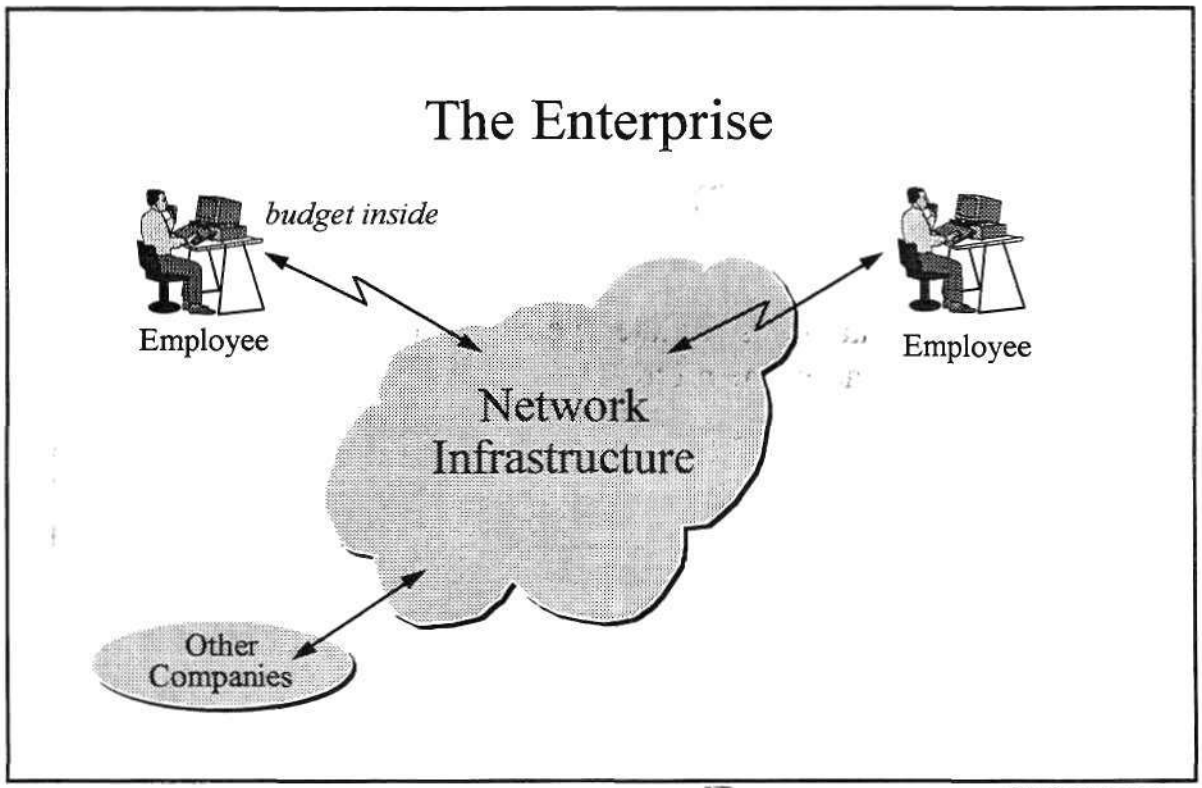
- Processing and memory
- Tamper-proof electronics
- Secure and trusted protocols
- Encryption



All electronic devices will have their own money chip

- Fundamental basis for interoperating with each other — part of the protocol
- Basis for a real information market infrastructure


The Future World
Electronic Devices
Value
Enabling Network Infrastructure
Individual Consumers
Information
Knowledge
Services
Manufacturing
Goods
Etc.
Enterprise


The Enterprise
budget inside
Employee
Employee
Network Infrastructure
Other Companies

Micro Transactions

- Electronic money part of the normal protocol — zero overhead
- Possible to transfer low-value items without vast accounting overhead — none required
- Same effort to transfer $\$10^{+12}$ or $\$10^{-12}$

Third Millenium

- Billions of electronic devices "talking" to each other, without human intervention, and transferring money as an integral part of the process
- Trillions of financial transactions
- Old financial/accounting systems totally obsolete
- Banking restructured
- Ultimate force for restructuring economy!

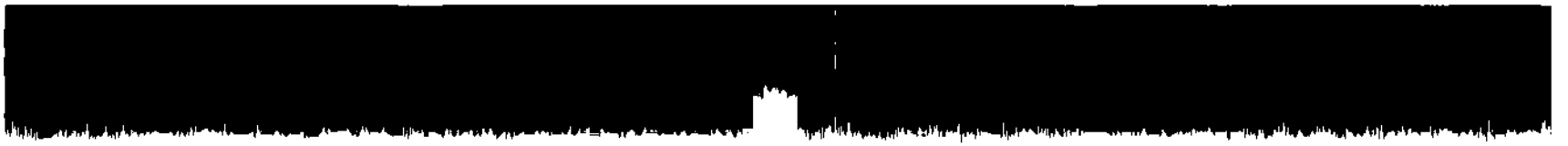
Don't Want to Carry Your Conference Binder Back to the Office?

You don't have to– use this Federal Express form to Semiconductor binder back to your office. Here's how:

1. The airbills are being sent "from you, to you."
2. If you are shipping internationally, please refer to the registration desk for an appropriate airbill.
3. Fill out Sections 1 and 2 completely – which require the following information:

    - Date
    - Section 1 is "From," Section 2 will be "To" (print your first and last name). Please print the complete address.
    - Phone number (office number)
    - Company Name
    - Address
    - City, State, Zip
    - Your internal billing reference information – if needed

4. Section 3 is payment method. Check the appropriate box. **YOU MUST INCLUDE YOUR FEDEX ACCOUNT NUMBER OR YOUR CREDIT CARD NUMBER.**
5. Section 4 is the service for delivery you are requesting. Check the appropriate box.
6. Sign your name in Section 7.
7. After the above steps are completed keep the last copy of the form (pink sender's copy).
8. Bring your binder and the completed Fedex form to the registration desk and a Dataquest representative will box and ship your binder.



FedEx® USA Airbill

Tracking Number 6913271584

Sender's Copy

1 From (please print)

Date _____ Sender's FedEx Account Number _____

Sender's Name _____ Phone ( ) _____

Company _____ Dept./Floor Suite/Room _____

Address _____

City _____ State _____ Zip _____

2 Your Internal Billing Reference Information

(Optional) (First 24 characters will appear on invoice) _____

3 To (please print)

Recipient's Name _____ Phone ( ) _____

Company _____ Dept./Floor Suite/Room _____

Address (To "HOLD" at FedEx location, print FedEx address here) _____ (We Cannot Deliver to P.O. Boxes or P.O. Zip Codes)

City _____ State _____ Zip _____

For "HOLD" Service check here

☐ Weekday ☐ Saturday (Not available at all locations)

For Saturday Delivery check here

☐ (Extra Charge. Not available to all locations)

Service Conditions, Declared Value, and Limit of Liability – By using this Airbill, you agree to the service conditions in our current Service Guide or U.S. Government Service Guide. Both are available on request. See back of Sender's Copy of this airbill for information and additional terms. We will not be responsible for any claim in excess of $100 per package whether the result of loss, damage, or delay, non-delivery, misdelivery, or misinformation, unless you declare a higher value, pay an additional charge, and document your actual loss in a timely manner. Your right to recover from us for any loss includes intrinsic value of the package, loss of sales, interest, profit, attorney's fees, costs, and other forms of damage, whether direct, incidental, consequential, or special, and is limited to the greater of $100 or the declared value but cannot exceed actual documented loss. The maximum declared value for any FedEx Letter and FedEx Pak is $500. Federal Express may, upon your request, and with some limitations, refund all transportation charges paid.

See the FedEx Service Guide for further details.

4 Service*

☐ FedEx Priority Overnight (Next business morning) ☐ FedEx Standard Overnight (Next business afternoon) ☐ FedEx 2Day (Second business day)

☐ FedEx Govt. Overnight (Authorized user only)

☐ FedEx Overnight Freight ☐ FedEx 2Day Freight

(For packages over 150 pounds. Call for delivery schedule.)

*Delivery commitment may be later in some areas.

5 Packaging

☐ FedEx Letter* ☐ FedEx Pak* ☐ FedEx Box ☐ FedEx Tube ☐ Other Packaging

*Declared value limit $500

6 Special Handling

Does this shipment contain dangerous goods? ☐ No ☐ Yes (As per attached Shipper's Declaration) ☐ Yes (Shipper's Declaration not required)

☐ Dry Ice Dry Ice, 9, UN 1845 III _____ x _____ kg. 904 (Dangerous Goods Shipper's Declaration not required)

CA ☐ Cargo Aircraft Only

7 Payment

Bill to: ☐ Sender (Account no. in section 1 will be billed) ☐ Recipient ☐ Third Party ☐ Credit Card ☐ Cash/Check

(Enter FedEx account no. or Credit Card no. below)

FedEx Account No. _____

Credit Card No. _____ Exp. Date _____

Total Packages	Total Weight	Total Declared Value*	Total Charges
		$ .00	$

*When declaring a value higher than $100 per package, you pay an additional charge. See **SERVICE CONDITIONS, DECLARED VALUE AND LIMIT OF LIABILITY** section for further information.

8 Release Signature

Your signature authorizes Federal Express to deliver this shipment without obtaining a signature and agrees to indemnify and hold harmless Federal Express from any resulting claims.

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Questions?
Call 1·800·Go·FedEx

The World On Time

Rev. Date 5/95 • PART #146163

GBFE 7/95

Terms And Conditions

Definitions On this airbill, we, our and us refer to Federal Express Corporation, its employees, and agents. You and your refer to the sender, its employees, and agents.

Agreement To Terms By giving us your package to deliver, you agree to all the terms in our current Service Guide, which is available on request. You also agree to those terms on behalf of any third party with an interest in the package. If there is a conflict between the Service Guide and this Airbill, the Service Guide will control. No one is authorized to change the terms of our Agreement.

Responsibility For Packaging And Completing Airbill You are responsible for adequately packaging your goods and properly filling out this airbill. If you omit the number of packages and/or weight per package, our billing will be based on our best estimate of the number of packages we receive, and/or an estimated "default" weight per package as determined by us.

Responsibility For Payment Even if you give us different payment instructions, you will always be primarily responsible for all delivery costs, as well as any cost we incur in either returning your package to you or warehousing it pending disposition.

Limitations On Our Liability And Liabilities Not Assumed

- Our liability for loss or damage to your package is limited to your actual damage or $100, unless you declare a higher value, pay an additional charge, and document your actual loss in a timely manner. You may pay an additional charge for each additional $100 of declared value. The declared value does not constitute, nor do we provide cargo liability insurance.
- In any event, we will not be liable for any damage, whether direct, incidental, special, or consequential in excess of the declared value of a shipment, whether or not Federal Express had knowledge that such damages might be incurred including but not limited to loss of income or profits.
- We won't be liable:
  - for your acts or omissions, including but not limited to: improper or insufficient packing, securing, marking, or addressing or those of the recipient or anyone else with an interest in the package.
  - if you or the recipient violate any of the terms of an Agreement.
  - for loss or damage to shipments of prohibited items.
  - for loss, damage, or delay caused by events we cannot control, including but not limited to acts of God, perils of the air, weather conditions, acts of public enemies, war, strikes, civil commotions, or acts of public authorities with actual or apparent authority.

Declared Value Limits

- The highest declared value allowed for FedEx Letter and FedEx Pak shipments is $500.
- For other shipments, the highest declared value allowed is $50,000 unless your package contains items of "extraordinary value," in which case the highest declared value allowed is $500.
- Items of "extraordinary value" include shipments containing such items as artwork, jewelry, furs, precious metals, negotiable instruments, and other items listed in our Service Guide.
- You may send more than one package on this airbill and fill in the total declared value for all packages, not to exceed the $100, $500 or $50,000 per package limit described above. (Example: 5 packages can have a total declared value of up to $250,000.) In that case, our liability is limited to the actual value of the package(s) lost or damaged, but may not exceed the maximum allowable declared value(s) or the total declared value, whichever is less. You are responsible for proving the actual loss or damage.

Filing A Claim YOU MUST MAKE ALL CLAIMS IN WRITING and notify us of your claim within strict time limits set out in the current Service Guide.

We'll consider your claim filed if you notify our Customer Service Department at 1•800•Go•FedEx and make your claim in writing as soon as possible.

Within 90 days after you notify us of your claim, you must send us all the information you have about it. We aren't obligated to act on any claim until you have paid all transportation charges, and you may not deduct the amount of your claim from those charges.

If the recipient accepts your package without noting any damage on the delivery record, we will assume the package was delivered in good condition. For us to process your claim, you must make the original shipping cartons and packing available for inspection.

Right To Inspect We may at our option open and inspect your packages before or after you give them to us to deliver.

Right Of Rejection We reserve the right to reject a shipment when such shipment would be likely to cause delay or damage to other shipments, equipment, or personnel or if its shipment is prohibited by law or if the shipment would violate any terms of our Agreement or our current Service Guide.

C.O.D. Services C.O.D. SERVICE IS NOT AVAILABLE WITH THIS AIRBILL. If C.O.D. Service is required, please use a Federal Express C.O.D. airbill.

Air Transportation Tax Included Our basic rate includes a federal tax required by Internal Revenue Code Section 4271 on the air transportation portion of this service.

Money-Back Guarantee In the event of untimely delivery, Federal Express will at your request and with some limitations, refund or credit all transportation charges. See current Service Guide for more information.

Part #146162/146163
Rev. 5/95

FedEx® USA Airbill

6913271584

FedEx Billing Copy

1 From

Date _____ Sender's FedEx Account Number _____

Sender's Name _____ Phone ( ) _____

Company _____ Dept./Floor Suite/Room _____

Address _____

City _____ State _____ Zip _____

2 Your Internal Billing Reference Information

_____

3 To

Recipient's Name _____ Phone ( ) _____

Company _____ Dept./Floor Suite/Room _____

Address (To "HOLD" at FedEx location, print FedEx address here) _____

City _____ State _____ Zip _____

For "HOLD" Service check here

1 ☐ Weekday 3 ☐ Saturday (Not available at all locations)

For Saturday Delivery check here

3 ☐ (Extra Charge. Not available to all locations)

6 9 1 3 2 7 1 5 8 4

4 Service*

1 ☐ FedEx Priority Overnight (Next business morning)
5 ☐ FedEx Standard Overnight (Next business afternoon)
3 ☐ FedEx 2Day (Second business day)
4 ☐ FedEx Govt. Overnight (Authorized user only)
7 ☐ FedEx Overnight Freight (For packages over 150 pounds. Call for delivery schedule.)
8 ☐ FedEx 2Day Freight

*Delivery commitment may be later in some areas.

5 Packaging

6 ☐ FedEx Letter*
2 ☐ FedEx Pak*
3 ☐ FedEx Box
4 ☐ FedEx Tube
1 ☐ Other Packaging

*Declared value limit $500.

6 Special Handling

Does this shipment contain dangerous goods?
☐ No
4 ☐ Yes (As per attached Shipper's Declaration)
☐ Yes (Shipper's Declaration not required)

6 ☐ Dry Ice Dry Ice, 9, UN 1845 III, _____ x _____ kg 904 (Dangerous Goods Shipper's Declaration not required)

CA ☐ Cargo Aircraft Only

7 Payment

☐ Obtain Recipient FedEx Account No.

Bill to: 1 ☐ Sender (Account no. in section 1 will be billed)
2 ☐ Recipient
3 ☐ Third Party
4 ☐ Credit Card
5 ☐ Cash/Check
(Enter FedEx account no. or Credit Card no. below)

FedEx Account No. _____

Credit Card No. _____ Exp. Date _____

Total Packages	Total Weight	Total Declared Value*	Total Charges
		$ .00	$

*When declaring a value higher than $100 per package, you pay an additional charge. See **SERVICE CONDITIONS, DECLARED VALUE AND LIMIT OF LIABILITY** section for further information.

Credit Card Auth. _____

8 Release Signature

_____

Your signature authorizes Federal Express to deliver this shipment without obtaining a signature and agrees to indemnify and hold harmless Federal Express from any resulting claims.

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FedEx USA Airbill 6913271584

FedEx Retrieval Copy

1 From

Date ______ Sender's FedEx Account ______

Sender's Name ______ Phone ( ) ______

Company ______ Dept./Floor/Suite/Room ______

Address ______

City ______ Zip ______

2 Your Internal Billing Reference Information ______

3 To

Recipient's Name ______ Phone ( ) ______

Company ______ Dept./Floor/Suite/Room ______

Address ______

City ______ Zip ______

For "HOLD" Service check here

For Saturday Delivery check here

4 Service

1 FedEx Priority Overnight 5 FedEx Standard Overnight 3 FedEx 2Day

4 FedEx Govt. Overnight

7 FedEx Overnight Freight 8 FedEx 2Day Freight

5 Packaging

6 FedEx Letter 2 FedEx Pak 3 FedEx Box 4 FedEx Tube 1 Other Packaging

6 Special Handling

Does this shipment contain dangerous goods? No Yes Yes

Dry Ice CA Cargo Aircraft Only

7 Payment

Obtain Recipient FedEx Account No.

Bill to: 1 Sender 2 Recipient 3 Third Party 4 Credit Card 5 Cash/Check

FedEx Account No. ______

Credit Card No. ______ Exp. Date ______

Total Packages	Total Weight	Total Declared Value	Total Charges
		$ .00	$

Credit Card Auth.

8 Release Signature

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6 9 1 3 2 7 1 5 8 4

FedEx® USA Airbill

Tracking Number 6913271584

Recipient's Copy

1 From

Date _____

Sender's Name _____ Phone ( )

Company _____ Dept./Floor Suite/Room _____

Address _____

City _____ State _____ Zip _____

2 Your Internal Billing Reference Information _____

3 To

Recipient's Name _____ Phone ( )

Company _____ Dept./Floor Suite/Room _____

Address (To "HOLD" at FedEx location, print FedEx address here) _____

City _____ State _____ Zip _____

For "HOLD" Service check here

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For Saturday Delivery check here

☐ (Extra Charge. Not available to all locations)

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(For packages over 150 pounds. Call for delivery schedule.)

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*Declared value limit $500

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(Enter FedEx account no. or Credit Card no. below)

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- We won't be liable:
  - for your acts or omissions including but not limited to improper or insufficient packing, securing, marking, or addressing or those of the recipient or anyone else with an interest in the package.
  - if you or the recipient violate any of the terms of an Agreement.
  - for loss or damage to shipments of prohibited items.
  - for loss, damage, or delay caused by events we cannot control, including but not limited to acts of God, perils of the air, weather conditions, acts of public enemies, war strikes, civil commotions, or acts of public authorities with actual or apparent authority.

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Air Transportation Tax Included Our basic rate includes a federal tax required by Internal Revenue Code Section 4271 on the air transportation portion of this service.

Money-Back Guarantee In the event of untimely delivery, Federal Express will at your request and with some limitations, refund or credit all transportation charges. See current Service Guide for more information.

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Rev. 5/95

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Dataquest®

Issue 2, September 1995

251 River Oaks Parkway, San Jose, California 95134-1913

DIRECT PRODUCTS NEWS

A Complimentary Publication Alerting You to New Products Available for Purchase from Dataquest.

Reports Featured Inside This Issue

Semiconductor Research Reports

New Video Game Hardware: Technology Playing at the Next Level

A Focus Report

Dataquest predicts that worldwide shipments of the new video game controllers will climb to almost 18 million by the year 2000. With the semiconductor content in this new generation of controllers leaping to over 66 percent of manufacturing cost, the semiconductor market driven by video game controllers will reach $2.3 billion by the year 2000. This report provides an overview of the video game market, including exhaustive analyses of the Sega Saturn and the Sony Playstation. A complete bill of materials with forecast component and manufacturing costs is provided for these two systems, as well as detailed information on products from other major players such as Nintendo, 3DO, and Atari. The report presents in-depth discussions of critical technologies such as compression, advanced DRAM architectures, 3-D graphics, CD-ROM drives, sound, modems, and virtual reality. A detailed forecast of the market opportunity by major semiconductor categories is also presented. At the end of the report, it highlights the products and design wins of a number of key semiconductor suppliers and provides insight into the challenges faced by semiconductor suppliers and strategies that may be employed to leverage investments and reduce risks.

Price: $5,495
Product Code: SAMM-WW-FR-95AA
Publication Date: August 7, 1995

DRAM Supply and Demand Quarterly Statistics

Quarterly Statistics Report Series

These statistics reports provide the most comprehensive quarterly forecast of 4Mb and 16Mb DRAM supply and demand available on the market. A core set of 12 tables provides worldwide production quarterly estimates for 20 DRAM suppliers for each configuration of 4Mb and 16Mb DRAM (x1, x4, x8, x16 configurations). Each of these tables includes an estimate of total worldwide demand by configuration. The entire set of tables aggregate into complete forecasts of 4Mb DRAM and 16Mb DRAM supply and demand. This report also includes worldwide DRAM fab information.

Price: $5,000/quarter
$15,000/year
Product Code: DSDP-WW-MS-0000
Publication Date: Feb/May/Aug/Nov

Trends in the MOS Memory Market

A Market Trends Report

This report reviews trends in all MOS memory types over the years for which Dataquest has been collecting data. It examines the DRAM market in detail, providing rationale for today's events and comparing them to past cycles, with a look at what the future holds. Then it focuses on speed information of SRAMs over the past four years to illustrate new trends that have not previously been tracked in this level of detail. Finally it examines each type of nonvolatile memory.

Price: $2,495
Product Code: MMRY-WW-MT-9501
Publication Date: July 31, 1995

PC Teardown Analysis Reports

Teardown Analysis Report Series

This report series is designed to provide PC manufacturers, OEMs, and their suppliers the vital information needed to make design and cost decisions on next-generation systems. Each month, Dataquest Engineers and Industry Analysts tear apart several state-of-the-art personal computer products. We analyze the mechanical assemblies and physical layout of all components, list the source of all parts, draw motherboard diagrams, and generate a complete bill of materials. Finally we produce a comprehensive report of our findings, which includes Dataquest's opinion on the strengths and weaknesses of the product and manufacturability. A floppy disk is also provided containing the complete bill of materials in spreadsheet format. Customer Teardowns are available by request, including other products such as cellular phones, set-top boxes, disk drives and network equipment. For further information or to obtain a list of the current reports available, please call Dataquest at 800-419-3282.

Price: $2,000/any single report
$5,000/any three reports
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Product Code: SAMM-WW-CR-0000

Dataquest®

Midyear 1995 Forecast: Capital Spending, Wafer Fab Equipment, and Silicon

A Market Trends Report

Dataquest provides historical market sizing, forecasts of market segments through year 2000, product technology trends, and overall analysis of the competitive landscape for the semiconductor equipment, manufacturing, and materials industry. Forecasts for semiconductor production and capital spending on a regional basis are provided, with a discussion of investment trends in semiconductor manufacturing.

Price: $2,495
Product Code: SEMM-WW-MT-9501
Publication Date: July 31, 1995

The DQ MONDAY Report

Electronic Newsletter—Weekly News and Commentary on Semiconductor Industry Events

SUBSCRIBE TODAY and receive weekly news and commentary on semiconductor industry events and issues, with a monthly snapshot of regional semiconductor pricing for 25 key semiconductors from six regions: United States, Japan, Europe, Taiwan, Korea, and Singapore. This popular electronic newsletter is available via CompuServe and the Internet.

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- ☐ **Cell-Based ICs to Dominate Gate Arrays in 1998** ($795)
- ☐ **Cell-Based ICs Soar in 1994** ($895)
- ☐ **Vertical Markets: Designing for International Success** ($2,995)
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Market/Technology Reports

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- ☐ **PC Core Logic: A Focused Analysis** ($1,995)
- ☐ **1994 PC Core Logic Market Share** ($395)
- ☐ **Competitive Trends in the Microcontroller Marketplace** ($2,495)
- ☐ **Advanced Microprocessor Update** ($1,500)
- ☐ **x86 Market: Detailed Forecast, Assumptions, Trends** ($2,595)
- ☐ **The PC Processor: What's Hot, What's Not** ($595)

Memories

Market/Technology Reports

- ☐ **1994 SRAM Regional Market in Review** ($995)
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Toward the 100 Million Unit PC Market

A Market Trends Report

This report examines the state of the PC industry ranging from traditional desktop and deskside PCs to ultraportable (subnotebook) PCs. Dataquest analyzes both the industry's 1994 results and a 1995-to-1999 forecast by region, product type, microprocessor type, and home and professional markets. The report focuses on the top 10 industry participants in the U.S. and the top 15 worldwide in 1994, supplemented by a review of the top 10 PC vendors worldwide ranked by unit shipments. Finally, the report analyzes Dataquest's view of major decisions facing PC vendors that they must consider to be competitive in the marketplace.

Price: $2,995
Product Code: PCIS-WW-MT-9501
Publication Date: June 26, 1995

The Delicate Future of Optical Disk Drives

A Market Trends Report

This report provides a quantitative and qualitative analysis of the current state of the CD-ROM, optical rewritable, and WORM disk drive industries worldwide. More important, Dataquest discusses the market trends and the key issues surrounding the growth of the optical disk drive market. This Market Trends document is designed to answer the questions concerning this market and provide Dataquest's opinions and views on the future direction and outlook of the optical disk drive market.

Price: $2,495
Product Code: OPTI-WW-MT-9501
Publication Date: June 26, 1995

Removable Storage on the Upswing

A Market Trends Report

Removable storage as a unique implementation of mass storage has dramatically surged in popularity over the past year. From the explosion in CD-ROM to the surprise from the low-end magnetic cartridge disk drive (MCDD), this category of storage is now figuring strongly into the overall storage equation. In fact, Dataquest predicts that by the turn-of-the-century some new removable, rewritable technology will have begun to replace the floppy disk drive (FDD) as the standard for data mobility on the PC. Considering that over 75 million FDDs shipped in 1994, the potential market for this emerging technology is vast. Exciting magnetic and optical rewritable technologies offer compelling arguments as to why they both should become the next removable standard. However, in the end only one will prevail. In Dataquest's 1995 Market Trends report these issues are addressed, including analysis and forecasts, providing a clearer picture for the future of this promising class of technology.

Price: $2,495
Product Code: RMDD-WW-MT-9501
Publication Date: September, 1995

Mobile Computing Drives Forward

A Market Trends Report

This new study summarizes industry activities in the past year and focuses on what Dataquest believes are the key trends shaping the mobile industry in the near and long term. It contains five-year unit and revenue forecasts for the mobile computer market worldwide, including four major regions: North America, Europe, Japan, and Asia/Pacific. The technology platforms covered in the study include PC, transportable, laptop, notebook, tablet-pencentric, ultraportable, notepad-pencentric, handheld, and expandable organizers.

Price: $2,495
Product Code: MBLC-WW-MT-9501
Publication Date: September 28, 1995

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Client/Server Virtual Views provides summaries and analyses of top announcements in client/server

computing. Topics cover client/server hardware, software, and operating environments. News briefs summarize the event and then provide a sharp recap of Dataquest analysis.

Channel Trax analyzes computer distribution channels news and events. Stories focus on developments in the distribution of mobile and desktop PCs, advanced desktop systems, workstations, and client/server and midrange computers. These popular electronic newsletters are available via CompuServe and the Internet.

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Copiers Benefit from Technology

A Market Trends Report

This report provides market size, market share, and market growth information for the copier market. The key players in this market include Canon, Xerox, and Sharp. Learn how multifunctionality and the increasingly networked environment will impact the growth of copiers. Will the battle for hard copy begin and end at the copier? Throughout the text, we refer to product segments for plain paper copiers, defined principally by the speed of the copier.

Price: $2,495
Product Code: COPY-NA-MT-9501
Publication Date: July 24, 1995

Printer Market Continues to Grow

A Market Trends Report

This report focuses on desktop and mobile, network and system, and color printing issues in North America. The report contains a five-year forecast and 1993 and 1994 market share information for ink jet, page/laser, dot matrix, line impact, and thermal transfer printers.

Price: $3,495
Product Code: PRNT-NA-MT-9501
Publication Date: June 12, 1995

Fax 1995: The Gap between Direct Thermal and Plain Paper Shrinks

A Market Trends Report

This report is a comprehensive guide to historical, current, and future trends in the fax industry. In addition to shipment data and five-year forecasts, the report examines the critical issues of fax distribution (as of this year by print technology), the role of multifunctional products, and the PC and network fax markets.

Price: $2,495
Product Code: DFAX-NA-MT-9501
Publication Date: June 12, 1995

The Evolution of Multifunctional Devices

A Focus Report

This new Focus Report by Dataquest examines the progress being made by a variety of manufacturers in different marketplaces with regard to multifunctional products. Dataquest segments the market into low-end, midrange, and high-end products and examines the types of functions, the price points, and other issues such as distribution that will have a bearing on the potential success of these products.

Price: $2,995
Product Code: DMGT-NA-FR-9501
Publication Date: April 10, 1995

What Do Users Want in Their Direct Attach Printer?

A User Perspective Report

This report details the findings of a recent survey of 203 users of personal desktop printers. The survey sample comprised three sets of respondents: desktop printer users in small businesses (20 employees or less), medium-size/large businesses (200 or more employees), and residential/home users. The survey defined a desktop printer as one that was used by up to three people. Dataquest targeted these three sectors to see if there are differences in installed base characteristics, applications, and usage patterns.

Price: $1,995
Product Code: DMPR-NA-UW-9401
Publication Date: October 24, 1994

Document Management NewsTakes

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Price: $595/year — Multiuser Licenses Available
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A Focus Report

This report, built from a database of more than 1,100 companies, is Dataquest's first attempt to size the entire worldwide software market. The software market, at over $80 billion in 1994, accounts for more than half of the total systems market. Dataquest estimates that worldwide packaged software revenue reached about $72.3 million in 1993 and will grow at 11.8 percent annually for five years to reach $126.2 million in 1998. In this report, we examine worldwide software revenue growth from numerous perspectives, including a forecast by software category, region, and operating system.

Price: $1,995
Product Code: MULT-WW-UW-9501
Publication Date: May 29, 1995

Business Use of Multimedia

A User Perspective Report

This report presents the results of a survey of 200 small to large companies that have already invested in multimedia technology in their businesses. By surveying companies that have made the initial investments in multimedia, we hoped to get an indication of where other companies will tend to go in the future. While this survey does not represent a sampling of all large businesses and their attitudes and propensity to purchase multimedia in the future, the picture it gives us of the early adopter portion of the market is helpful in understanding where the rest of the market will be going.

Price: $1,995
Product Code: MULT-WW-UW-9501
Publication Date: May 29, 1995

Under the Online Big Top: Magic and Reality

A Market Trends Report

This report brings together Dataquest's expertise in everything from semiconductors to telecommunications

to create a unified outlook for the future of consumer online services. Included are results of numerous end-user and vendor surveys and rigorous analyst discussions. Analysis of applications, technology, regional trends, and online market influences are all contained in this report.

Price: $2,495
Product Code: OLST-WW-MT-9501
Publication Date: July 17, 1995

Internet Users: Who They Are, What They Want

A User Perspective Report

In recent years, few things have captured the public's imagination as furiously as the Internet. While Internet users are counted in a number of ways, rarely are they queried or analyzed. This study examines those users, particularly focusing on their attitudes toward both electronic commerce and security on the Internet.

Price: $1,495
Product Code: OLST-WW-UW-9501
Publication Date: May 22, 1995

1994—Another Suite Year

A Market Trends Report

This report summarizes the results of our 1994 PC software industry data and analyzes current and future trends for the PC software industry. We focus on each of the 15 markets within PC software and compare the strategies of the top 10 PC software vendors. Developments in each of the major operating systems and worldwide regions are also discussed.

Price: $2,495
Product Code: PCSW-WW-MT-9501
Publication Date: July 17, 1995

PC Software: Consumer Buying Habits

A User Perspective Report

The survey that forms the basis of this report was conducted in an effort to present software vendors with information on what today's consumer software buyers own (in regard to software and some related hardware) and what they plan to buy in the future. Understanding the needs of the typical consumer enables software vendors to more strategically target the consumer market. The study addresses topics such as what software is installed in a typical home PC, how consumers buy their software, what factors are important to consumers when selecting a title, and what consumers plan to do when Windows 95 ships. We asked our respondents questions on the type of software they anticipated buying in the next 12 months, and for which operating system—Macintosh or Windows—and we asked how soon they planned to migrate to Windows 95 after it ships. We have the answers to these questions and more.

Price: $1,995
Product Code: PCSW-WW-UW-9501
Publication Date: June 19, 1995

Digital Documents Enter the Mainstream

A Market Trends Report

"Digital Documents Enter the Mainstream" is the first jointly produced report from Dataquest's recently merged Digital Documents and Workgroup Computing research programs. This report provides North American and worldwide market statistics and forecasts for electronic document management (EDM) software, systems, and services. Revenue by product category is provided for imaging systems, EDM consulting and systems integration services, and software. Dataquest classifies EDM software products into creation, management, and delivery tools categories and presents the relative sizes of the document creation, EDM, and electronic document delivery software markets. Information on products spanning the OCR, text retrieval, workflow, Lotus Notes, electronic forms, PC and LAN fax, platform-independent document exchange, and text and image management software categories is included.

Price: $2,495
Product Code: WKGP-WW-MT-9501
Publication Date: July 31, 1995

Lookers and Leapers in the Digital Document Era 1995

A User Perspective Report

Digital Documents is a rapidly changing market. To help clients understand what users expect from their digital document management solutions, Dataquest conducted a survey reflecting patterns of electronic document management (EDM) adoption and use in

corporations and details what users expect from digital document management solutions.

Price: $2,495
Product Code: DDOC-NA-UW-9501
Publication Date: June 12, 1995

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This report is based on an analysis of the total worldwide market for cellular telephony, covering each and every country. It includes data on cellular penetration levels, subscriber numbers, telephone shipments, equipment, and service revenue. The data is presented over a 10-year period, from 1990 to 1999, inclusive.

Price: $4,995
Product Code: PERS-WO-FR-9501
Publication Date: May 31, 1995

Spending on Cellular Communications Will Grow in the United States

A User Perspective Report

This report represents the analysis of an in-depth telephone survey into the status of mobile communications among corporate users across the United States. The aim is to construct a picture of the current use and the perception of cellular telephony among businesses in the United States and to investigate the future expectations, requirements, and preferences for mobile voice and data services and products among those that oversee business mobile communications.

Price: $1,995
Product Code: PERS-NA-UW-9501
Publication Date: July 24, 1995

IrDA: On Your Mark, Get Set, Point and Shoot

A Dataquest Predicts Report

The very low cost of adding a wireless infrared transceiver into mobile and desktop computers and peripherals will make the decision to include the IrDA standard interface a "nondecision." Initially becoming pervasive in laptops and handheld computers, over 75 million IrDA interfaces will be shipped before 1999. Semiconductor manufacturers are designing IrDA into silicon, and software companies are incorporating IrDA API into their code. Wirelessness in the PC world will become as common as remote controls in consumer electronics.

Price: $795
Product Code: LANN-NA-PD-9502
Publication Date: July 10, 1995

Scalability: A Key Ingredient for CTI Market Success

A Dataquest Competitive Analysis Report

In this document, we raise the issue of pricing and its role in pushing end users toward first- or third-party call control using TAPI and/or TSAPI offerings. Key points of focus are CTI platform entry costs and the importance of scalability.

Price: $495
Product Code: VOIC-NA-CA-9501
Publication Date: June 26, 1995

Continued Consolidation in the Modem Industry

A Dataquest Predicts Report

In this newsletter Dataquest discusses consolidation in the modem market over the last two years, examines the factors that contributed to this phenomenon, and makes some predictions regarding consolidation.

Price: $495
Product Code: WANA-NA-PD-9503
Publication Date: July 31, 1995

Telcos and Manufacturing

A Dataquest Predicts Report

Pending telecommunications legislation should free the regional Bell operating companies (RBOCs) from restrictions on manufacturing imposed by the 1982 AT&T antitrust settlement known as the Modified Final Judgement. This document explores likely RBOC responses.

Price: $695
Product Code: PNEQ-NA-PD-9502
Publication Date: July 31, 1995

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Services and Support Research Reports

Education and Training: Market Analysis and Outlook

A Focus Report

"Timely curriculum and revision updates are the price of admission to the competitive education and training arena." This report is based on vendor and user research, which confirms that this professional service segment of the information technology (IT) industry continues to offer providers tremendous growth and profit potential. The purpose of this report is to bring to the forefront a variety of perspectives on education and training, an industry that Dataquest considers young, fragmented, and having many players. Information contained in this report is based on surveys and telephone interviews with PC and technical workstation users, users of software services, corporate and reseller certification candidates and managers, and education and training vendors. The contents of the report include the market trends and forecast, the competitive landscape, user needs, technical certification market, and market outlook and opportunities.

Price: $2,500
Product Code: PFST-NA-FR-95AA
Publication Date: July 24, 1995

The Independent/Multivendor Services Marketplace: Strategies for Success

A Focus Report

The independent/multivendor services market is currently a hot spot in the information technology (IT) services marketplace. This report assesses the independent/multivendor services market from several angles:

- It examines the current market size and forecast of the independent/multivendor services market.
- It assesses the major trends and issues that are having an impact on the independent/multivendor industry now and that will have an impact on the industry in the future.
- It provides a competitive assessment of the independent/multivendor services market.

- It includes a competitive capabilities matrix of 16 service providers. Revenue and anticipated growth information are also provided.
- It reviews and presents the major findings from a survey conducted in April 1995 of more than 200 end users.
- It provides action items for service providers to use the presented information proactively.

Price: $2,500
Product Code: CUST-NA-FR-9501
Publication Date: July 31, 1995

System Integration: Market Innovators

Company Profiles

The competition in the systems integration and application development market continues to grow both in number of competitors and scope of services offered. This report profiles 10 competitors and provides some comparisons in strategy, approach to market, and unique capabilities. The companies profiled are:

- BSG Alliance/IT
- Cambridge Technology Partners (CTP)
- Computer Science Corporation (CSC)
- EDS
- Ernst & Young
- Integrated Systems Solutions Corporation
- SHL Systemhouse Inc.
- SPL WorldGroup
- Technology Solutions Company (TSC)
- TRECOM Business Systems, Inc.

Price: $2,500
Product Code: PFSI-NA-CP-9501
Publication Date: September, 1995

Network Integration and Support Services: Who's Spending What, Where, and Why?

A User Perspective Report

As customer demands for greater networking capabilities rise, the cost of implementing and managing this technology escalates. Customers recently surveyed by Dataquest's Worldwide Services Group estimate that they currently spend over 16 percent of their total IT professional services money on data communications issues. These services, ranging from consulting and advisory services to operations and management services, have become the focal point of customer demand when it comes to network support services.

Price: $995
Product Code: NWCM-NA-UW-9502
Publication Date: September, 1995

Help Desk Software: Players, Strategies, and Target Markets

A Competitive Trends Report

This critical new study examines the burgeoning help desk software market. Twenty of the leading help desk software companies are profiled, comparing their product positioning, competitive strengths, and strategic direction. The report specifically examines what help desk publishers consider the primary feature, management, and reporting strengths of their products, as well as who these companies target.

Price: $995
Product Code: SWSV-NA-CT-9501
Publication Date: June 19, 1995

Desktop Support Services

Market/Technology Reports

- ☐ Desktop Support Services Market Trends ($2,495)

Network/Communications Support

Market/Technology Reports

- ☐ Network Integration and Support Services User Wants and Needs ($3,000)
- ☐ Tracking the Pulse of the Network Integration and Support Services Market ($895)
- ☐ Network Communications Support Trends and Data Book ($1,995)

Professional Services

Market/Technology Reports

- ☐ Professional Services Systems Management Market Trends: The Next Wave in Outsourcing ($2,500)
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- ☐ Discrete Manufacturing: Integrated Product Development ($2,000)
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- ☐ Professional ServiceTrends: Vertical Market Opportunities User Wants and Needs ($1,500)

Software Services

Market/Technology Reports

- ☐ Outsourcing Software Support 1995: Players, Options, and Benchmarks ($2,000)
- ☐ Software Consulting: Overviews and Tactics of Key Market Players ($2,500)
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Company Profiles

- ☐ IBM—Desktop Support Services ($495)
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- ☐ Unisys Corporation ($395)
- ☐ Bell Atlantic Network Integration ($395)
- ☐ Powersoft Corp. ($395)
- ☐ Dataware Technologies Inc. ($395)
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- ☐ Novell Inc. ($395)
- ☐ BSC, the Service Division of BancTec, Inc. ($395)

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International Information Technology Reports

Information Technology Report Series: Latin America

Focus Report Series

Dataquest just released a report series profiling the PC, Networking Hardware, and Printers markets in Latin America, including Argentina, Brazil, Mexico, and Chile. A total of 12 reports are published in this series. Each country series contains three technology reports—PC, networking hardware, and printers. The primary in-country research was conducted between May and August 1995.

These focus reports examine the background of each country. IT expenditures for hardware, software, and services are presented and vertical markets are sized. Dataquest looks at companies by their sizes and market shares. On a country-by-country basis, Dataquest looks at product markets. For each product market, we present units and revenue for 1994 and project units and revenue for 1995. In addition, the studies provide both a quantitative and qualitative examination of distribution channels. Finally the studies conclude with specific recommendations for action, allowing your company to most efficiently implement the insight provided in these studies. Dataquest has committed to providing continuous information on Latin America. In 1996, Dataquest will update the reports offered in this series and will likely add some new studies.

Price: $1,200/each
$3,300/country series
$4,400/technology series
$12,500/full Latin America Series

Asia/Pacific Regional Information Technology (IT) Reports

Semiannual Market Trends Reports

Each semiannual report contains five-year forecasts of hardware, software, and services markets in the given country by business sector and by product. The reports also provide competitive information on key vendors, including their target business sectors and strengths and weaknesses in the country. To put national IT trends into context, reports include regional IT market and economic information. Countries covered are:

Australia	China
Hong Kong	Indonesia
Korea	Malaysia
New Zealand	Singapore
Taiwan	Thailand

Price: $2,000/each
Product Codes: Australia Report—RITS-AS-MT-95H2
China Report—RITS-CH-MT-95H1
Hong Kong Report—RITS-HK-MT-95H1
Indonesia Report—RITS-IN-MT-95H1
Korea Report—RITS-KO-MT-95H1
Malaysia Report—RITS-MA-MT-95H1
New Zealand Report—RITS-NZ-MT-95H2
Singapore Report—RITS-SI-MT-95H1
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Thailand Report—RITS-TH-MT-95H1

Now Available...

Japan

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- ☐ **Japan Semiconductor Industry: Market and Vendors in Transition** ($2,495)
- ☐ **Japanese Semiconductor Market Trends** ($2,495)
- ☐ **Japanese LCD Application Market** ($2,995)

Asia/Pacific

Market/Technology Reports

- ☐ PC Tracking Report ($2,500/country)
- ☐ Printer Tracking Report ($2,000/country)
- ☐ Personal Computers Asia/Pacific ($2,495)
- ☐ CAD/CAM Asia Market Trends ($2,495)
- ☐ Taiwanese Electronic Equipment Production Outlook ($495)
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- ☐ Notebook PCs and PC Peripherals Dominate Taiwan's Market ($495)
- ☐ Singapore: Cautious Fab Expansion Under Way ($495)
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- ☐ Singaporean/Malaysian Semiconductor Market ($2,495)
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- ☐ Asia/Pacific Memory and Microcomponent Explosion ($2,495)

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- ☐ European Tape Drive Market ($2,995)
- ☐ European Small Rigid Disk Drive Market ($2,995)
- ☐ Network Printing—User Wants and Needs ($3,495)
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Latin America

Market/Technology Reports

- ☐ Information Technology Snapshot: Latin America Series ($1,795/set)

Company Profiles

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Title:
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Address:
City:
State/Zip:
Telephone:
Fax:
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Send Invoice To:

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- ☐ Distributor
- ☐ Networking

Please indicate the number of employees in your company:

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What is your annual U.S. revenue?

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- ☐ Developing Markets
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- ☐ Latin America

Type of Information

- ☐ Market Trends Analysis and Forecast
- ☐ Market Statistics
- ☐ User Wants and Needs Information
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- ☐ Productivity Software
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Semiconductors '95

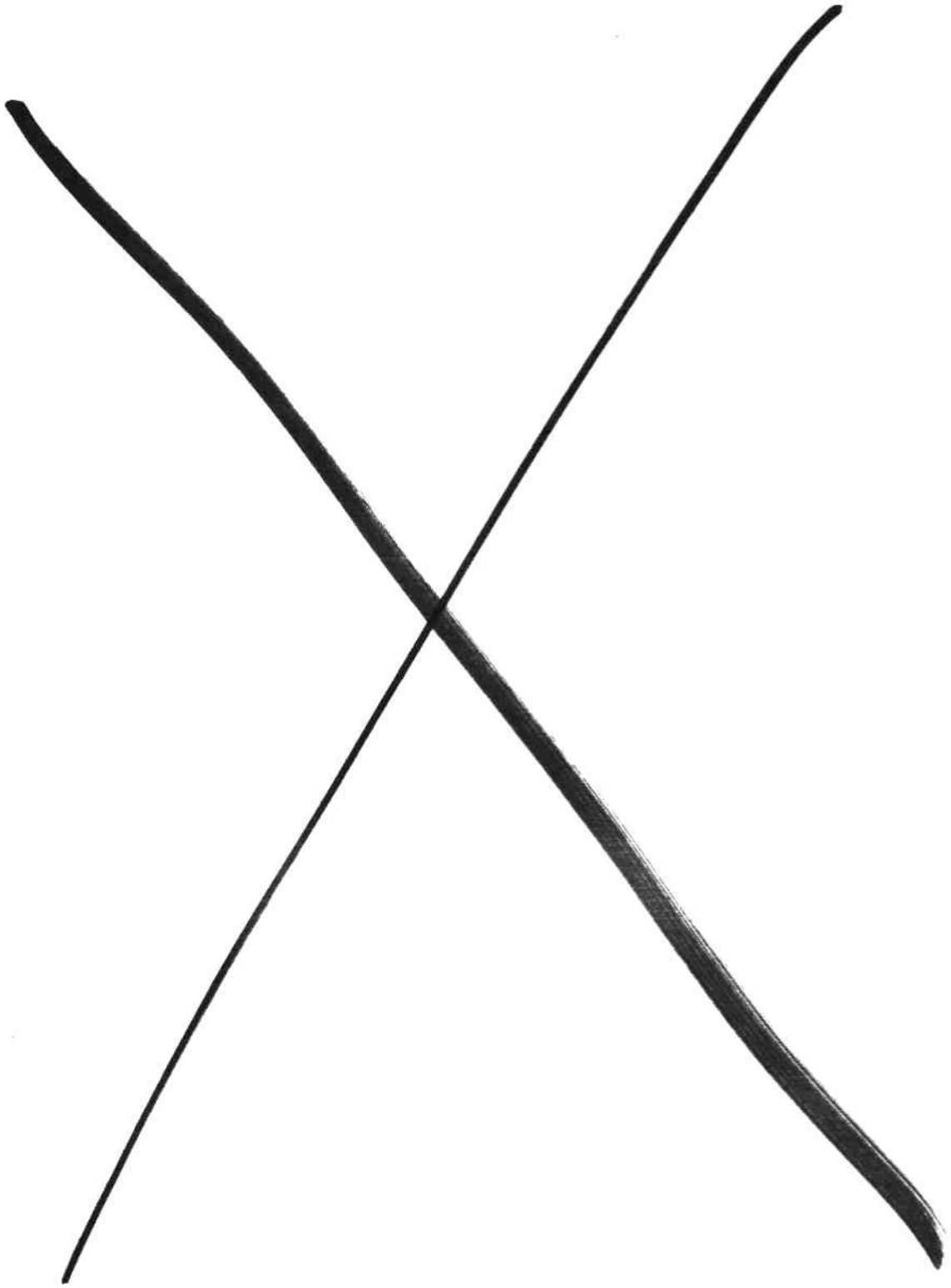
The Building Blocks of a New World Order

21st Annual Semiconductor Conference

October 12-14, 1995
Marriott Desert Springs Resort and Spa
Palm Desert, California

Dataquest

Published by Dataquest Incorporated



Agenda

21st Annual Semiconductor Conference

October 12-14, 1995
Marriott Desert Springs Resort and Spa
Palm Desert, California

Wednesday, October 11
5:00 pm - 7:00 pm
Early registration _____ **Desert Ballroom Foyer**

Thursday, October 12 — **Desert Ballroom**

7:00 am - 8:15 am Registration

8:15 am **Welcome Address**
Judith H. Hamilton, President and Chief Executive Officer, Dataquest Incorporated

8:30 am **The State of the Economy**
Joseph W. Duncan, Vice President, Corporate Economist and Chief Statistician, The Dun & Bradstreet Corporation

9:15 am **From Wireless to the Web: System Design as We Approach the Millennium**
Enrico Pesatori, Vice President and General Manager, Computer Systems Division, Digital Equipment Corporation

10:00 am **Networking Break** _____ **Desert Ballroom Foyer**

10:30 am - 11:00 am
Semiconductor Outlook: Will It Get Any Better?
Gene Norrett, Corporate Vice President and Director, Semiconductors Group, Dataquest Incorporated

11:00 am - 12:15 pm
Semiconductors: The Building Blocks of a New World Order

Moderator
Gene Norrett, *Vice President and Director, Worldwide Semiconductors, Dataquest Incorporated*

Panelists
Eric T. Miller, *Senior Vice President, Donaldson, Lufkin and Jenrette*

Harjit Bhalla, Ph.D., *Vice President and Director, Planning and Market Research, World Marketing, Motorola Semiconductor Products Sector, Motorola Inc.*

Joseph W. Duncan, *Vice President, Corporate Economist and Chief Statistician, The Dun & Bradstreet Corporation*

Chintay Shih, Ph.D., *President, Industrial Technology, Research Institute Taiwan*

Martin Reynolds, *Director/Principal Analyst, PC Technology Directions Program, Computer Systems and Peripherals Worldwide, Dataquest Incorporated*

Agenda

12:15 pm - 2 pm — **Springs Ballroom**

Luncheon and Featured Presentation
Technology Stocks: Picking the Right Investments
Ronald E. Elijah, Portfolio Manager, Value Plus Growth Fund, Robertson, Stephens & Company

Track I — Trends and Forecasts — **Desert Ballroom 7**

2:00 pm — **On the Cusp of the Flat Panel Display Revolution**

Moderator
Jack Roberts, *Director and Principal Analyst, Graphics and Displays Program, Computer Systems and Peripherals Worldwide, Dataquest Incorporated*

Panelists
Joel Pollack, *Senior Product Marketing Manager, Displays, Sharp Electronics Corporation*

Peter H. Goebel, *Executive Vice President and Chief Operating Officer, Ulvac Technologies Inc.*

Harry Marshall, *Chairman and Chief Executive Officer, Silicon Video Corporation*

Douglas J. Bartek, *President, Visual and Systems Interface Company, Cirrus Logic Inc.*

Malcolm J. Thompson, Ph.D., *Chief Technologist and Director, Electronic Imaging Laboratory, Xerox Palo Alto Research Center*

3:15 pm — **Networking Break** — **Desert Ballroom Foyer**

3:45 pm — **Reaching $300 Billion in Semiconductor Revenue by the Year 2000: What's It Going to Take?**

Moderators:
Stanley A. Bruederle, *Vice President and Principal Consultant, Consulting Group, Dataquest Incorporated*

Clark J. Fuhs, *Director and Principal Analyst, Semiconductor Equipment, Manufacturing, and Materials Program, Semiconductors Group, Dataquest Incorporated*

Panelists
Roger D. McDaniel, *Chief Executive Officer, MEMC Electronic Materials Inc.*

David N. K. Wang, Ph.D, *Senior Vice President, Worldwide Business Operations, Applied Materials*

Wei-Shan Lin, *President, Tatung Company*

Marcus T. Wilson, *Vice President and General Manager, Semiconductor Products Group, Intel Corporation*

James J. Kim, *Founder, Chairman, and Chief Executive Officer, AMKOR Electronics Inc.; Chairman, ANAM Group*

Agenda

Track II	New Products	Desert Ballroom 8

2:00 pm **The Next Step in High-Speed Interface Technology**
Geoff Tate, President and Chief Executive Officer, Rambus Inc.

2:30 pm **Programmable ICs—Beyond Microprocessors**
Wes Patterson, President, Chromatic Research Inc.

3:15 pm **Networking Break** — **Desert Ballroom Foyer**

3:45 pm **Micromachines: What Are They and Where Do They Fit?**
Jerry Curtis, Vice President and General Manager, Sensor Products Division, Semiconductor Products Sector, Motorola Inc.

4:15 pm **Digital Imaging: Reflecting the Future**
Randall Ledford, Vice President, Deputy General Manager, Digital Imaging Group, Texas Instruments Incorporated

5:00 pm **Conference Adjourns**

6:00 pm **Cocktail Reception and Dinner** — **The Grove**
Featured Appearance by Fred Hoar, President and Chief Executive Officer Miller/Shandwick Technologies

Agenda

Friday, October 13 — **Desert Ballroom**

8:15 am - 8:30 am
Welcome Address
Joseph Grenier, Vice President and Director, Semiconductor Device and Applications Group, Semiconductors Worldwide, Dataquest Incorporated

9:00 am **Achieving 0.1-Micron Technology: What Will It Take?**
Jim Owens, Chief Operating Officer, SEMATECH Inc.

9:30 am **Deconstructing the Semiconductor Industry**
William H. Davidow, Ph.D., General Partner, Mohr, Davidow Ventures

10:00 am **Multimedia 2000**
Michael L. Hackworth, President and Chief Executive Officer, Cirrus Logic Inc.

10:30 am **Networking Break** — **Desert Ballroom Foyer**

11:00 am **Dataquest Panel:**
The Impact of Interactive Multimedia on Systems and Semiconductors

Moderator
Daniel L. Klesken, Ph.D., *Managing Director and Senior Semiconductor Analyst, Robertson, Stephens & Company*

Dataquest Panelists
James D. Hood, Ph.D., *Senior Consultant, Consulting Group*

Allen Weiner, *Principal Analyst, Online Strategies Program Worldwide, Online, Multimedia, and Software Group*

Bruce Ryon, *Director and Principal Analyst, Multimedia Worldwide, Online, Multimedia, and Software Group*

Rob Enderle, *Senior Industry Analyst, Client/Server Software Worldwide, Online, Multimedia, and Software Group*

12:15 pm - 2 pm
Luncheon — **Springs Ballroom**

Agenda

Track I — **Applications** — **Desert Ballroom 7**

2:00 pm **The Wireless Communications Odyssey: What Adventures Lie Ahead?**

Moderator

Dale Ford, *Senior Industry Analyst, Semiconductor Application Markets Worldwide, Semiconductors Group, Dataquest Incorporated*

Panelists

Peter Karsten, *Business Development Manager, Nokia Mobile Phones*

Angelo V. Ugge, *Vice President, North America (Tele)-Communication Business Unit, SGS-Thomson Microelectronics*

Sohail Khan, *Vice President, Wireless and Multimedia Business Unit, AT&T Microelectronics IC Group*

Ray Millington, *Vice President and Director of Engineering, Advanced Products and Technology Division, Cellular Subscriber Group, Motorola Inc.*

Toshio Miki, *Vice President and Executive Research Engineer, NTT Mobile Communications Network Inc.*

3:15 pm **Networking Break** — **Desert Ballroom Foyer**

3:45 pm **How to Succeed in the Multimedia Consumer Systems Marketplace**

Moderator

Gregory L. Sheppard, *Director and Principal Analyst, Semiconductor Applications Markets Worldwide, Semiconductors Group, Dataquest Incorporated*

Panelists

Kazuaki Mayumi, *Director, Applications Laboratory, Matsushita Electronics Corporation*

Kenji Hori, *Member of Board of Directors, Sony Corporation, President and Chief Technology Officer, Research Laboratories, Sony Corporation of America*

Paul Rioux, *Executive Vice President, Consumer Products Division, Sega of America Inc.*

Klaus Volkholz, Ph.D., *Senior Director, Corporate Strategy, Philips Electronics*

Track II — **Devices** — **Desert Ballroom 8**

2:00 pm **System-Level Integration: Profits on a Chip**

Moderator

Bryan Lewis, *Director and Principal Analyst, ASICs Worldwide Program, Semiconductors Group, Dataquest Incorporated*

Panelists

Brian Halla, *Executive Vice President, LSI Logic Products, LSI Logic Corporation*

Donald Ciffone Jr., *Vice President and General Manager, VLSI Product Divisions, VLSI Technology Inc.*

Hiro Hashimoto, *General Manager, ASIC Division, NEC Corporation*

Gary Smith, *Director and Principal Analyst, EDA Program, Online, Multimedia, and Software Group, Dataquest Incorporated*

3:15 pm **Networking Break** — **Desert Ballroom Foyer**

Agenda

3:45 pm **New DRAM Architectures: Who Needs 'Em?**

Moderator

Jim Handy, *Director and Principal Analyst, Semiconductor Memories Worldwide Program, Worldwide Semiconductors Group, Dataquest Incorporated*

Panelists

Hans A.M. Wiggers, *Senior Memory Systems Engineer, Memory Technology Center, Hewlett-Packard Company*

Paul Baker, *Director of CPU Engineering, Macintosh Desktop Systems Group, Apple Computer Inc.*

Jodie Hughes, *Vice President, New Business Development, Western Digital Corporation*

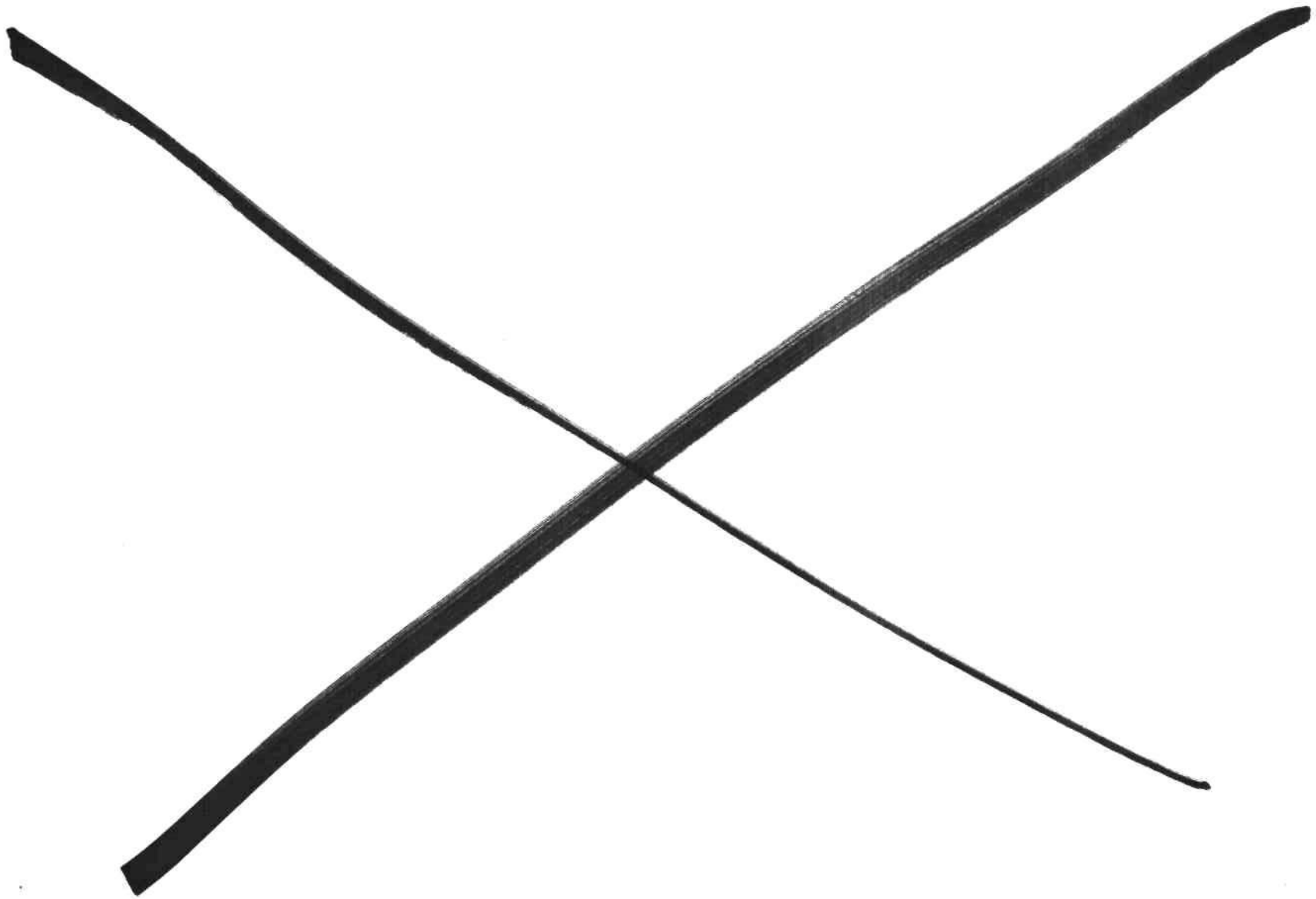
Max Bouknecht, *Manager, Server Systems Development, IBM Corporation*

Dipankar Bhattacharya, *Principal Engineer, Core-Logic Business Unit, Opti Inc.*

5:00 pm **End of Conference**

Saturday, October 14

Golf Tournament - 7:30 a.m. tee-off time



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this section optional

Name: _____ Title: _____

Company Name: _____ Tel: _____

Nature of company's primary activity: _____

_____

Where did you originally hear about this conference?

◯ Brochure ◯ Fax ◯ Telephone ◯ Electronic Delivery ◯ Other _____

How important were the following reasons for attending this conference?

Please circle your rating:	Not Very Important				Very Important
To hear and talk to Dataquest analysts	1	2	3	4	5
To learn more about Dataquest services	1	2	3	4	5
To hear industry speakers	1	2	3	4	5
To network with conference attendees	1	2	3	4	5

Additional reasons:

_____

_____

	Not Very Satisfied				Very Satisfied
How satisfied are you that the conference met these objectives?	1	2	3	4	5

	Poor				Excellent
How would you rate this hotel					
Meals	1	2	3	4	5
Sleeping rooms	1	2	3	4	5
Service	1	2	3	4	5
Conference facilities	1	2	3	4	5

In what city would you prefer to attend this conference in the future? Please list:

_____

Would you participate in a golf tournament at next year's conference? ◯ Yes ◯ No

Please evaluate the sessions you attended. See the reverse side.

DATAQUEST CONFERENCE EVALUATION

Please evaluate the sessions you attended by circling your rating

1 = Low, 5 = High | 1 = Poor, 5 = Excellent | 1 = Poor, 5 = Excellent | Did Not Attend

Day One

	Interest Level	Presentation	Content	
The State of the Economy:				
Joseph W. Duncan, Dun & Bradstreet Corporation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
From Wireless to the Web: System Design as We Approach the Millennium				
Enrico Pesatori, Digital Equipment Corporation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
The Semiconductor Outlook: Will It Get Any Better?				
Gene Norrett, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panel—Semiconductor: Outlook: Will It Get Any Better?				
Moderator:				
Gene Norrett, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panelists:				
Eric T. Miller, Donaldson, Lufkin and Jenrette	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Harjit Bhalla, Ph.D., Motorola Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Joseph W. Duncan, Dun & Bradstreet Corporation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Chintay Shih, Ph.D., Industrial Technology Research Institute, Taiwan	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Martin Reynolds, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Technology Stocks: Picking the Right Investments				
Ronald E. Elijah, Robertson, Stephens & Co.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○

Track 1 • Trends and Forecasts

Panel—On the Cusp of the Flat Panel Display Revolution				
Moderator:				
Jack Roberts, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panelists:				
Joel Pollack, Sharp Electronics Corp.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Peter H. Goebel, Ulvac Technologies Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Harry Marshall, Silicon Video Corp.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Douglas J. Bartek, Cirrus Logic Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Malcom J. Thompson, Ph.D., Xerox PARC	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panel—Reaching $300 Billion in Semiconductor Revenue by the Year 2000: What's It Going to Take?				
Moderators:				
Stanley A. Bruederle, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Clark J. Fuhs, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panelists:				
Roger D. McDaniel, MEMC Electronic Materials Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
David N.K. Wang, Ph.D., Applied Materials	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Wei-Shan Lin, Tatung Company	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Marcus T. Wilson, Intel Corporation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
James J. Kim, Amkor Electronics Inc./ANAM Group	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○

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Day One

	Interest Level	Presentation	Content	
Track 2 • New Products				
The Next Step in High-Speed Interface Technology Geoff Tate, Rambus Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Programmable ICs—Beyond Microprocessors Wes Patterson, Chromatic Research Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Micromachines: What Are They and Where Do They Fit? Jerry Curtis, Motorola Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Digital Imaging: Reflecting the Future Randall Ledford, Texas Instruments Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○

Day Two

Achieving 0.1-Micron Technology: What Will It Take? Jim Owens, SEMATECH Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Deconstructing the Semiconductor Industry William H. Davidow, Ph.D., Mohr, Davidow Ventures	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Multimedia 2000 Michael L. Hackworth, Cirrus Logic Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Dataquest Panel—The Impact of Interactive Multimedia on Systems and Semiconductors				
Moderator:				
Daniel L. Klesken, Ph.D., Robertson, Stephens & Co.				
Dataquest Panelists:				
James D. Hood	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Allen Weiner	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Bruce Ryon	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Rob Enderle	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Track 1 • Applications				
Panel—The Wireless Communications Odyssey: What Adventures Lie Ahead?				
Moderator:				
Dale Ford, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panelists:				
Peter Karsten, Nokia Mobile Phones	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Angelo V. Ugge, SGS-Thompson Microelectronics	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Sohail Khan, AT&T Microelectronics IC Group	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Ray Millington, Motorola Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Toshio Miki, NTT Mobile Communications Network Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○

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Day Two

	Interest Level	Presentation	Content	
Panel—How to Succeed in the Multimedia Consumer Systems Marketplace				
Moderator:				
Greg Sheppard, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panelists:				
Kazuaki Mayumi, Matsushita Electronics Corp.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Kenji Hori, Sony Corporation of America	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Paul Rioux, Sega of America Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Klaus Volkholz, Ph.D., Philips	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○

Track 2 • Devices

Panel—System-Level Integration: Profits on a Chip				
Moderator:				
Bryan Lewis, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panelists:				
Brian Halla, LSI Logic Corporation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Donald Ciffone, Jr., VLSI Technology Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Hiro Hashimoto, NEC Corporation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Gary Smith, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panel—New DRAM Architectures: Who Needs 'Em?				
Moderator:				
Jim Handy, Dataquest Incorporated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Panelists:				
Hans A.M. Wiggers, Hewlett-Packard Company	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Paul Baker, Apple Computer Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Jodie Hughes, Western Digital Corporation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Max Bouknecht, IBM Corporation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Dipankar Bhattacharya, Opti Inc.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○

What topics/issues would you like to see addressed at future conferences? Please list.

_____

_____

What changes would you recommend in terms of format/agenda?

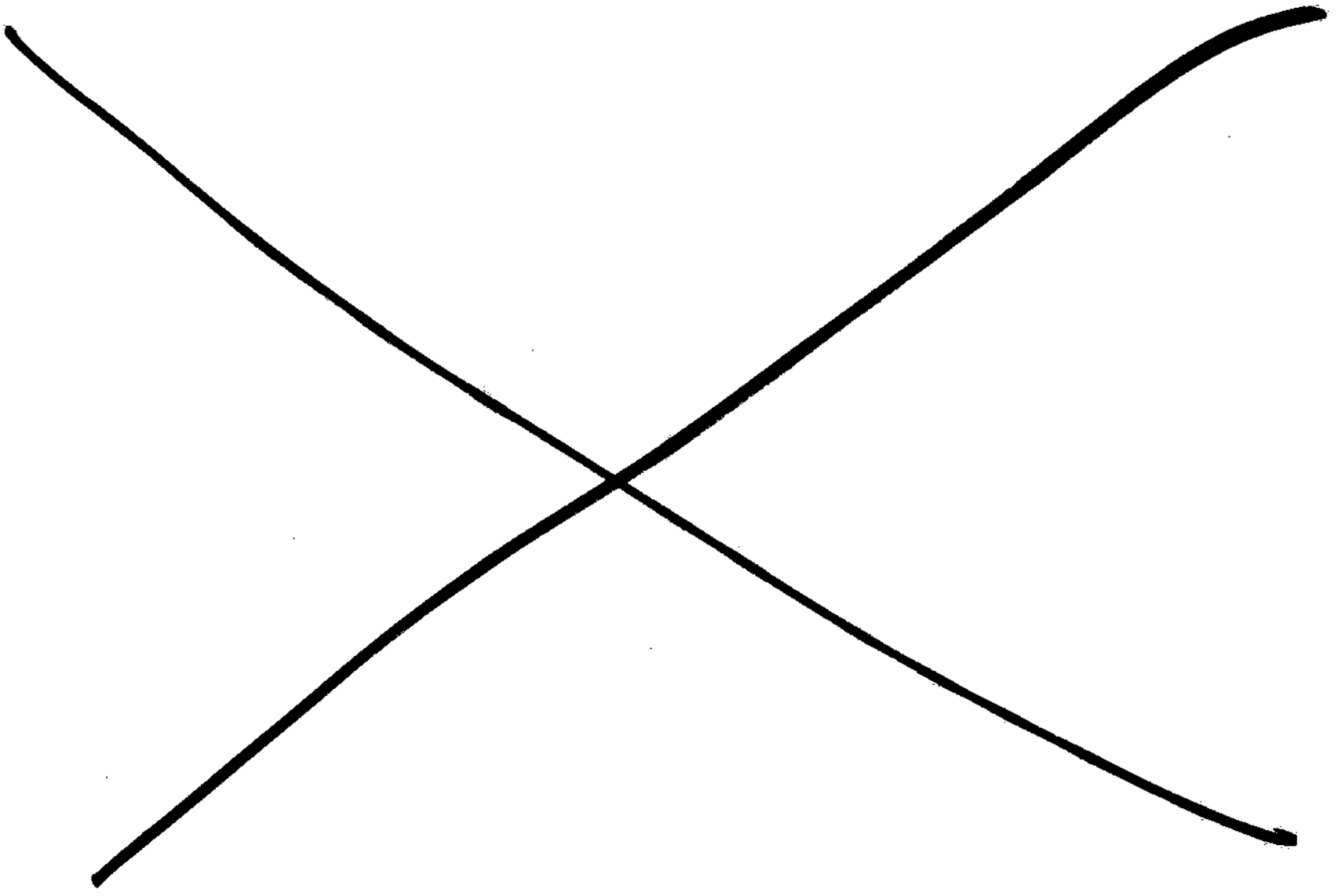
_____

_____

General Comments

_____

_____



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Vice President, North American Telecommunications Business Unit

Sharp Electronics Corporation
Joel Pollack
Senior Product Marketing Manager, Displays
Shoji Sakamoto
Manager

Shawmut Bank N.A.
Frank Benesh
Director

Shawmut Bank of Boston
Olaperi Onipede
Vice President

Shin-Etsu Handotai Co. Ltd.
Kazuo Morohashi
Manager, Corporate

Siemens Components Inc.
William R. Scharrenberg
Director
Tom Sennhauser
Director of Marketing

Siemens Corporation Inc.
Terence Bentley
Director
Marita Drude
Technical Marketing
Renate Schillberg
Purchasing Agent

Silicon Video Corporation
Harry Marshall
Chairman and Chief Executive Officer

Smi Ceramics America Inc.
Iwao (Rocky) Fujimaki
President

Solectron Corp
Gary Ogden
Director of Marketing
Larry Supan
Supply Base Manager
Sam Ung
Commodity Manager
Elizabeth Verea
Analyst

Sony - Semiconductor Headquarters
J.P. (Jean Pierre) Laussade
Executive Vice President

Sony Corporation of America
Kenji Hori
Member of Board of Directors, Sony Corporation, President and Chief Technology Officer, Research Laboratories

Standard Microsystems Corp
Doug Finke
Vice President
Robert Hollingsworth
Director, Business Development

Sumitomo Chemical America
Masaaki Hama
Manager and Chief Representative

Sumitomo Sitix Silicon Inc.
George Rehfeldt
President and Chief Executive Officer

Swire Technologies
Jackson Harmon
Vice President

Symbios Logic
Steve Easley
Director, Strategic Planning
Alan Lofthus
AVP Microperipheral Production and Site Manager

T. Rowe Price
Jill Hauser
Semiconductor Analyst

Taiwan Semiconductor Manufacturing Co.
Justin Wang
Strategic Planning Manager

Tandem Computers Inc.
Aurangzeb Khan
Director of TCD

Tatung Company
Wei-Shan Lin
President

Tech Semiconductor
Ee Tee Lee
Vice President Finance
David Smith
Vice President

Teradyne Inc.
Chip Thayer
Director, Marketing

Texas Instruments Inc.
Jim Benson
Market Analyst
Gary Euscher
Manager, Semiconductor
Tom Finn
SE Purchasing Manager

Attendees

Randall Ledford
Vice President, Deputy General Manager, Digital Imaging Group

Kevin McGarity
Senior Vice President, Components Sector

Steve McLendon
Market Research Analyst

Warren Salzman
Commodity Manager

Cathy Wyman
Financial Communications Manager

Tokyo Electron, Ltd.
Ken Muroi
Marketing Coordinator

Toshiba America Information Systems
Satchit Dokras
Manager

Tosoh SMD Inc.
Steve Bardus
New Business Development

Raymond L. Kidner
President and Chief Executive Officer

Bruce Nelson
Vice President, Marketing

TSMC
David Hannaford

Tylan General Corporation
Mike Grandinetti
Senior Vice President

UCOM California
H. Terashima
Director

Ultratech Stepper Inc.
Susan Billat
Contractor

Marc De Leeuwe
Director

Scott Zafiropoulo
PR Specialist

Kevin Zollinger
Manager

Ulvac Technologies Inc.
Peter H. Goebel
Executive Vice President, Chief Operating Officer

Unisys Corporation
James Vanhollebeke
Manager, Supply Base

United Microelectronics Corporation
Andy Chang
Manager

United Technologies Microelect. Center
Ron Hehr
New Product Definition

Valley Technology, Inc.
Paul Lui
President and Chief Executive Officer

Vanguard International Semiconductor Corporation
S.J. Paul Chien
Vice President, Sales Marketing

Pei - Lin Pai
Director of Marketing

VLSI Technology Inc.
Donald Ciffone, Jr.
Vice President, General Manager, VLSI Product Divisions

Watkins-Johnson Company
Richard Yerman
Director, Marketing

Western Digital Corporation
Jodie Hughes
Vice President, New Business Development

Winbond Electronics Corporation
Patrick Chang
Director

Ding-Yuan Yang, Ph.D.
President

World Semiconductor Trade Statistics
Mark Norwood
Administrator

Wyle Electronics
Charley Clough
Chairman

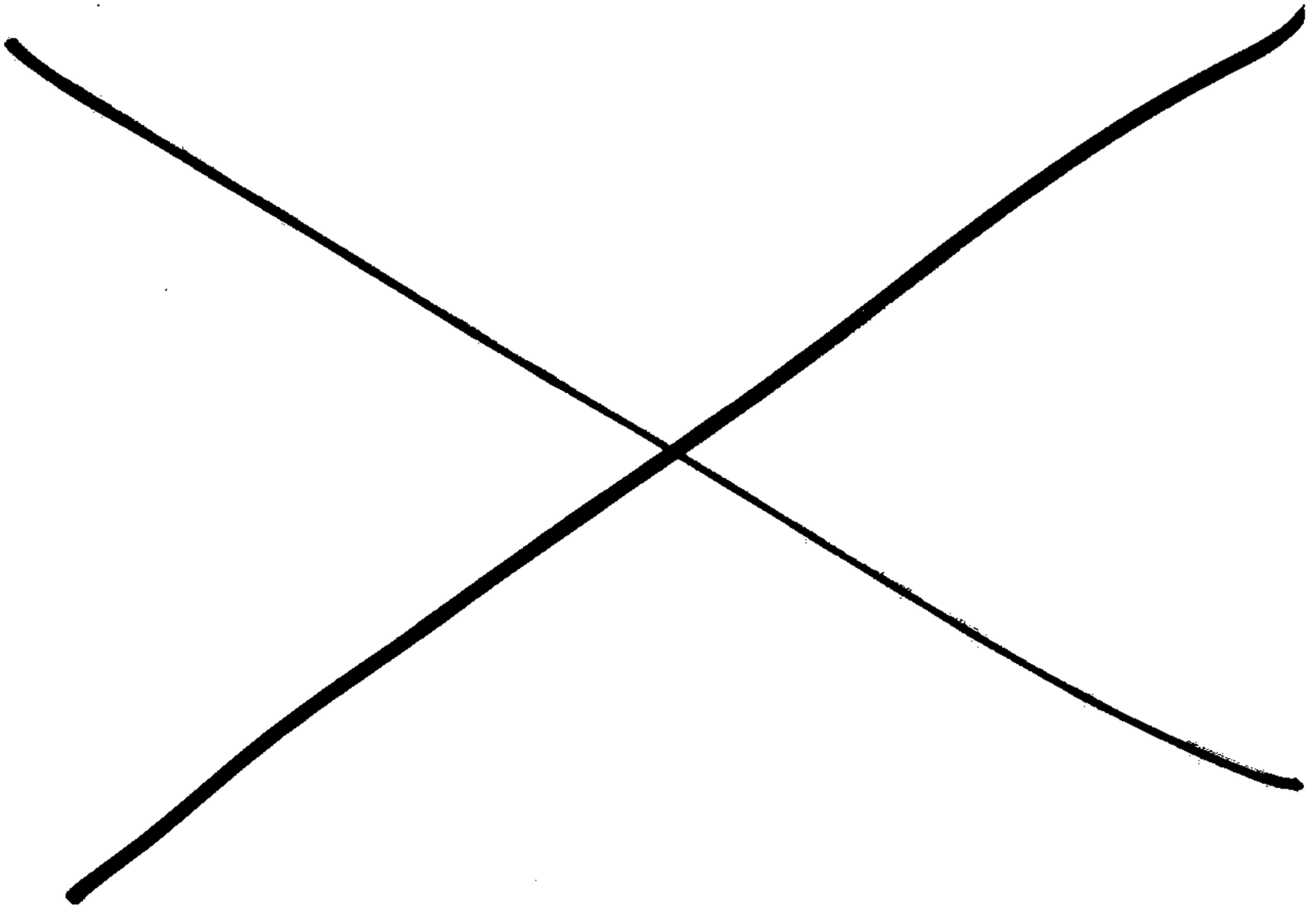
Ralph Ozorkiewicz
President and Chief Executive Officer

Xandex Inc.
Nariman Manoocheri
Vice President of Operations

Kamran Shamsavari
President

Xerox Palo Alto Research Center
Malcom J. Thompson
Chief Technologist and Director, Electronic Imaging Laboratory

Xilinx Inc.
Brent Dichter
Curt Wozniak
President



Welcome

Judith H. Hamilton

President and Chief Executive Officer
Dataquest Incorporated

Dataquest is a 24-year-old global information technology market research, analysis, and consulting company based in San Jose, California. The company provides worldwide market coverage, publishes reports and newsletters, and holds conferences on the semiconductor, computer systems and peripherals, communications, document management, software, and services sectors of the information technology industry. Dataquest is a subsidiary of The Dun & Bradstreet Corporation, with 507 associates and more than 2,100 clients, including all the major players in the IT industry.

Ms. Hamilton has spent 27 years in the information technology industry in a variety of leadership positions. Ms. Hamilton was a Partner and the National Director of Market Development for the Information Technology Organization of Ernst & Young in New York from 1988 to 1991 and with Ernst & Young's Los Angeles office from 1987 to 1988.

From 1981 to 1988, Ms. Hamilton was Vice President and General Manager of Commercial Professional Services for Computer Sciences Corporation (CSC) in Los Angeles. Prior to CSC, she served four years as Director of Commercial Software Engineering at System Development Corporation in Los Angeles and three years as President of her own company, Databasics, in California. This company, which offered consulting, applications development, and systems integration to the shipping industry, was sold to System Development Corporation in 1976.

Ms. Hamilton is actively involved in a number of community and business-related organizations including the Information Technology Association of America (ITAA, formerly ADAPSO) where she is a member of the board of governors. She was on the board for six years and was the Chairman during 1991, a four-term ADAPSO Conference Chairman, and Chair of the 1989 World Computing Conference. She is a trustee of the Committee for Economic Development, a board member of the Northern California District Export Council, a board member of the California Chamber of Commerce, on the board of the San Jose World Forum, and a board member of Joint Venture: Silicon Valley Network. She participated in the Aspen Institute's Roundtable on the Future of Technology in 1993, 1994, and 1995.

Ms. Hamilton graduated from Indiana University with a B.A. degree in history in 1966. She then went to Germany for two years where she completed course work for a master's degree in international relations from Boston University in Heidelberg. Returning to the United States in 1968, she completed technical training for computer programming at System Development Corporation in 1969. In 1978, Ms. Hamilton completed the executive program at the UCLA Graduate School of Management.

jhamilton@dataquest.com

What a Difference a Year Makes!

- PCs invade the home office
- IT goes Hollywood (Dreamworks, etc.)
- The Internet and Web enter the mainstream
- Windows 95 from the TV to our desktops
- Megamergers and breakups
  - Sybase—Powersoft
  - Seagate—Conner
  - AT&T split
- P6 (almost . . .)

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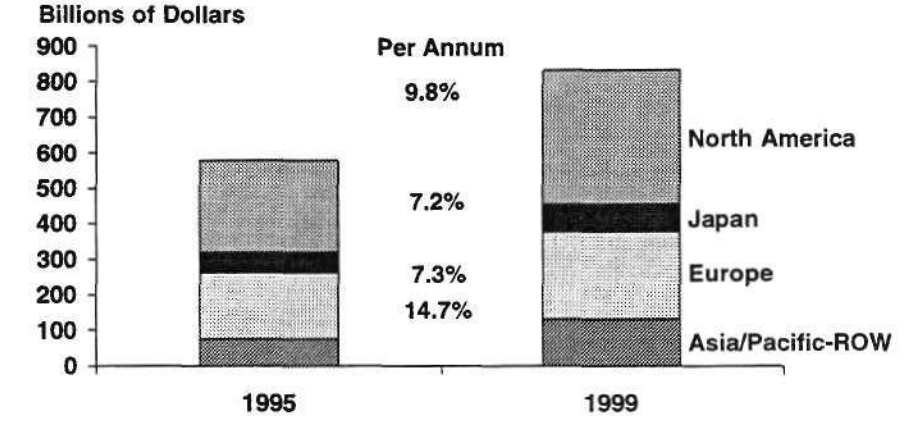
Worldwide IT Consumption by Regional Market



Source: Dataquest preliminary estimates
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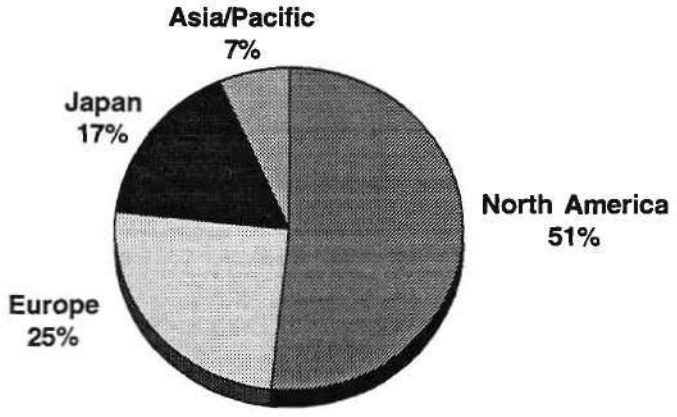
Dataquest

Dataquest Business by Regional Market (1995)



Source: Dataquest
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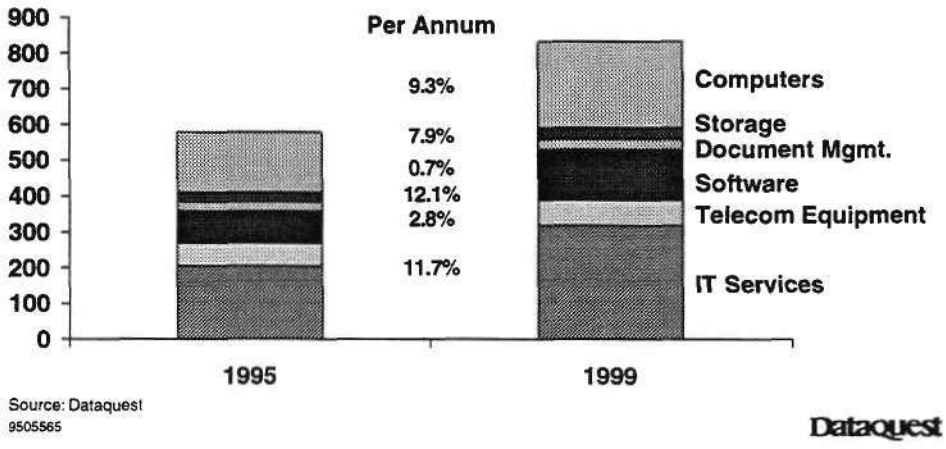
Worldwide IT Market by Segment



Source: Dataquest
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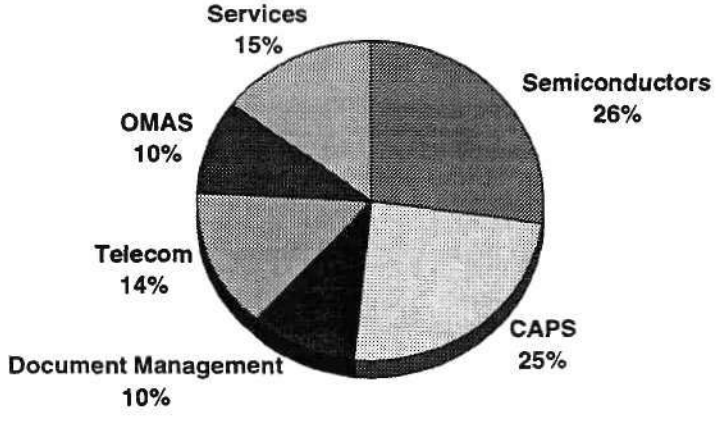
Dataquest

Dataquest Business by IT Segment (1995)



Source: Dataquest
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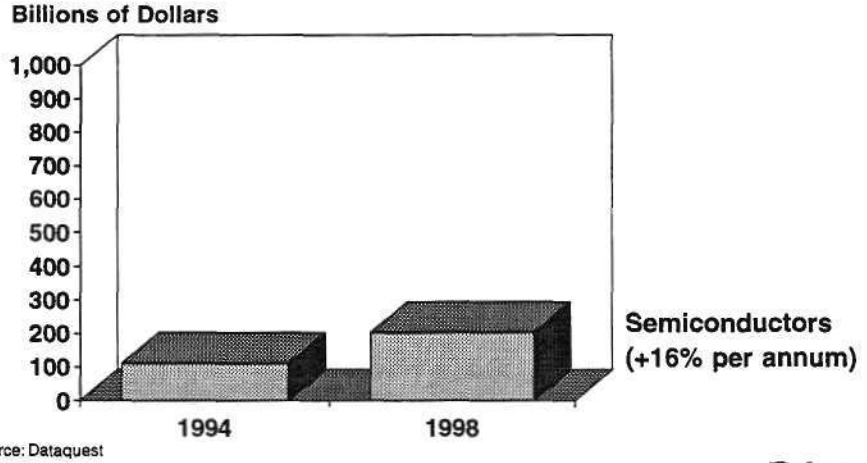
Dataquest

Growth of Worldwide Semiconductors



Source: Dataquest
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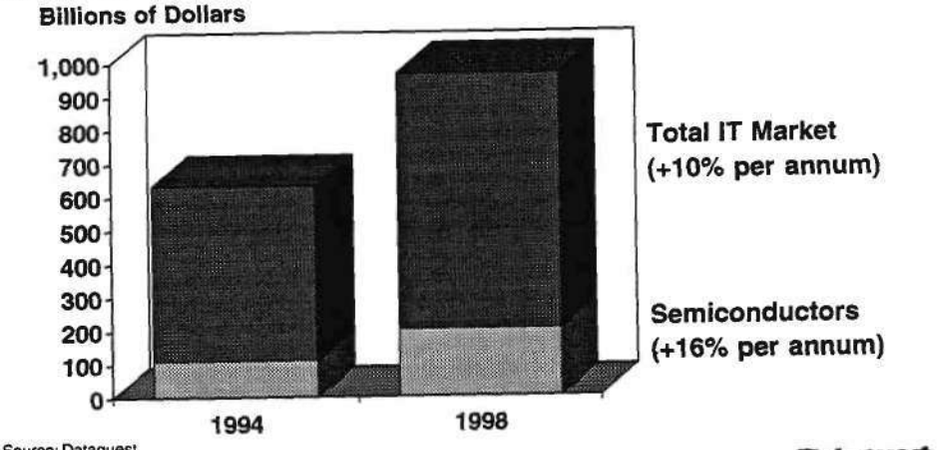
Growth of Worldwide Semiconductors Relative to IT Market



Source: Dataquest
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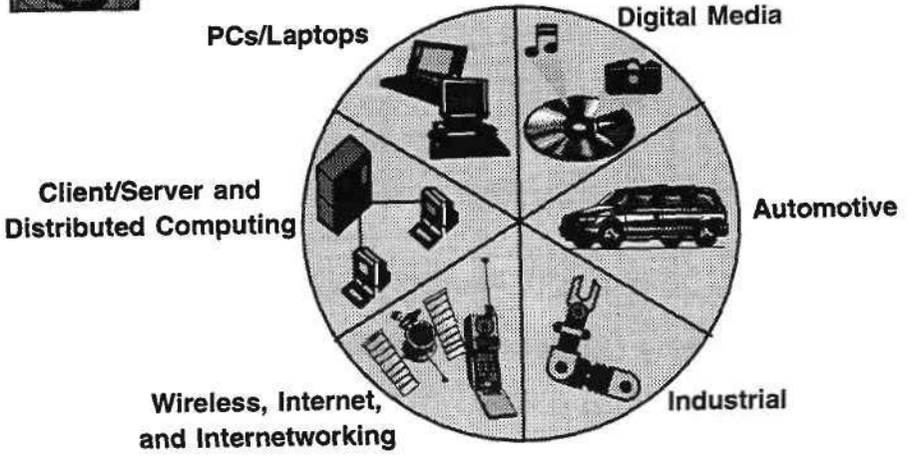
What's Driving This Growth?



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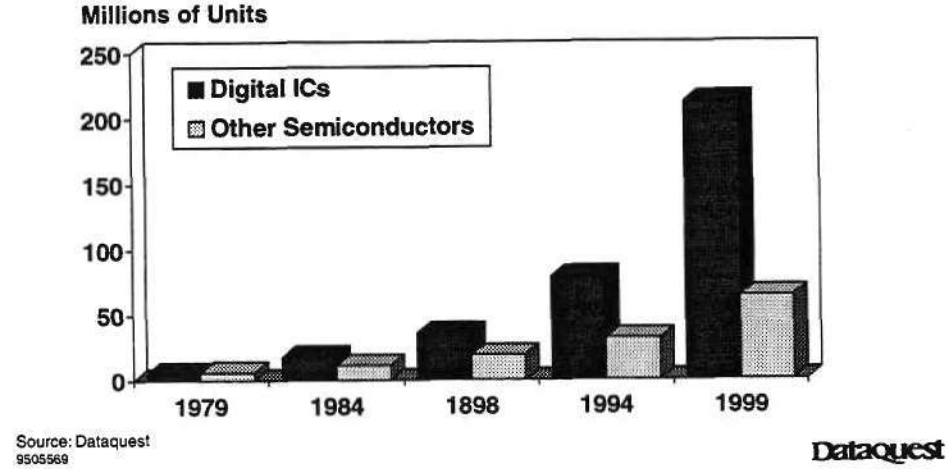
Digital Drives the Semiconductor Market



Source: Dataquest
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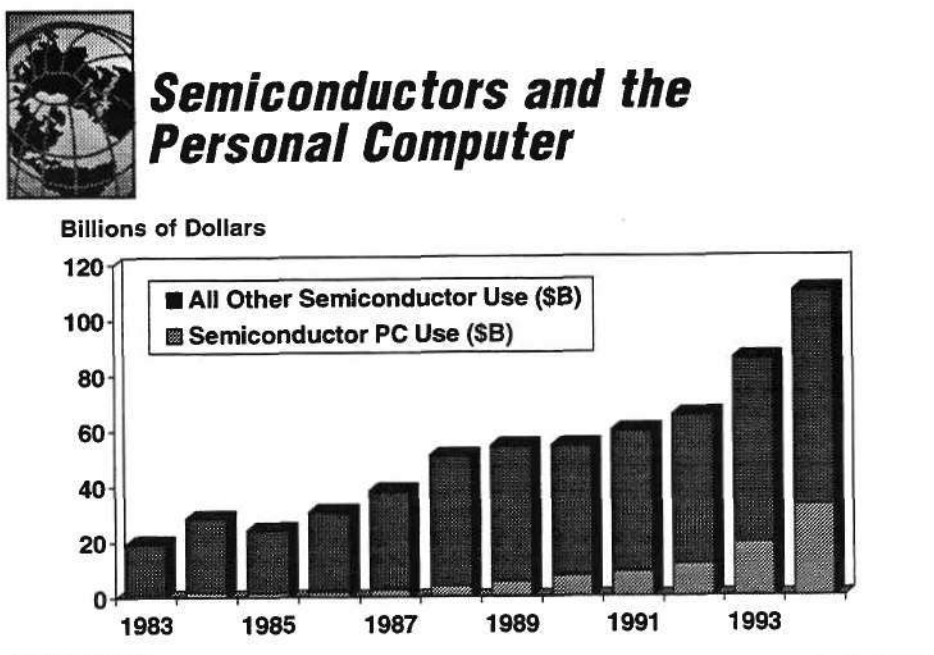
Semiconductors and the Personal Computer



Source: Dataquest
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What's New at Dataquest

- Electronic delivery
  - IT MarketWatch
  - Weekly newsletters (DQ Monday, etc.)
  - Internet/World Wide Web
- New Research Offerings
  - PC Teardown—expanded
  - PC Technology Directions and PC-SAM
  - Online Strategies
- "Virtual" Program Offerings
  - Cross technology, markets
  - Pooled data and expertise
  - Example: General SAM (Semiconductor Application Markets)

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Semiconductors '95

The Building Blocks of a New World Order

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Notes:

The State of the Economy

Joseph W. Duncan

Vice President
Corporate Economist and Chief Statistician
The Dun & Bradstreet Corporation

Dr. Duncan joined The Dun & Bradstreet Corporation in January 1982 and serves as the Corporate Economist and Chief Statistician. He was elected an officer of the corporation in 1986 and was named Vice President in 1989.

Dr. Duncan oversees the quality of the databases maintained at all D&B divisions. He also works with the extensive information resources of The Dun & Bradstreet Corporation to develop new economics-related products and services, to analyze economic trends, and to evaluate the economic impact of government policies and business practices. He heads the corporate Economic Analysis Department.

An active contributor of economic commentary and analysis and the author of over 100 published technical articles, Dr. Duncan is the executive editor of *Dun & Bradstreet Looks at Business*, a bimonthly economics newsletter featuring data from the corporation's own proprietary business information files. He is also the author of the *Statistics Corner in Business Economics*, the journal of the National Association of Business Economics. He is the coauthor of the book entitled *Statistics for the 21st Century*, published in 1995 by Irwin Professional Publishing. This book is addressed to business decision makers as a call for action to improve the statistical information base for public and private decision making.

Dr. Duncan was previously chief statistician for the Office of Information and Regulatory Affairs in the Office of Management and Budget where he was responsible for national statistical policy. He served as the U.S. representative to the United Nations Statistical Commission, of which he was chairman in 1981.

Dr. Duncan is a past president of the National Association of Business Economists (1992-1993). He was elected a fellow of the association in 1989. He is also an elected member of the Conference of Business Economists and the International Statistical Institute (ISI), serving as a vice president and member of the executive committee of the ISI (1991-1993). He received the Adolphe Quetelet medal of the ISI in 1994 for outstanding leadership of the association. He is a past president and chairman of the National Economists Club, past president of the Forecasters' Club of New York, a fellow for the American Statistical Association, and the founding chairman of the Statistics Committee of NABE.

Dr. Duncan received his B.S.M.E. from Case Institute of Technology, an M.B.A. from Harvard Graduate School of Business Administration, and a Ph.D. in Economics from Ohio State University. He also attended the London School of Economics. He has lectured at a number of universities and has taught city planning at Ohio State University and the University of Rhode Island.

The Building Blocks of the New World Order

The Global Economic Outlook

Remarks by Joseph W. Duncan
The Dun & Bradstreet Corp.
October 12, 1995 - Marriott Desert Springs Resort and Spa, Palm Desert

27th Annual Dataquest Semiconductor Conference

Topics

- The interconnected elements of the global economy
- Global business expectations
- The economic outlook
- The role of the information economy
- Changing data about our industry
- What does this mean to you?

Recent Business News

USA Today - October 12

- "Former Lotus chief Mansf leaves IBM"

Wall Street Journal - October 12

- "Earnings data suggest gloom is unwarranted."
- Yesterday The Financial Times said the opposite!

New York Times - October 12

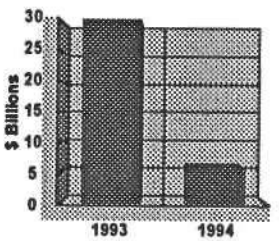
- "Why is a rich country down in the dumps, if it is?"
- '$70 billion is being added to income without being counted.' - Peter Passell

The "peso crisis" in Mexico - the interconnected economy

First, what happened in Mexico?

- In 1994, foreign reserves dropped
- The peso was devalued
- Result - a crisis

Mexico - Reserves



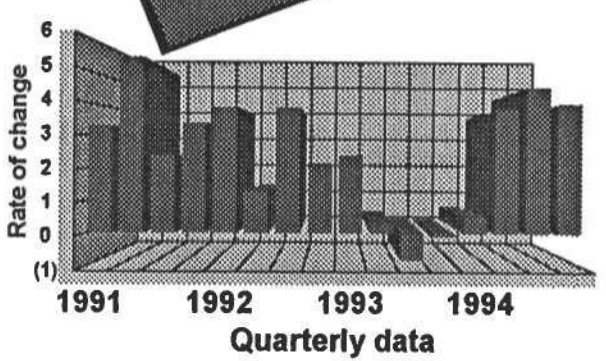
Second, some history

Mid 1980's:

- Before Carlos Salinas
  - Inflation - nearly 70% during decade
  - Inflation - nearly 100% in 87 & 88
- Recessions
  - 1982-83
  - 1986
- Peso
  - 1980 - 23 per $
  - 1990 - 2500 per $

Economic Impact

Mexico - GDP Growth by Quarter



What are the implications?

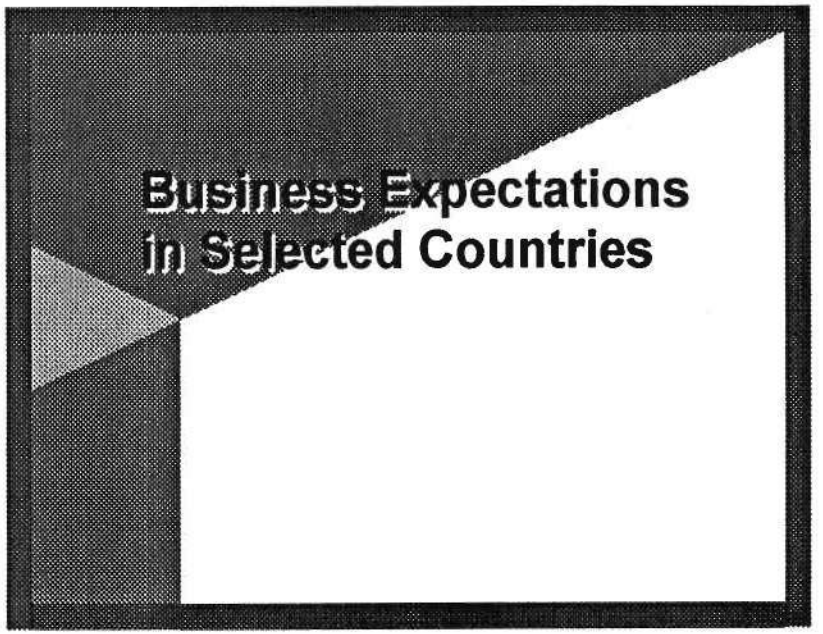
Political

- Ernest Zedillo's government under extreme political pressure
- Trade relations are strained; U.S. will have a large deficit with Mexico in 1995
- Political reform movement gaining strength

Let's Turn to the Overall Economic Outlook

A Brief Review of Unique D&B Data

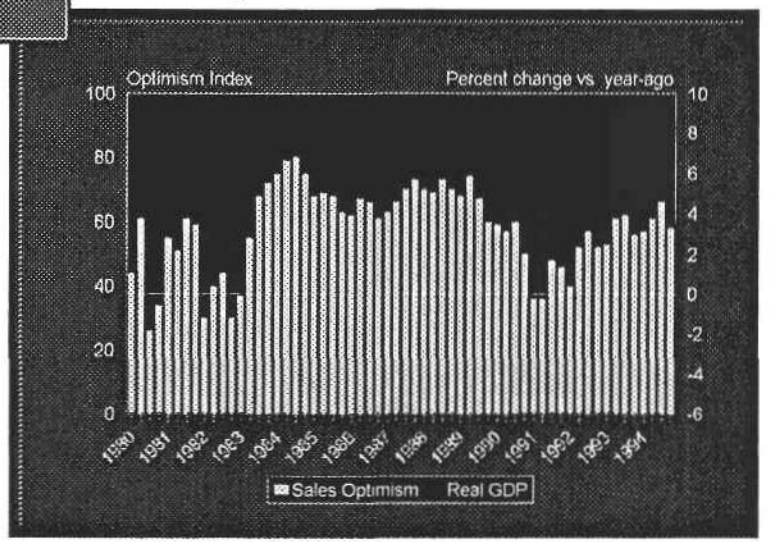
Business Expectations
A unique survey
in selected countries
15 nations
14,000 businesses



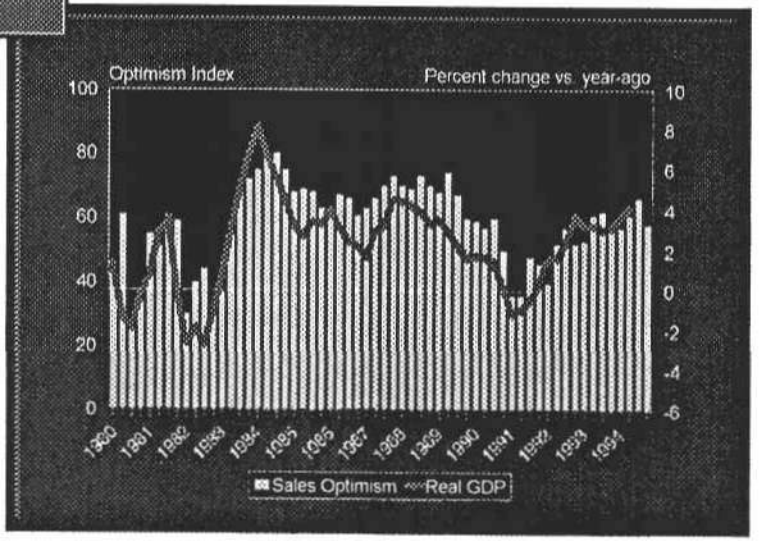
What are Business Expectations?

Survey initiated in 1947.
Goal: Gain a business point of view.
What do you think?
Increased sales vs. decreased sales next quarter.

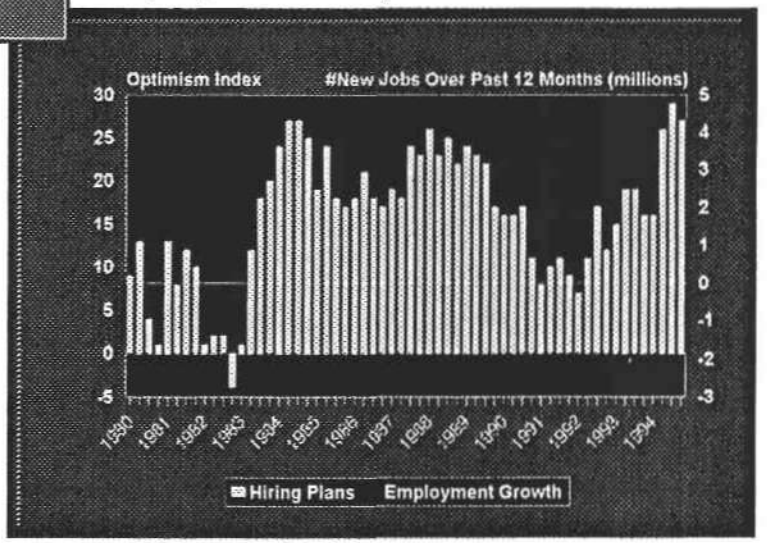
Sales Optimism



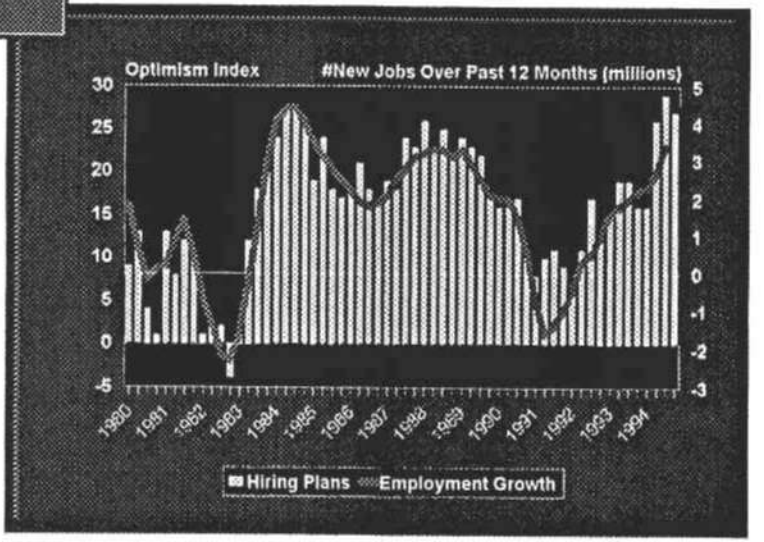
Leads to GDP Growth



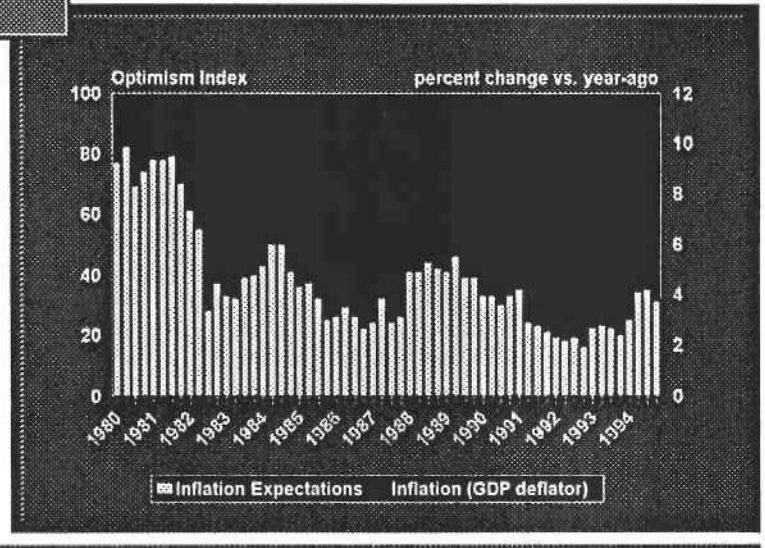
Employment Expectations



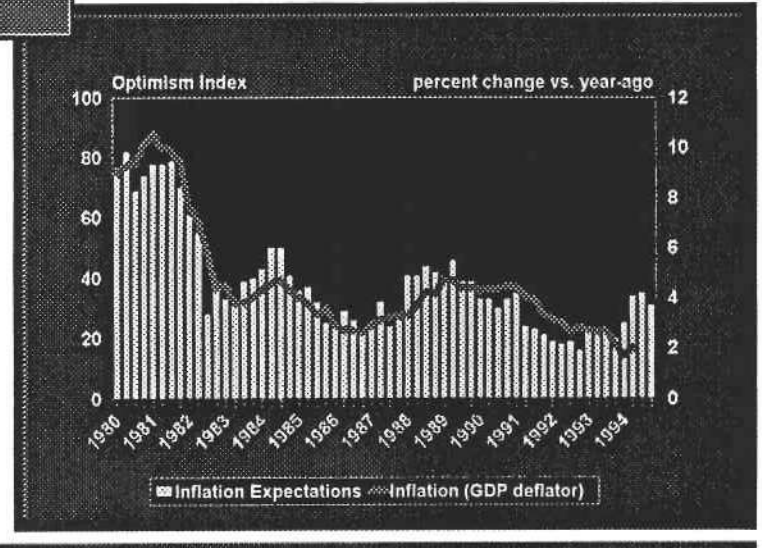
Leads to New Jobs!



Plans for Price Changes



Reflected in GDP Deflator

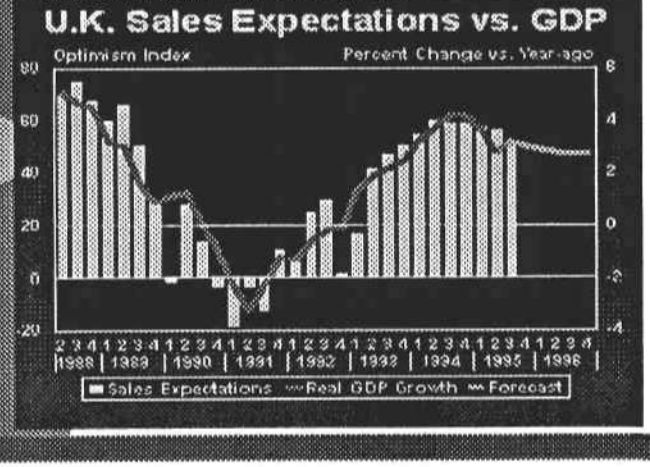


Business Optimism

Canadian Sales Expectations vs. GDP

Business Optimism

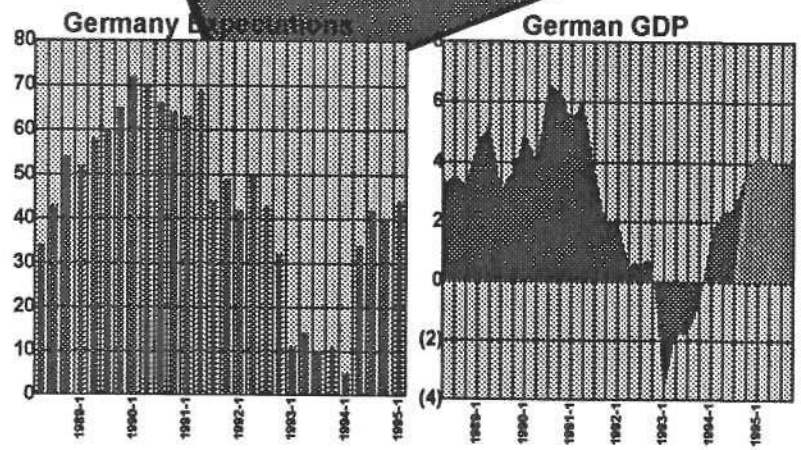
U.K. Sales Expectations vs. GDP



Business Optimism

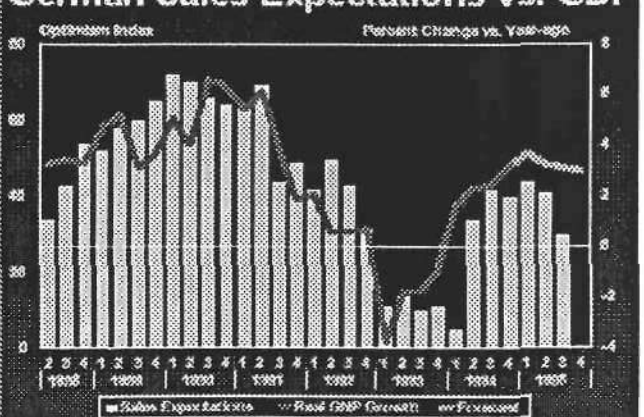
French Sales Expectations vs. GDP

Results for Germany



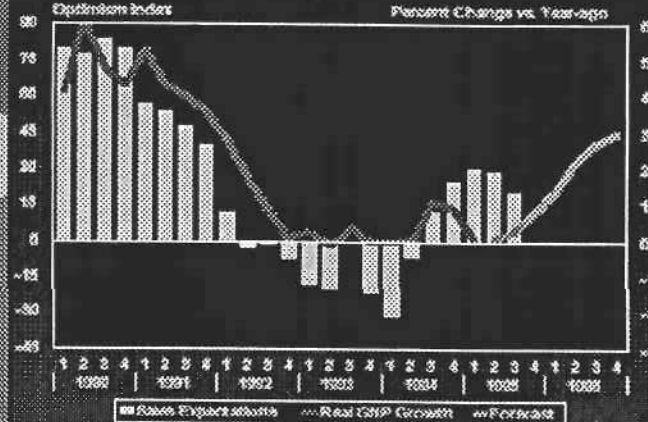
Business Optimism

German Sales Expectations vs. GDP



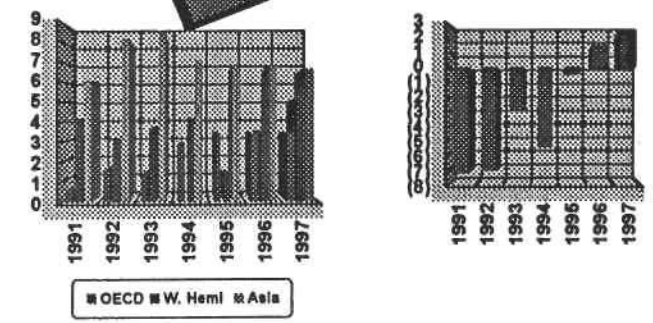
Business Optimism

Japan Sales Expectations vs. GNP

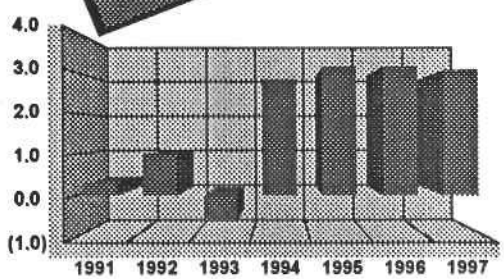


Global Growth Summary

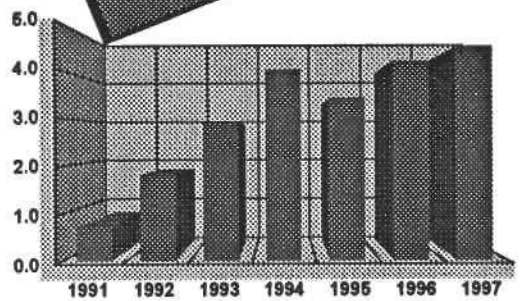
Growth by Region



Growth in Europe



Global Growth



	1991	1992	1993	1994	1995	1996	1997
World	0.7	1.9	3.1	4.2	3.4	3.8	4.2
--Industrial Countries	0.5	1.5	1.3	3.1	2.6	2.9	3.2
U.S.	(0.6)	2.6	3.1	4.1	3.1	3.4	3.6
Japan	4.0	1.3	(0.2)	0.6	0.8	1.5	2.6
W. Europe	0.3	1.0	(0.6)	2.9	2.9	2.9	2.9
--Developing Countries	4.5	5.8	6.1	6.5	5.1	5.4	5.8
W. Hemisphere	4.2	3.1	3.7	4.8	2.2	3.2	4.6
Asia (ex. JAP, PRC, AUS, NZ)	7.6	5.9	6.1	7.1	7.1	6.7	6.6
--Emerging Europe	(7.2)	(7.1)	(2.9)	(5.4)	(0.4)	1.5	2.5

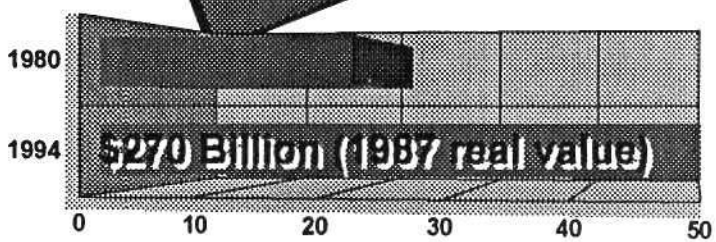
The Information Industry

Basic elements

- Information for decisions
- Cross border information for globalization of trade
- Telecommunications costs are declining
- Computer costs down 88% since 1982

High Tech Capital Equipment

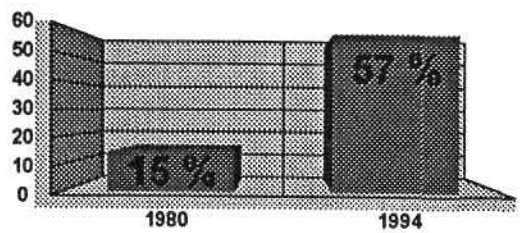
(% Producer's Durable Equipment)



High Tech spending is up 88% in the past three years

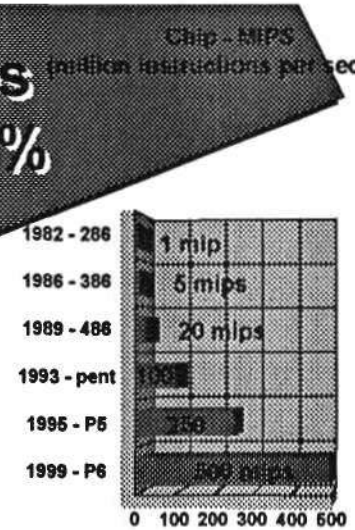
Computers dominate high tech spending

Computers % of high tech



While prices plunged 88%

Computing power surged



A new method - calculation of GDP

- New chain weights eliminate "substitution bias" from 1987 weights
- Average GDP growth since end of recession down from 3.1% to 2.6%
- Much closer to potential GDP growth / reduced inflation threat
- Business fixed investment, particularly high-tech, significantly reduced
- Productivity gains overstated - poor wage growth now explained
- Adds justification for lower interest rates

What does this mean for you?

The information revolution is just beginning

- Growth will slow
- But the industry will be large

Innovation and change will continue to be rapid

- Competition will be global
- Households will be the surprise market

Conclusions

Global Connections - World trade will expand

Information technology is the key to competitiveness

Global success requires good targeting of customers and alliances


Thank you

Notes:

From Wireless to the Web: System Design as We Approach the Millennium

Enrico Pesatori

Vice President and General Manager
Computer Systems Division
Digital Equipment Corporation

Mr. Pesatori is Vice President and General Manager of Digital Equipment Corporation's Computer Systems Division. The Computer Systems Division includes three worldwide business units, each with control over the business functions critical to their success, including engineering and product development, manufacturing and logistics, marketing and communications, business information systems, channel recruitment and support, and sales. The business units are: Business Unit (ABU), Personal Computer Business Unit (PCBU), Systems Business Unit (SBU), and Accounts.

Mr. Pesatori has been responsible for Digital's PCBU, SBU and worldwide sales and marketing operations since April 1994. In early 1993, he joined Digital as vice president and general manager of the Personal Computer Business Unit. During his tenure, Digital has doubled its PC revenue and has become one of the fastest-growing PC companies in the world. He reports directly to Digital president and CEO, Robert B. Palmer. Mr. Pesatori served for the previous two years as president and CEO, Zenith Data Systems (ZDS), a leading worldwide supplier of notebook and desktop personal computers, owned by Groupe Bull of France.

Previously, Mr. Pesatori served 21 years with Ing. C. Olivetti & C., S.p.A. During his executive tenure at the Italian computer and electronics company, his positions included President and CEO of Olivetti North America; President and CEO of Docutel-Olivetti, where he was responsible for restructuring the Dallas-based company; Vice President of Corporate Product Strategy; and head of the Olivetti Systems Group, where he was responsible for marketing, manufacturing, and R&D of all data processing and microcomputer products. He also served as President of Olivetti's first business unit, Electronic Calculators; the Electronic Typewriters business unit was then added to his responsibilities. Prior to that, he was Vice President of manufacturing for Olivetti's operations in the United States and Manufacturing Manager of Olivetti's factory in Ivrea, Italy. Mr. Pesatori joined Olivetti as a product manager in 1969 after four years at General Electric in the United States and Italy.

Mr. Pesatori was awarded a master's degree in electronic's engineering in 1965 from Polytechnic University in Turin, Italy.

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From Wireless to the Web: System Design As We Approach the Millennium

Enrico Pesatori
Vice President & General Manager
Computer Systems Division
Digital Equipment Corporation

Presented to:
Dataquest 1995 Semiconductor Conference
Palm Desert, California
October 12, 1995

Thank you, Gene, and good morning.

When Gene asked me a few months ago if I would deliver the keynote address at this conference I quickly accepted.

As the head of a business that designs, manufactures and sells systems ranging from personal computers to high-performance servers, I am keenly aware of the importance of semiconductors to Digital's success in the marketplace.

Although Digital is itself a semiconductor company, we also do business with many of the companies represented in this room. Your ability to deliver high-quality, cost-effective semiconductors has a lot to do with our ability to deliver high-quality, cost-effective systems to Digital's customers.

So I am delighted to be with you today and to have this opportunity to talk about some of the key trends in the systems business.

* * *

This is an exciting time to be in the information technology business. Our products and services are transforming society -- the way we do business. . . the way we work. . . the way we play. . . the way we interact with others throughout the world.

Yet the information revolution is not so much a great leap forward as a series of rapid, but evolutionary changes.

What I want to talk about this morning are some of the key evolutionary changes that are taking place in our industry:

- the evolution of customer demands and expectations,
- the evolution of two dominant platforms -- personal computers and servers, and,
- perhaps the most transforming change of the next decade, the evolution of the networked world.

I want to start with the customer because it is the end-user that is driving information technology.

For most of our history as an industry, corporate customers bought information technology to automate manual tasks, such as accounting, reservations and manufacturing. Large, proprietary systems dominated. Centralized decision-making was the rule.

But that paradigm has changed.

Although automation is still important, information technology is seen more and more as a competitive advantage -- as something that affects the top line, not just the bottom line.

It is the basis for re-engineering organizations and processes. . . for increasing time-to-market and customer responsiveness. . . and for improving productivity and profitability.

Retail companies, for example, have learned from pioneers like Wal-Mart that sophisticated inventory management and distribution systems are not luxuries -- they are competitive necessities.

Overnight delivery companies have learned from Federal Express and UPS that systems that keep track of every package -- from pickup to delivery -- not only save money but significantly increase customer satisfaction.

And we are all finding that giving our sales people immediate, remote access to critical information can make the difference between winning or losing an account.

In other words, information technology enables companies to differentiate themselves in the marketplace.

A recent MIT study conducted for *Information Week*, concluded that companies that focus their IT investments on quality, customer service, flexibility and speed reaped the benefits of increased productivity and profitability.

Information technology allows these companies to flatten their organizations and push decision-making much closer to the customer. It gives employees greater access to business-critical information -- in the office and on the road. And it makes it easier for customers to do business with them through on-line ordering. . . electronic data interchange. . . and other emerging forms of electronic commerce.

So it should come as no surprise that corporate end-users are pushing for more flexible, cost-efficient systems -- systems that support the way they do business.

They want information technology that gives them a competitive edge.

They want open systems that work together in multivendor environments, including mainframes and other legacy systems.

And, they want systems that support the ways decisions are made in a rapidly changing marketplace.

That is why more and more companies today are moving to client/server computing, because it gives them more flexibility. . . allows them to deliver critical business information to more people. . . and supports more decentralized decision-making.

* * *

This demand for open and flexible systems and the shift toward client/server computing is driving the rapid growth of two platforms -- PC's and servers.

I want to take the next few minutes to discuss these two platforms and how they are evolving to meet the needs of customers.

First, let me give you an idea of how we expect the market to grow over the next five years.

Between now and the year 2000, we expect personal computers to grow at a compound annual rate of 16 percent.

Servers -- excluding mainframes and minicomputers -- will grow at the same rate. Some important segments of the market will grow even faster. We expect the Internet server market, for example, to double annually for the next few years.

Overall, the server market will more than double, from $17 billion last year to $40 billion in the year 2000.

While there will still be a market for mainframes and minicomputers, it will continue to decline as server performance, scalability and availability continues to improve.

It goes without saying that most of these platforms will run Intel microprocessors.

This is already true with PCs. And it is increasingly true with servers.

With the Pentium processor today, and with the Pentium Pro and P7 to come, Intel is moving farther and farther up the performance scale.

We see tremendous growth opportunities with Intel-based platforms.

But there is plenty of room above Intel for high-performance RISC platforms.

The only sustainable business proposition, however, is to deliver a product that has a commanding performance lead -- by at least a factor of two -- over the latest Intel chip. Digital's Alpha chip is designed to sustain that kind of performance advantage over the long term.

* * *

If the ongoing debate between Larry Ellison and Bill Gates is any indication, the future of the personal computer is a subject that generates very strong opinions.

Clearly the PC will evolve into many new forms to fit the technology needs of end-users -- from wireless portables and PDAs to so-called "smart" terminals linked to enterprise networks or the Internet.

But there is one thing I am certain about -- the PC will continue to be the main engine of information technology for years to come.

In the business world, the PC is the primary interaction layer, and customers want the world of the enterprise displayed through the PC -- as easily and transparently as possible.

But it is the consumer -- not business -- that is driving the evolution of the personal computer.

While business, education and government still account for most of the PC's sold in the United States, sales to consumers are growing much more rapidly.

Even Compaq -- the market leader -- learned during the Christmas season last year that underestimating consumer demand for the latest and greatest technology is a big mistake.

Consumers are looking for the fastest processors. . . the latest in multimedia and telephony. . . and the newest software.

Just look at the sales of Microsoft Windows 95.

Those were not IS managers you saw lined up at midnight at CompUSA. They were consumers, and they are driving the initial success of Windows 95.

There are a lot of reasons consumers are buying PCs today -- telecommuting, games, personal productivity, entertainment. Millions of parents also are buying PCs because of their growing importance in education.

But that is just the beginning. As the market matures, we will begin to see more homes with more than one PC -- just as most homes today have multiple televisions.

We are not far away, for example, from the home network.

I am sure that in many of your homes there is intense competition for the computer. You have a report to finish. One child has homework. Another wants to play Doom.

Now. . . imagine having a server tucked away in a closet somewhere, connecting one PC for the child doing homework. . . another for your home office. . . and a third for entertainment.

As inter-networking becomes more reliable and secure, we are also going to see an explosion of what is often called the tiny office/home office. New businesses will spring up to create, market and sell products and services directly on the Internet or other networks. You only have to look at the number of personal home pages on the Internet today to see the potential.

But there is one potential problem with this optimistic scenario -- ease of use.

I think it is safe to say that all of the technophiles now have their home computers. To continue the rapid growth of the consumer market, we have to produce PCs that are not only easy to set up, but easy to use.

The new generation of operating systems and advances such as Plug 'n Play technology represent some advancement in ease of use.

But we have a lot more work to do.

Even the newest software is difficult for many technically-savvy consumers to load on their computers. Until we can resolve these problems -- until we can make it easier to use a computer than it is to program a VCR -- many of our potential customers will be reluctant to buy a PC -- or a second one.

On the corporate front, ease of use is not so much the issue as ease of management. Most businesses are less concerned with bells and whistles than with managing growing networks of PCs and the significant expense involved in supporting them.

They want performance, but most of all they want open and standardized solutions. . . reliable products. . . competitive prices. . . and dependable service and support.

One of the most important platform improvements for the corporate customer is the ability to manage PCs from a remote site.

With the network management features now being built into more and more PCs, software upgrades and other changes can be made over the network -- saving time and money.

The most profound changes in the corporate environment are happening not on the desktop but in areas such as mobile computing.

Portable computers are becoming thinner, lighter and more functional. Users have to make fewer and fewer compromises for mobility. And since they are no longer bound to the desktop, they can spend more time with customers and partners.

Today, portable PCs account for about 26 percent of all PC sales. By the year 2000, that number will grow to more than one-third.

And most of those users are going to be connected to private and public networks. This is already driving significant growth in the infrastructure needed to support mobile computing -- including mobile software, wired and wireless networks, and remote access server ports.

* * *

Clearly the last decade was the decade of the PC.

But the next decade will be the decade of network connections, servers and distributed information.

As I mentioned earlier, servers represent a high-growth market because of the accelerating shift to client/server computing.

Some of the most significant growth is going to be in emerging applications, such as interactive video. . . multimedia. . . Internet connections and services. . . electronic publishing. . . and very large database/very large memory.

Each of these areas involves new ways of distributing information, both locally and globally. And each will require powerful, scalable, secure and reliable systems.

In addition to emerging applications, servers are taking on many of the tasks traditionally handled by mainframes and minicomputers.

With advances such as symmetric multiprocessing and clustering, servers deliver both reliability and availability -- at a fraction of the cost of mainframes.

That is why mainframe downsizing is such a strong and growing market.

Two of the key drivers the server market are the emergence of Windows NT and the acceptance of UNIX as a mission-critical computing platform.

Over the next five years, these two operating environments will dominate the server market.

Today, UNIX has 50 percent of the server market. Other operating systems -- like OpenVMS, MVS, OS/400 and Netware -- have 45 percent. Windows NT has about 5 percent.

But by the year 2000, we expect Windows NT and UNIX to have roughly equal shares of the market -- about 40 percent each.

And 95 percent of all customers will have a mixed environment. This will make it all the more important to have interoperability between UNIX, Windows NT and proprietary systems such as OpenVMS and MVS.

I want to discuss these trends in a little more detail.

Windows NT is clearly the next strategic server operating system for enterprise computing, and many large companies are already embracing it -- much as they did a few years ago with UNIX.

The growing popularity of Windows NT reflects the natural evolution of the Windows desktop to the enterprise.

In fact, we regard Windows NT as the key ingredient of the emerging client/server computing model. It will drive the servers that link the desktop with enterprise databases, legacy systems and global networks.

From a small base today, Windows NT will grow dramatically over the next few years.

According to Dataquest's own analysts, new shipments of hardware running Windows NT will increase from 850,000 units this year to almost 4 million units in 1997. That is an increase of almost 400 percent in only two years.

By the year 2000, we believe Windows NT will have about 50 percent of the low-end server market and 18 percent of the high-end market.

As a result of NT's influence, platforms will start to emulate PC economics. Scale will become even more critical, especially in the server market, where it is not as important today.

The favorable economics of this environment -- a standardized operating system running on standardized platforms -- is attracting some significant converts -- companies like Citicorp, K-Mart, Saturn and Dow Chemical.

K-Mart, for example, recently announced plans to replace more than 2,000 UNIX servers in its stores with servers running Windows NT. And Citicorp is the first major bank to standardize on NT.

As Windows NT becomes more integrated with the enterprise, it will take over many of the tasks now performed by UNIX machines.

But UNIX is also moving up the performance curve, taking over more and more of the enterprise applications once commanded by mainframes and other large, proprietary systems.

The knock on UNIX -- at least from the mainframe advocates -- was that it did not have the performance or the reliability to handle mission-critical computing.

But advances such as symmetric multiprocessing, 64-bit computing, UNIX clusters, high-performance database software, and new system management tools enable UNIX systems to deliver mainframe performance and reliability at a fraction of the cost.

As a result, more and more customers are deploying UNIX for mission-critical computing.

Take data warehousing, for example.

In the past, data warehousing required boutique software, sophisticated custom programming and massively parallel processing. Only the largest companies could afford it.

Not anymore. With the very large memory capabilities made possible by 64-bit technology, companies can now deploy what amounts to a standard data warehousing solution. And you do not have to be a Fortune 500 company to afford it.

Because UNIX was the first to capitalize on 64-bit technology, very large memory and very large database capability, it is now in a position to emerge as the dominant platform for high-performance, enterprise servers over the next five years.

Digital has been building 64-bit servers and workstations running 64-bit Digital UNIX for some time now, and the performance improvements are incredible. Our newest Alpha servers, running Oracle's 64-bit database software, are more than an order of magnitude faster than 32-bit systems.

This kind of performance opens up vast new opportunities in areas such as speech recognition. . . complex simulations used in aircraft design. . . gene mapping. . . or very large memory databases accessed in real time.

Even as I speak, a 64-bit Digital UNIX server is completing the task of indexing the entire World Wide Web -- more than 30 million pages of information retrieved from more than 80,000 computers worldwide -- a task previously considered economically unfeasible.

It is retrieving information at the rate of 1 million pages a day -- or 700 pages per minutes. This is 15 to 100 times faster than any other retrieval engine currently operating on the network that we are aware of.

* * *

The advances we are making in UNIX and Windows NT platforms are building the foundation for the last evolutionary change I want to discuss -- a change, as I said at the beginning, that could be the most transforming of the next decade.

It is the evolution of the networked world.

Everybody today is talking about the Internet. . . and much of that talk is about the Internet as an electronic commercial trade route.

But the Internet also holds great promise as the next paradigm of computing -- the next generation application development platform.

As this world evolves over the next decade, the hardware and operating systems on the clients will become less and less of a competitive issue. Instead, clients of all kinds will connect to a standardized application and content environment like the Internet.

We are already seeing today how the Internet can be used as a private network to meet the needs of the enterprise. Businesses are discovering that it is a cost-effective way to create virtual LANs.

But the evolution of the Internet into the kind of network we are talking about will require some significant advances in the network infrastructure.

In the last decade, for example, low-cost MIPS have increased more than 1,000 times. But remote, widely available, telephone-based bandwidth has increased only ten times.

Bandwidth will have to increase significantly in order for the Internet to become the primary platform for distributed information. In the short term that means investing in universal ISDN solutions, moving over time to remote cable modems.

The Internet is just one piece of the growing market for inter-enterprise connectivity.

Digital believes that by the year 2000, end-user spending on inter-enterprise connectivity will reach $100 billion a year.

The business opportunities will fall into four broad categories: communication. . . information. . . transactions. . . and entertainment. They encompass everything from computer collaboration and electronic commerce. . . to on-line services and video-on-demand.

But we believe this is only part of a larger opportunity.

This $100 billion market is much like the interstate highway system. The interstates transformed commerce in America. Their biggest impact, however, was in creating vast new business opportunities along the way -- the shopping malls, service plazas, gas stations, restaurants, and motels.

Internetworking will have the same impact. It will create an environment in which new businesses will flourish.

As I said a moment ago, the network infrastructure still needs a lot of work. To build truly high-speed networks, we need significant improvements not only in bandwidth. . . but in processing power. . . interoperability. . . security. . . and navigation and access.

This will require a significant amount of investment over the next few years. But by overcoming these challenges, we have the chance to literally redefine computing and the information society.

* * *

I have talked about a lot of changes today -- from the continuing evolution of the PC and the explosive growth of the server market to the vast potential of internetworking.

But none of these changes would be possible without the semiconductor industry and the tremendous advances that have been made in the last two decades.

You are going to hear a lot of industry numbers during this conference, but I want to cite one statistic that clearly defines the importance of this industry.

Twenty-five years ago, semiconductors accounted for only 4 percent of worldwide sales of electronics equipment. By 1990 that had grown to 9.4 percent. And it will double this year to almost 19 percent.

Projections are that by the year 2000, semiconductors will account for 28 percent of electronics sales.

Clearly our appetite for advanced silicon products -- from microprocessors and D-RAM to cache RAM and PCI chips -- is only going to grow.

The fact that dozens of new fabs are under construction or being designed is an important recognition of the need for advanced fabrication techniques and increased capacity to meet this demand.

Emerging markets such as 64-bit computing, high-speed networks, speech recognition and wireless communication will require new levels of semiconductor performance and functionality.

And the emergence of PDA's, set-top boxes and other information appliances will challenge the industry to deliver chips that provide both low power and high performance.

In fact, it is hard to think of any significant advance in technology that will not be driven at least in part by silicon.

Semiconductors companies have been successful because they have delivered a product that is essential in meeting the information technology needs of customers.

And that brings me back to where I started.

Nothing is more important than our focus on the customer -- whether it is the CIO of a major corporation or the home consumer.

After all, technology is not an end in itself. It is an enabler -- a tool that allows people to become more informed. . . more productive. . . and more competitive.

Our success as a business ultimately depends <u>not only</u> on our technological excellence but on our ability to <u>harness</u> that technology to meet customers needs.

Through a continuing partnership between systems companies and the semiconductor industry, we can deliver the best of both worlds -- great technology <u>and</u> great products for our customers.

Notes:

Semiconductor Outlook: Will It Get Any Better?

Gene Norrett

Corporate Vice President and Director
Semiconductors Group
Dataquest Incorporated

Mr. Norrett is Corporate Vice President and Director of Dataquest's Worldwide Semiconductors Group and is responsible for all U.S. semiconductor research and coordination of Europe- and Japan-based semiconductor research. Prior to this, he was Director of Marketing, responsible for the worldwide marketing strategies. Mr. Norrett was also the founder of Dataquest's Japanese Semiconductor Industry Service and is a Director of Dataquest Japan.

Mr. Norrett coordinates the North American research with the Semiconductors Europe, Semiconductors Japan, and Semiconductors Asia services.

Before joining Dataquest, Mr. Norrett spent 14 years with Motorola's semiconductor product sector, serving in various marketing and management positions. Mr. Norrett was also a founder of the World Semiconductor Trade Statistics Program and was Chairman of the Board of Directors of the Statistics Committee. He speaks frequently at Client Industry and Trade Association conferences. In 1987 he was voted by the *San Jose Mercury News* as one of Silicon Valley's top 100 influential people.

Mr. Norrett's education includes a B.S. degree in Mathematics from Temple University and an M.S. degree in Applied Statistics from Villanova University.

gnorrett@dataquest.com

Agenda

- Semiconductor industry status
- Semiconductor drivers forecast
- Semiconductor industry forecast to 2000
- Capital spending plans and implementations
- Summary

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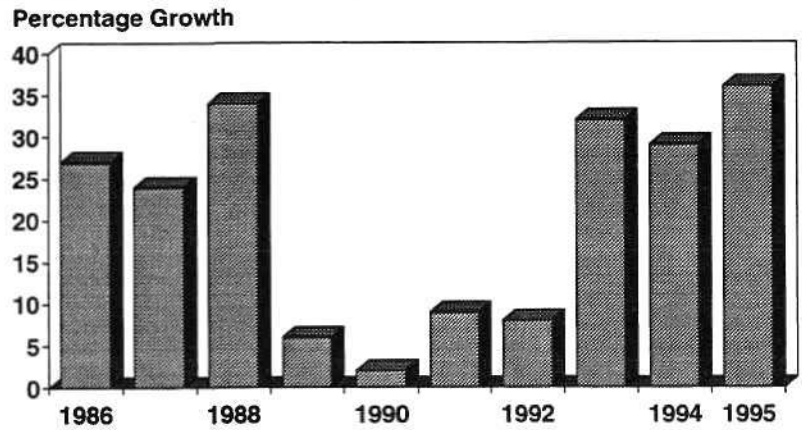
Worldwide Semiconductor Industry Track Record



Source: Dataquest
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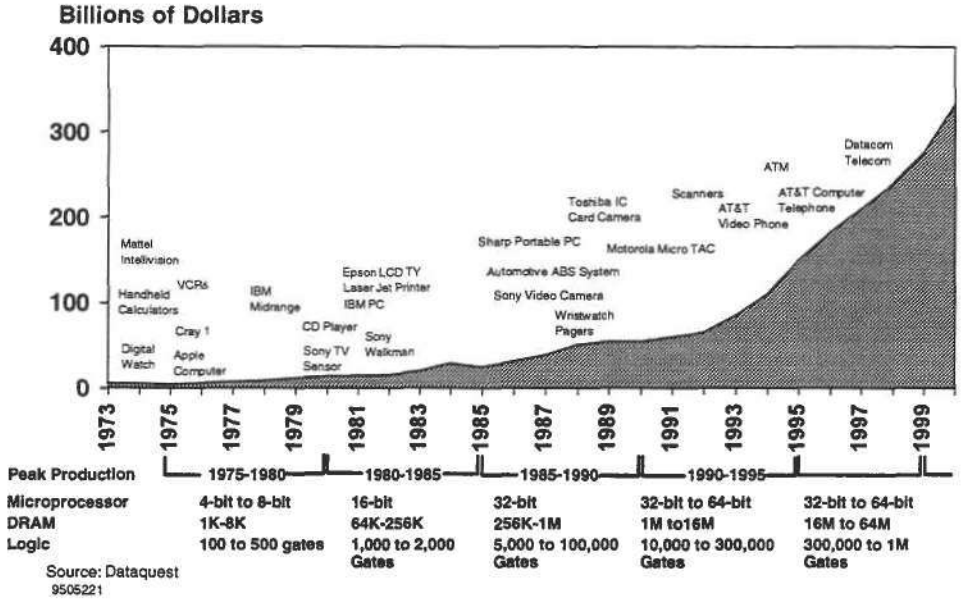
Technology in Transition



Source: Dataquest
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Integrated Circuit Pricing— 1990-1995

	1990	1991	1992	1993	1994	1995 Year to Date
MPR	5.09	4.70	4.67	5.04	5.61	6.19
MCU	2.74	2.77	2.76	2.95	3.11	3.56
MPU	19.77	26.31	38.10	51.50	64.60	71.77
DRAMs	4.38	5.18	5.75	8.76	12.20	14.88
SRAMs	3.76	3.57	3.25	3.66	4.88	5.26

Source: WSTS
9505222

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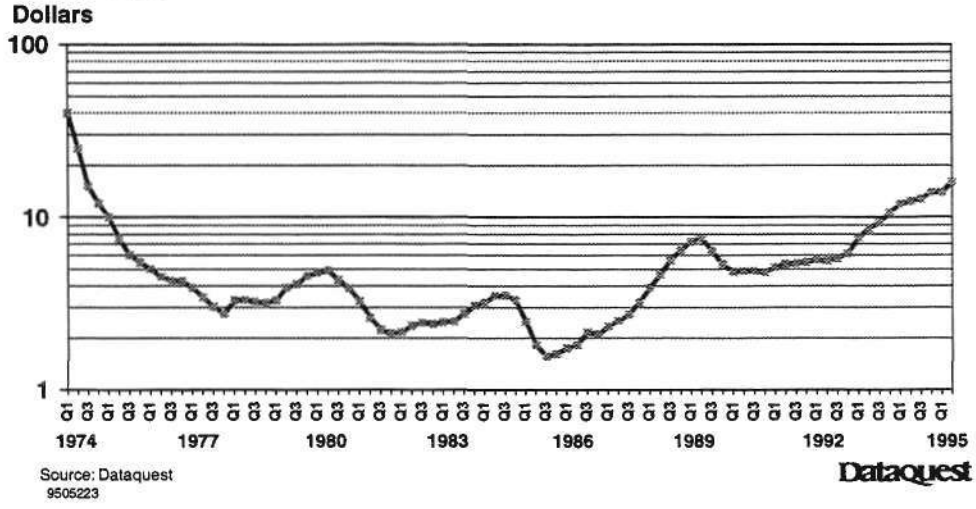
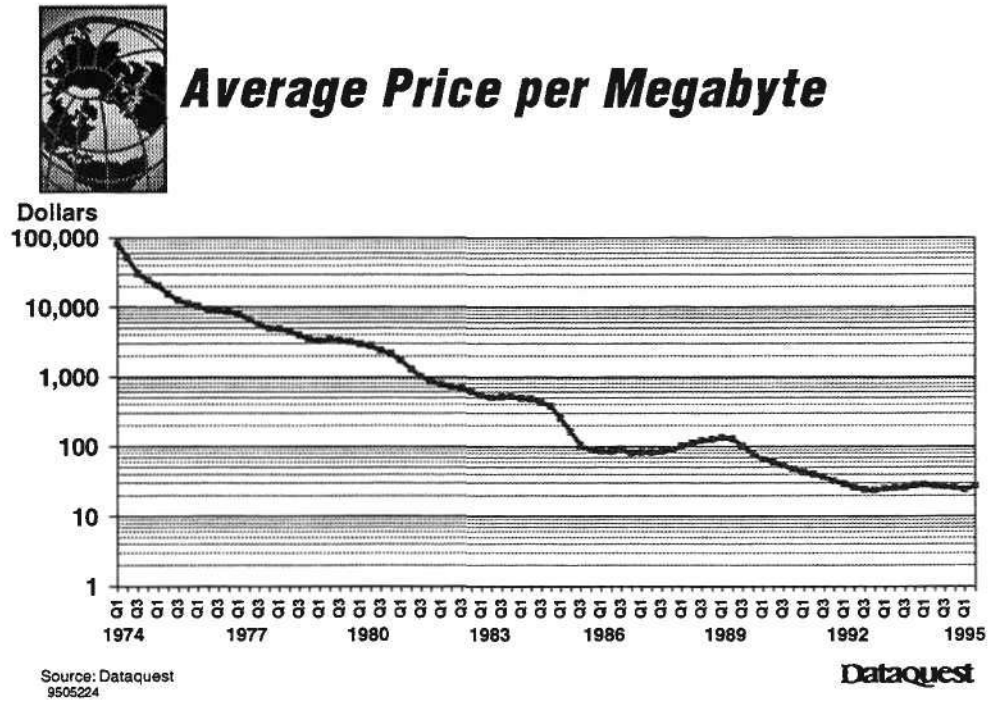
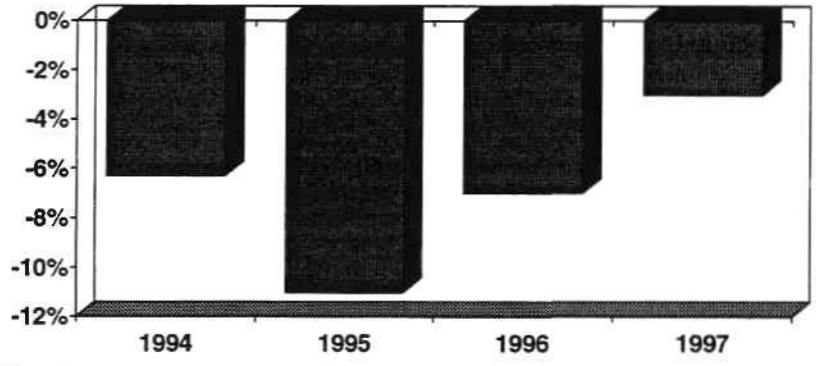
DRAM Average Selling Price



Average Price per Megabyte



4Mb-16Mb DRAM Supply/Demand Scenario



Note: Area less than zero shows shortage.

Source: DRAM Supply-Demand Quarterly Statistics, Dataquest
9505225

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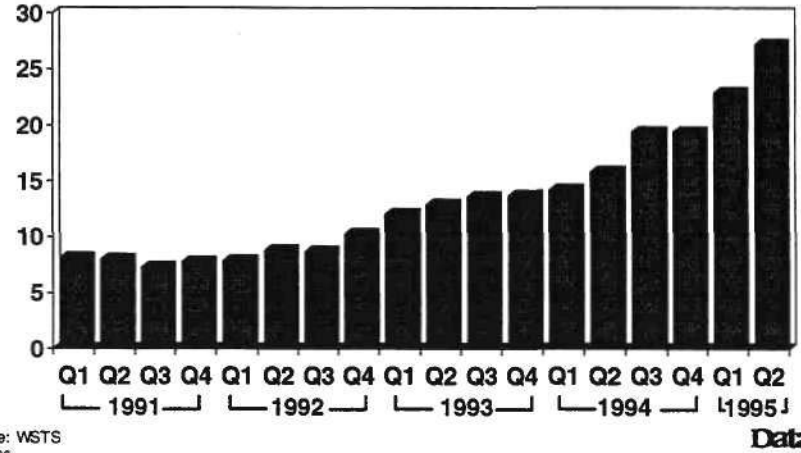
Semiconductor Industry Backlog

Billions of Dollars



Source: WSTS
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Will It Get Any Better?

Chip Supplier

Chip Buyer

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Semiconductor Drivers

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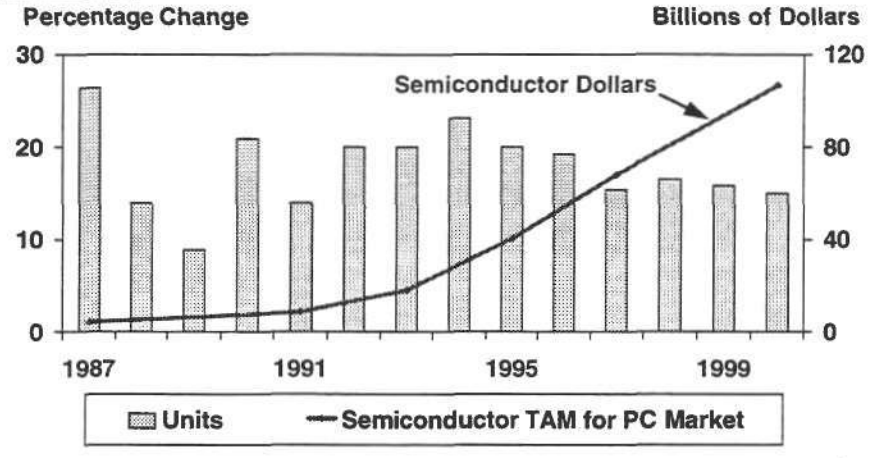
Worldwide PC and Related Semiconductors



Source: Dataquest
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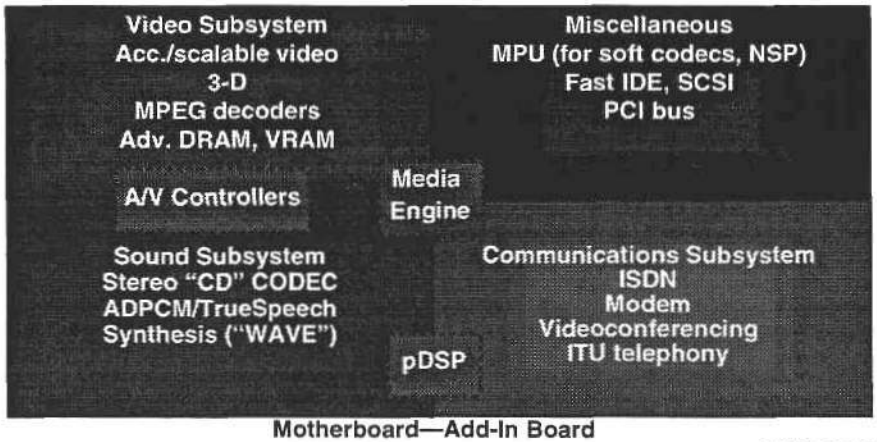
Multimedia PC Chip Opportunities



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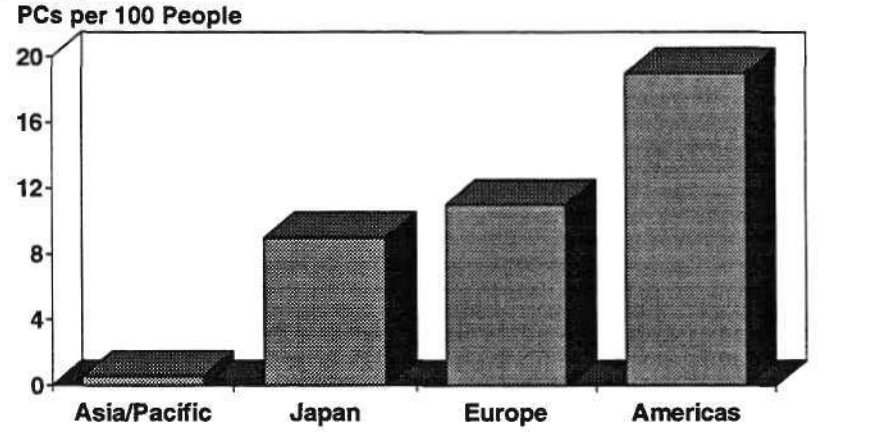
PC Penetration—1994



Source: Dataquest
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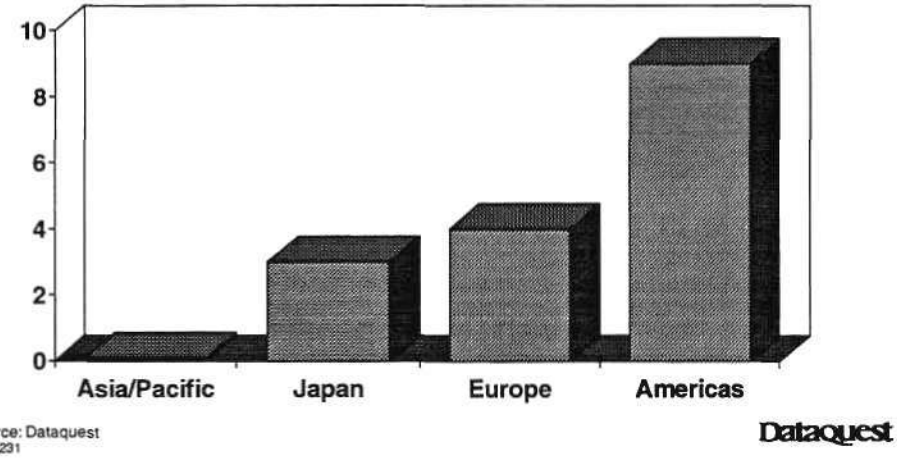
Cellular and Broadband PCS Penetration—1994



Source: Dataquest
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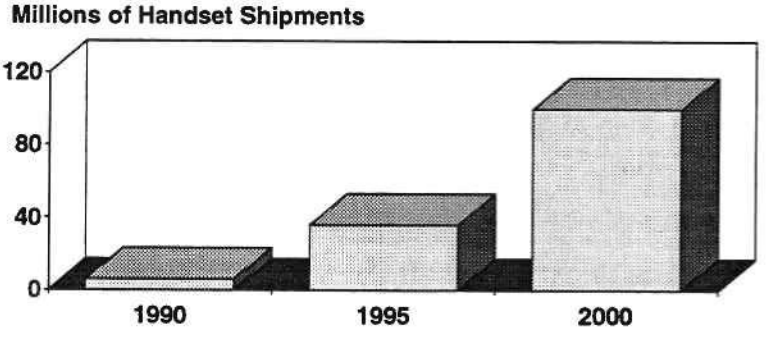
Cellular and Broadband PCS Market



	1990	1995	2000
TAM Semiconductor (Billions of Dollars)	0.5	2.5	7.5
Millions of Subscribers	10	77	330

Source: Dataquest
9505232

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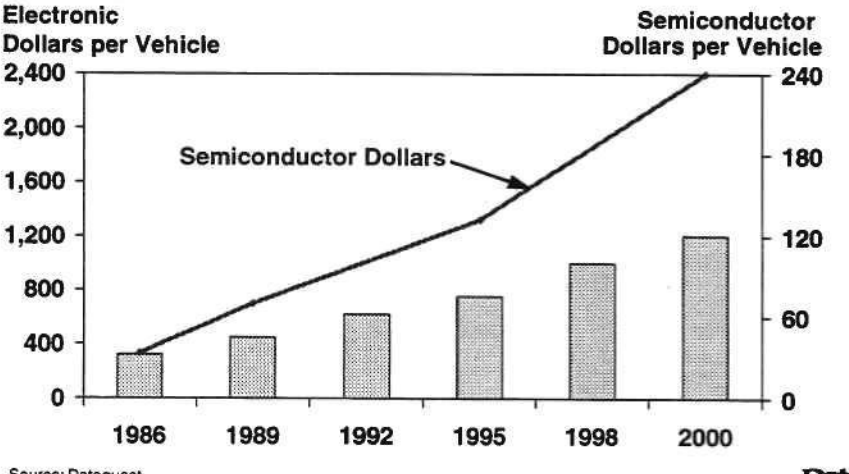
Transportation Electronics— Revenue per Unit



Source: Dataquest
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Multimedia/Consumer Semiconductor Opportunity

	2000
■ TV video games	$2.4 Billion
■ Digital set-top boxes	$1.6 Billion
■ Sound chips	$1.0 Billion
■ Videoconferencing	$1.0 Billion
■ Digital Videodisks (DVD)	$.7 Billion

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Are We So Optimistic?

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Reality: 1994-2000

Global economy	$27 trillion → $33 trillion
Global population	5.7 billion → 6.2 billion
Middle class population	1.2 billion → 1.4 billion
Politics	Communism → Capitalism
Electronics industry	World's largest manufacturing industry
Semiconductor industry	$110 billion → $330 billion

Source: The Dun & Bradstreet Corporation, U.N., McGraw Hill, Dataquest
9505236

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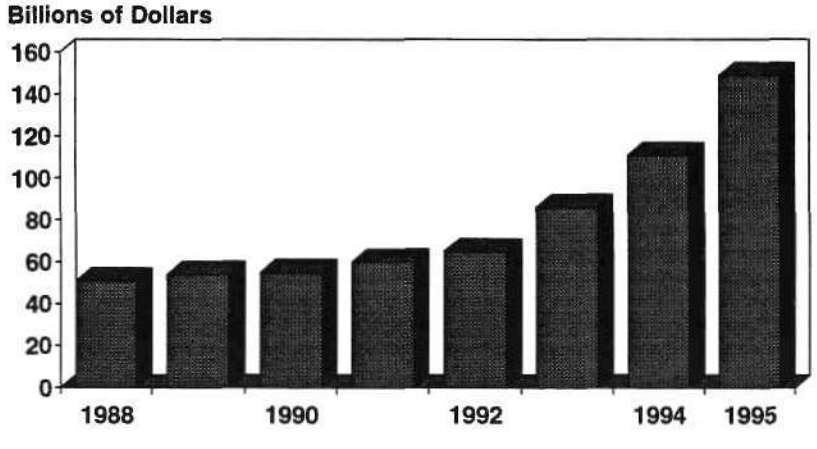
Semiconductor Forecast 1988-1995



Source: Dataquest
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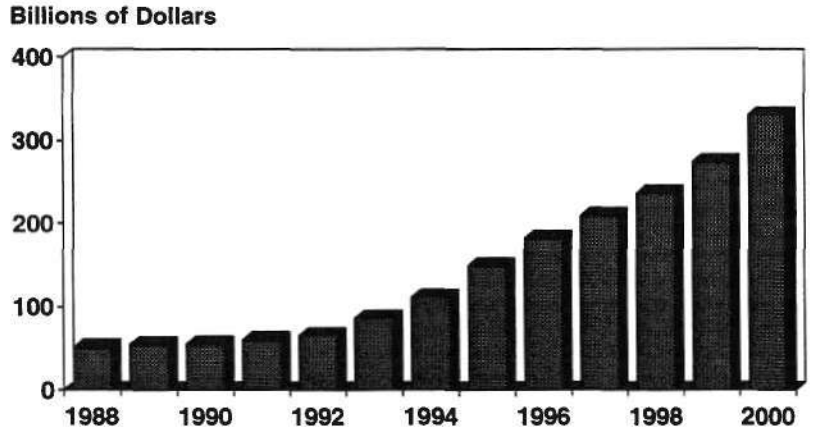
Semiconductor Forecast 1988-2000



Source: Dataquest
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Semiconductor Revenue Forecast

	1995 $B	Percent Growth	1996 $B	Percent Growth
United States	47.8	33.0	60.3	26.2
Europe	29.0	39.3	35.5	22.5
Japan	41.8	34.9	47.6	13.8
Asia/Pacific	31.2	36.5	39.4	26.7
Worldwide	149.8	35.5	182.9	22.1

Source: Dataquest
9505239

Dataquest

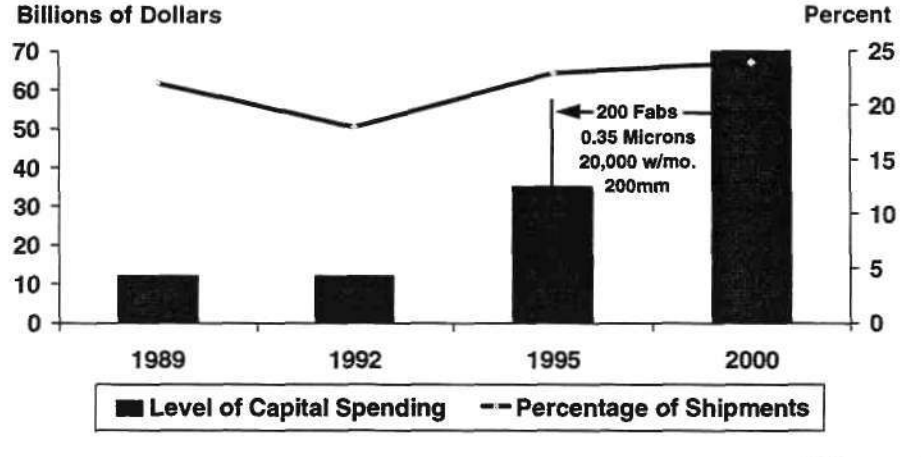
Semiconductor Revenue Forecast

	1995 $B	Percent Growth	1996 $B	Percent Growth
Memory	51.3	52.2	66.2	29.1
Microcomponents	34.7	34.2	43.9	26.6
Logic	23.8	23.3	26.9	13.2
Analog	19.1	23.8	22.3	17.1
Discrete	14.1	30.8	15.9	13.2
Optoelectronic	5.1	30.0	5.7	12.5
Total	149.8	35.5	182.9	22.1

Source: Dataquest
9505240

Dataquest

Capital Spending— Relief Is on the Way



Source: Dataquest
9505241

Dataquest

Summary: Will It Get Better? Yes and No

- 20% compound annual growth rate for semiconductors
- Pervasiveness increases to 22% at end of decade
- Capital spending will not keep up with demand
- Average selling price increasing
- Shortage of capital and people

9505241A

Dataquest

Notes:

Notes:

Semiconductors—The Building Blocks of a New World Order

Moderator

Gene Norrett
Vice President and Director, Dataquest Incorporated

Panelists

Eric T. Miller
Senior Vice President, Donaldson, Lufkin and Jenrette

Harjit Bhalla, Ph.D.
Vice President and Director, Motorola Inc.

Joseph W. Duncan
Vice President , Corporate Economist and Chief Statistician
The Dun & Bradstreet Corporation

Chintay Shih, Ph.D.
President, Industrial Technology, Research Institute Taiwan

Martin Reynolds
Director and Principal Analyst, Dataquest Incorporated

Moderator: Semiconductors—The Building Blocks of a New World Order

Gene Norrett

Corporate Vice President and Director
Semiconductors Group
Dataquest Incorporated

Mr. Norrett is Corporate Vice President and Director of Dataquest's Worldwide Semiconductors Group and is responsible for all U.S. semiconductor research and coordination of Europe- and Japan-based semiconductor research. Prior to this, he was Director of Marketing, responsible for the worldwide marketing strategies. Mr. Norrett was also the founder of Dataquest's Japanese Semiconductor Industry Service and is a Director of Dataquest Japan.

Mr. Norrett coordinates the North American research with the Semiconductors Europe, Semiconductors Japan, and Semiconductors Asia services.

Before joining Dataquest, Mr. Norrett spent 14 years with Motorola's semiconductor product sector, serving in various marketing and management positions. Mr. Norrett was also a founder of the World Semiconductor Trade Statistics Program and was Chairman of the Board of Directors of the Statistics Committee. He speaks frequently at Client Industry and Trade Association conferences. In 1987 he was voted by the *San Jose Mercury News* as one of Silicon Valley's top 100 influential people.

Mr. Norrett's education includes a B.S. degree in Mathematics from Temple University and an M.S. degree in Applied Statistics from Villanova University.

gnorrett@dataquest.com

Panelist: Semiconductors—The Building Blocks of a New World Order

Eric T. Miller

Senior Vice President
Donaldson, Lufkin and Jenrette

Mr. Miller is a Senior Vice President of Donaldson, Lufkin and Jenrette with whom he's been associated for 16 years as Chief Investment Officer and Chairman of the Stock Selection Committee. He is also comanager of the Portfolio Advisory Service.

Prior to joining DLJ, Mr. Miller was Chief Investment Strategist at Oppenheimer and Co. for seven years after leaving Dominick and Dominick, where he had been Director of Research and Head of the Investment Department. He entered the investment profession with The New York Trust Company

Mr. Miller received his B.A. degree at Dartmouth College and studied for his master's degree at New York University's Graduate School of Business. He served as a U.S. Marine Corps officer in Korea.

Panelist: Semiconductors—The Building Blocks of a New World Order

Harjit Bhalla, Ph.D.

Vice President and Director
Planning and Market Research
World Marketing
Motorola Semiconductor Products Sector, Motorola Inc.

Dr. Bhalla is Vice President and Director of Planning and Market Research, World Marketing, at Motorola Semiconductor Products Sector. He was promoted to his current position in 1990, and added responsibility for providing a comprehensive view of the global semiconductor industry and analysis of strategic business issues.

Dr. Bhalla joined Motorola's Semiconductor Products Sector as a Research Analyst in 1973 after earning a Ph.D. degree in operations research from the University of Massachusetts at Amherst. In 1975, he moved to the Sector's Planning Department, with responsibility for strategic planning, forecasting, and business analysis of Motorola's semiconductor business.

Prior to earning a doctoral degree, Dr. Bhalla received a B.S. degree in engineering from Panjab Engineering College in Chandigarh, Panjab, India. He also received an M.S. degree in industrial engineering from the University of Massachusetts.

Economic Growth

- Stable growth in developed economies
- Vast new markets in emerging countries
  - A mad rush to join the 20th century
    - Political ideologies take back seat to economic growth

M95.175

MOTOROLA

Demand Trend: Driven by Lifestyle

- Very strong, significant acceleration in last three years
  - Electronic goods enable higher quality lifestyle
  - New mobile lifestyle with global connectivity is emerging
  - More functionality/lower price
  - Communication infrastructure is prerequisite to economic growth
  - Environmental/energy conservation efforts demand electronic solutions in energy management
  - Evolution towards intelligent traffic systems

M95.175

MOTOROLA

Brand New Technology Bazaar Emerges

- New markets will emerge from the synthesis of low cost hardware, software
  - Global in nature
  - Will NOT be a linear extrapolation of existing industries
  - No "legacy rights," new companies with creative business models will achieve leadership

M95.175 MOTOROLA

Summary

- Unprecedented leveraging of individual lifestyles
- Electronics equipment achieves economies of mass production, while delivering benefits of customization
- Within reach of billions of people for the first time

M95.175 MOTOROLA

Notes:

Panelist: Semiconductors—The Building Blocks of a New World Order

Joseph W. Duncan

Vice President
Corporate Economist and Chief Statistician
The Dun & Bradstreet Corporation

Dr. Duncan joined The Dun & Bradstreet Corporation in January 1982 and serves as the Corporate Economist and Chief Statistician. He was elected an officer of the corporation in 1986 and was named Vice President in 1989.

Dr. Duncan oversees the quality of the databases maintained at all D&B divisions. He also works with the extensive information resources of The Dun & Bradstreet Corporation to develop new economics-related products and services, to analyze economic trends, and to evaluate the economic impact of government policies and business practices. He heads the corporate Economic Analysis Department.

An active contributor of economic commentary and analysis and the author of over 100 published technical articles, Dr. Duncan is the executive editor of *Dun & Bradstreet Looks at Business*, a bimonthly economics newsletter featuring data from the corporation's own proprietary business information files. He is also the author of the *Statistics Corner in Business Economics*, the journal of the National Association of Business Economics. He is the coauthor of the book entitled *Statistics for the 21st Century*, published in 1995 by Irwin Professional Publishing. This book is addressed to business decision makers as a call for action to improve the statistical information base for public and private decision making.

Dr. Duncan was previously chief statistician for the Office of Information and Regulatory Affairs in the Office of Management and Budget where he was responsible for national statistical policy. He served as the U.S. representative to the United Nations Statistical Commission, of which he was chairman in 1981.

Dr. Duncan is a past president of the National Association of Business Economists (1992-1993). He was elected a fellow of the association in 1989. He is also an elected member of the Conference of Business Economists and the International Statistical Institute (ISI), serving as a vice president and member of the executive committee of the ISI (1991-1993). He received the Adolphe Quetelet medal of the ISI in 1994 for outstanding leadership of the association. He is a past president and chairman of the National Economists Club, past president of the Forecasters' Club of New York, a fellow for the American Statistical Association, and the founding chairman of the Statistics Committee of NABE.

Dr. Duncan received his B.S.M.E. from Case Institute of Technology, an M.B.A. from Harvard Graduate School of Business Administration, and a Ph.D. in Economics from Ohio State University. He also attended the London School of Economics. He has lectured at a number of universities and has taught city planning at Ohio State University and the University of Rhode Island.

Panelist: Semiconductors—The Building Blocks of a New World Order

Chintay Shih, Ph.D.
President
Industrial Technology
Research Institute, Taiwan

Dr. Shih is the President of the Industrial Technology Research Institute (ITRI). ITRI is an R&D institution founded under the auspices of the government to serve the technological needs of Taiwan's industry. It is organized under 10 divisions serving industry sectors ranging from electronics, computers, communication, optoelectronics, metrology to machinery, automation, materials, chemicals, textiles, aerospace, energy, and environmental protection. Dr. Shih joined the Electronics Research and Services Organization (ERSO) of ITRI as an engineer manager in 1976 and became its general director and ITRI vice president in 1984. During his tenure, Dr. Shih was instrumental in building ERSO into a strategic technical center for the development and growth of Taiwan's electronics industry, and has directed and participated in several major milestone ventures including the founding of the United Microelectronics Corporation (UMC) and the Taiwan Semiconductor Manufacturing Company (TSMC). He was appointed executive vice president of ITRI in 1989 and became president in 1994.

Dr. Shih is a Fellow of the IEEE. He has served as the president of the Chinese Institute of Electrical Engineering and is the managing director of the Taiwan Electrical and Electronics Manufacturers' Association and the deputy executive secretary of the NII Steering Committee of Executive Yuan as well as a member of the NII Civil Advisory Council.

Dr. Shih received his undergraduate degree in electrical engineering from the National Taiwan University in 1968, and a Ph.D. degree in electrical engineering from Princeton University in 1975. He also received a master's degree of management from Stanford University in 1985.

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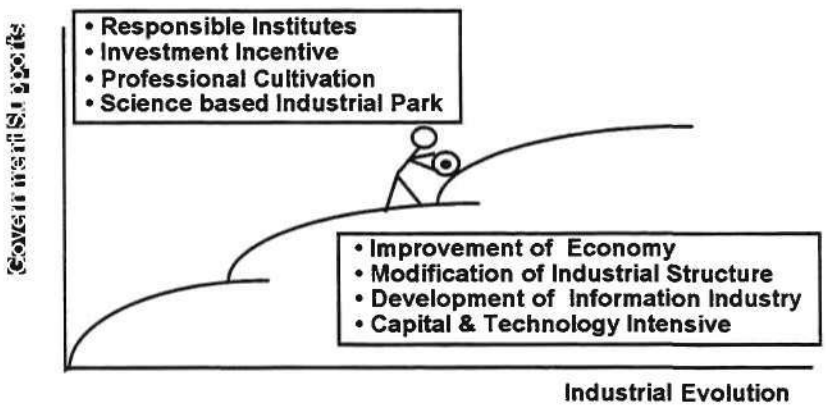
Industrial Technology Research Institute

Semiconductor Industry becomes the Focus of Asian-Pacific Region



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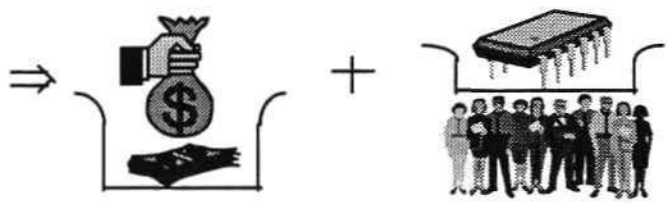
Industrial Technology Research Institute

The Irreplaceable Star

High Profit-making Capability & Bright Industrial Prospects



- **Sufficient Capital**
  - -- Tenacious Stock Market
  - -- Sustaining Bank Loans
  - -- Conglomerate Capital
  - -- Overseas Capital

- **Ample Talent**
  - -- Returned Overseas Experts
  - -- Ambitious Younger Generation
  - -- Talents from other Professions
  - -- Foreign Workers
  - -- Supporting Industries

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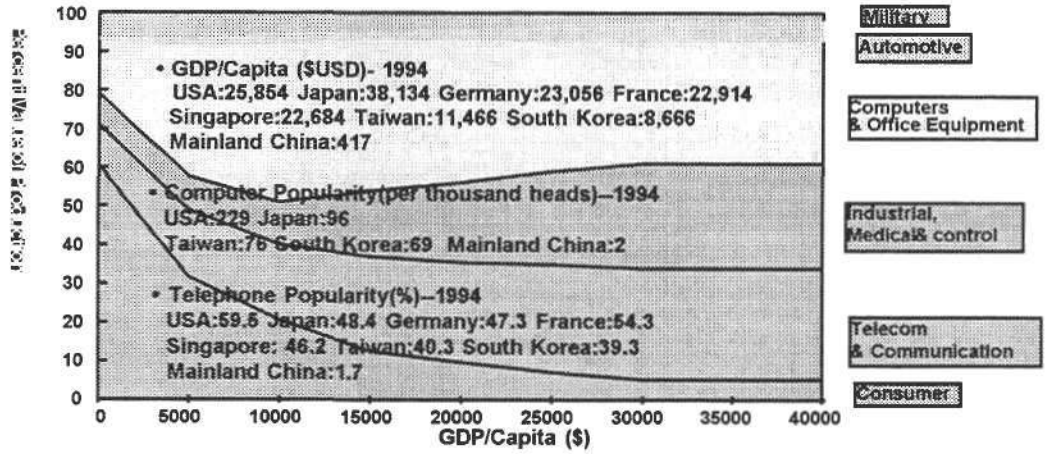
Industrial Technology Research Institute

Flourishing Industrial Development in Response of Demand Expectation



source:BPA (Technology &Management) Ltd

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Industrial Technology Research Institute

Revised Map of Global Semiconductor Industry

- Discernible International Division of Labor
- Increasing Market Share & Production Value from Asian Pacific Region
- Asian-Pacific Players Achieve Significant Roles on the International Stage

Notes:

Panelist: Semiconductors—The Building Blocks of a New World Order

Martin Reynolds

Director
PC Technology Progam
Computer Systems and Peripherals Worldwide
Dataquest Incorporated

Mr. Reynolds is the Director of Dataquest's PC Technology program, which analyzes desktop, notebook, and handheld personal computer products technologies and trends. The analyses focus on product costs and viability of technologies, which are factors that relate directly to the success or failure of products in the market.

Prior to joining Dataquest, Mr. Reynolds was employed by Computer Intelligence InfoCorp where he developed the Technology Roadmap Services. Prior to that, Mr. Reynolds spent nine years with Memorex Telex as Director of Engineering, where he was responsible for the design and development of IBM 3270 communications and personal computer products, system architectures, and technological planning. Before joining Memorex Telex, Mr. Reynolds lived and worked in the United Kingdom, where he designed and developed advanced electronic cash registers, wrote software as a consultant in the banking industry, and was involved in the early development of IBM-compatible personal computers. He has been involved with industry groups including the Video Electronics Standards Association (VESA) and the Micro Channel Developers Association (MCDA).

Mr. Reynolds, originally from London, England, was educated at Oxford University and holds an M.A. degree and a B.A. degree in engineering science.

Technology Stocks: Picking the Right Investments

Ronald E. Elijah
Portfolio Manager
Value Plus Growth Fund
Robertson, Stephens & Company

The Robertson, Stephens Value Plus Growth Fund is managed by Mr. Elijah, a longtime successful analyst with 16 years of experience in a variety of business sectors. He began his career as an underwriter bonding contractor in the mid-1970s. From there, he moved to Wall Street in 1980, beginning his career as a technology analyst for Montgomery Securities.

Mr. Elijah joined Robertson, Stephens & Company (RSCO) in 1985 and left in 1989. While at RSCO, he provided analytical coverage on several companies and sectors including technology, environmental, and business services. From 1990 through 1992, Mr. Elijah worked as an investment advisor for a $400 million hedge fund known as Water Street Capital. Water Street Capital from 1990 to 1992 had principally two funds, a hedge fund and a "short" only fund. While at Water Street, his analytical research broadened into consumer retailing and wholesaling natural resources and other sectors. After rejoining RSCO, Mr. Elijah was selected to manage the Value Plus Growth Fund in February 1992.

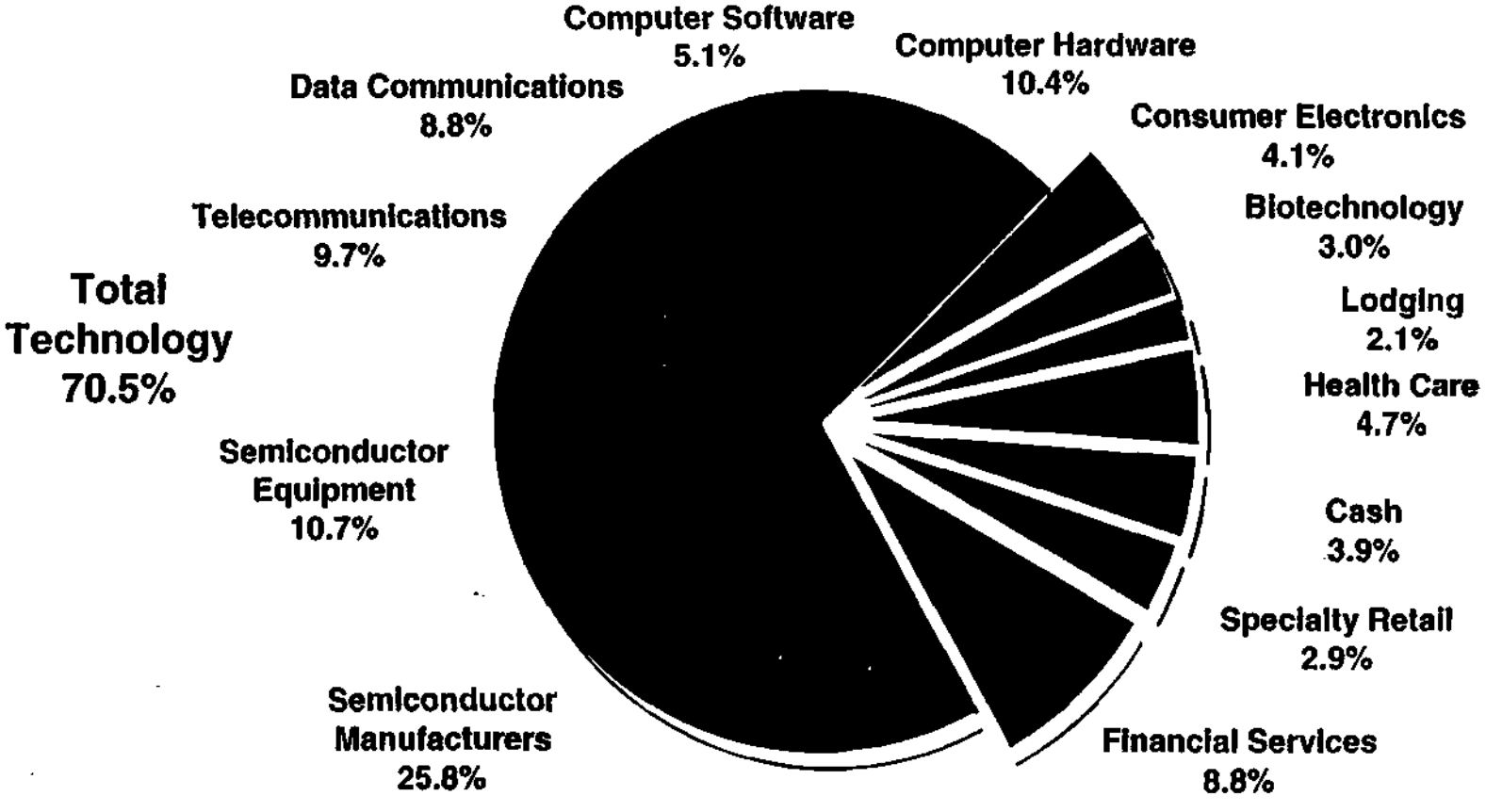
Fundamentals of Technology Investing

Ron Elijah, Portfolio Manager
Robertson, Stephens & Co.

ROBERTSON
STEPHENS &
COMPANY

RS Value + Growth Fund Asset Allocation - 10/6/95

Total Assets $1.4 Billion



Source: Robertson, Stephens

Market View and Investment Themes

Valuation Historical Considerations - 10/6/95

S&P Industrials 683.45

		Years	Average* S&P Industrials P/E High	Average CPI	Average Yield Aaa Bond
Moderate Inflation	<	1958-1967	19.2x	1.7%	4.5%
	<	1968-1972	19.2x	4.6%	7.2%
High Inflation	<	1973-1977	12.2x	7.7%	8.2%
	<	1978-1982	9.6x	9.8%	11.6%
Disinflation	<	1983-1990	15.3x	3.9%	10.4%
Low Inflation	<	1991-1994	18.0x	3.2%	8.0%
		1995E	16.8x	2.8%	7.2%
		1996E	15.4x		
		37 Year Avgs.	16.1x	4.6%	8.0%

* S&P Industrials P/E Before Extraordinary Items.

Source: Standard and Poors and First Call

Relative Valuation RS Value + Growth Fund - 10/6/95

	Price	1995E EPS	1996E EPS	YR/YR % Change	CAL 96E P/E
S&P Industrials	$683.45	$41.15	$44.50	+8.5%	15.4x
RS Value + Growth Fund	$26.68	$1.30	$1.68	+28.7%	15.9x

Source: First Call and Robertson, Stephens

Dominant Investment Theme

Technology Theme - World Going Digital

Productivity Improvement

- Restructuring
- Retooling
- Reengineering
- Reinventing

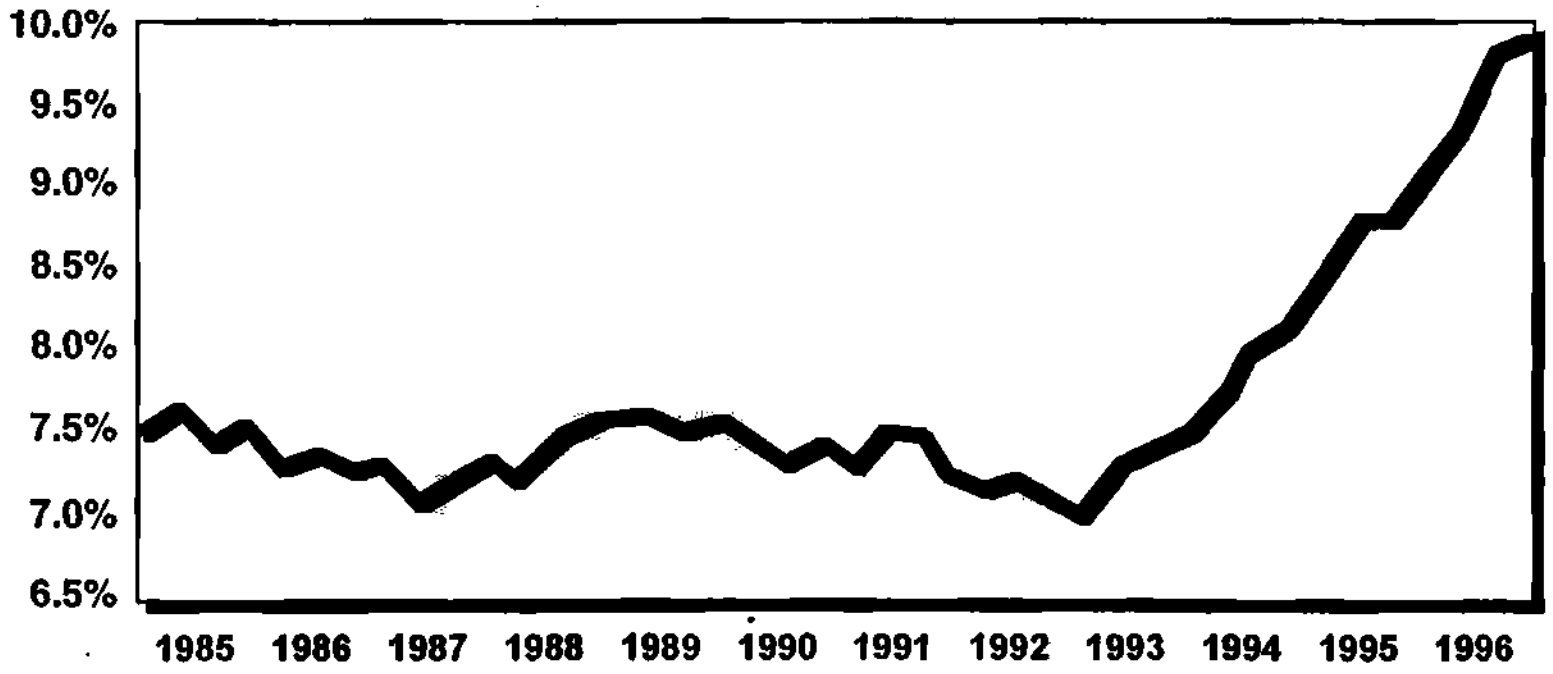
IBM Dominance Reduced

- Open Systems
- Multiple Platforms
- Intel, Microsoft, Compaq – PACE SETTERS

Global Opportunities

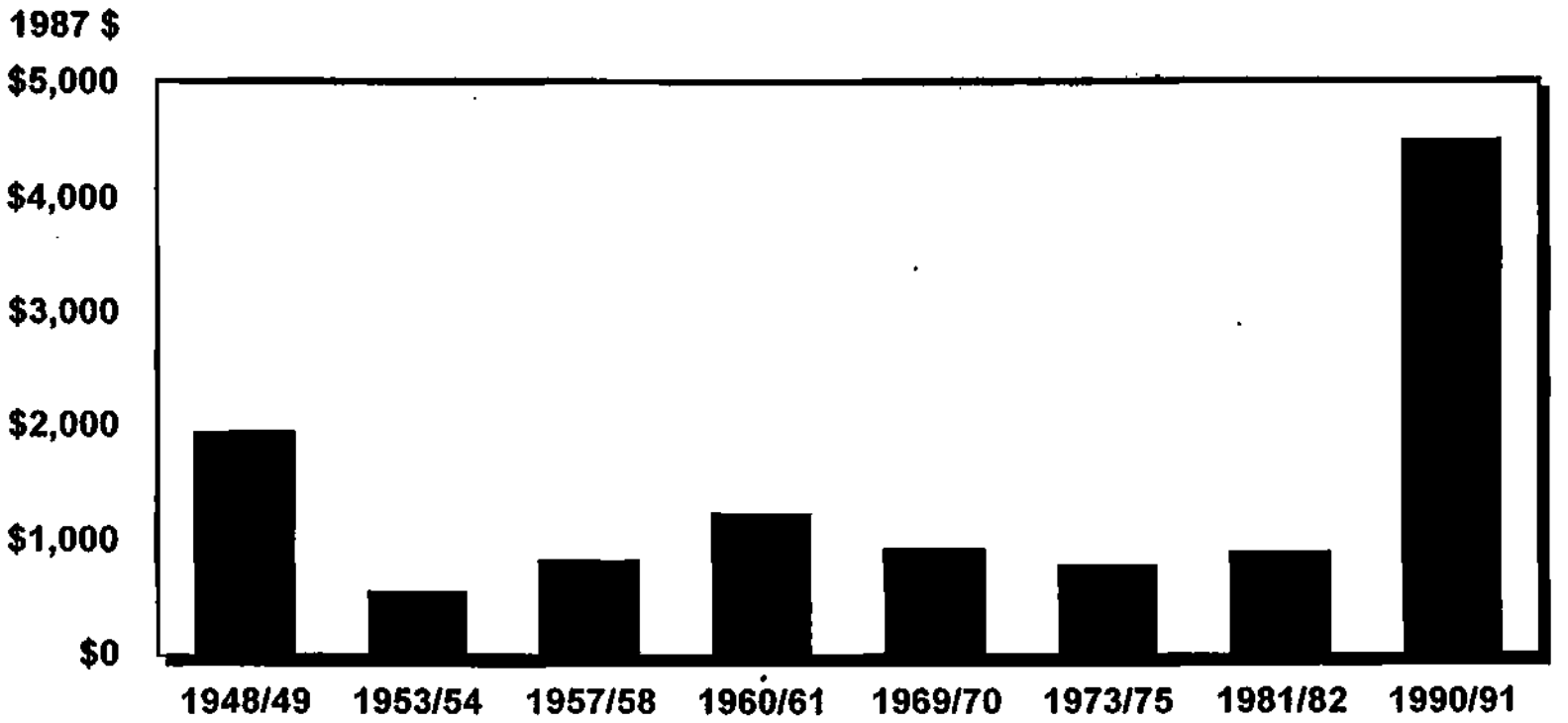
- Fall of Berlin Wall/ Russian Coup
- Emerging Markets/ Third World Development
- NAFTA, GATT – Free Trade
- Global Capital Flows/ World Capitalism

Durable Equipment as % of U.S. GDP



Sources: Bureau of Economic Analysis

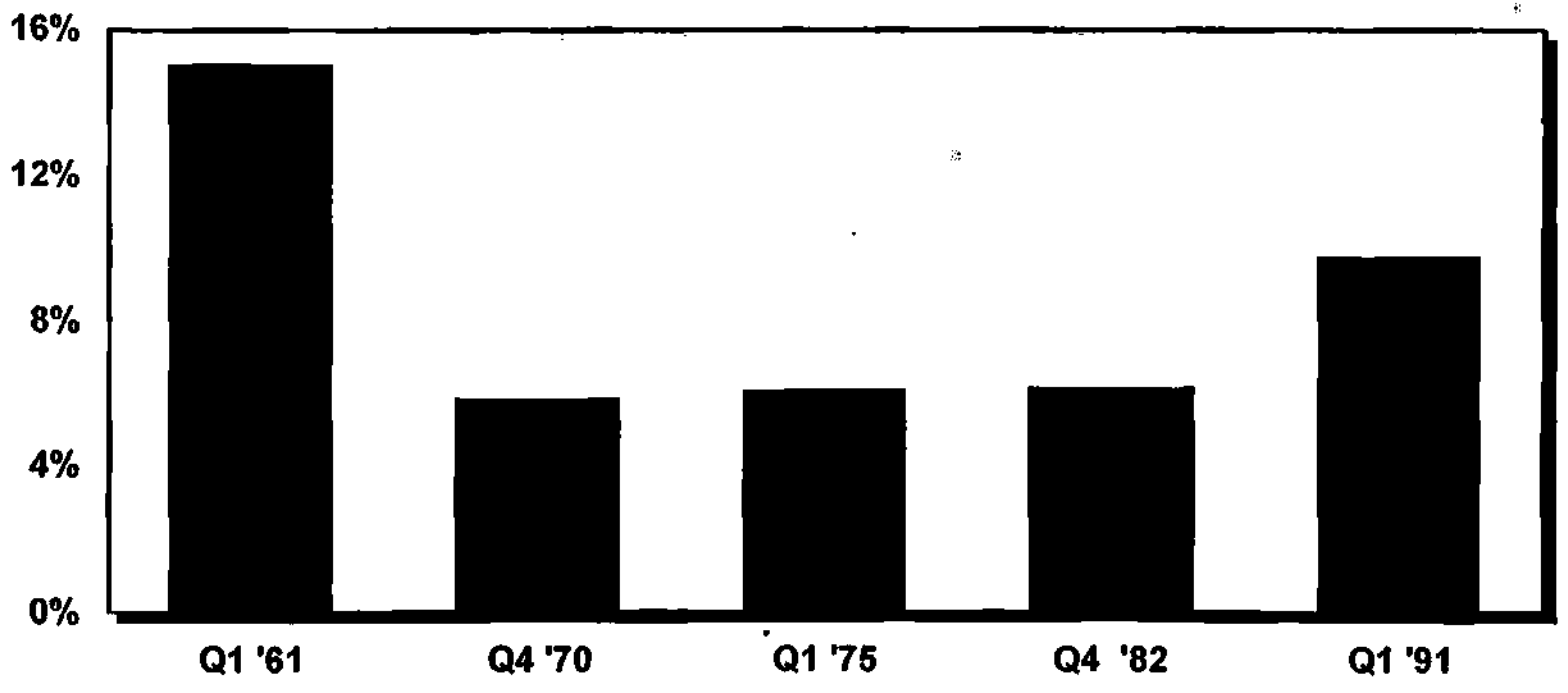
Companies Are Investing in Their Employees



17-Quarter Cumulative Change in Capital Spending on Equipment/Worker, as Measured from Economic Trough
Sources: U.S. Dept. of Commerce; BLS; DLJ

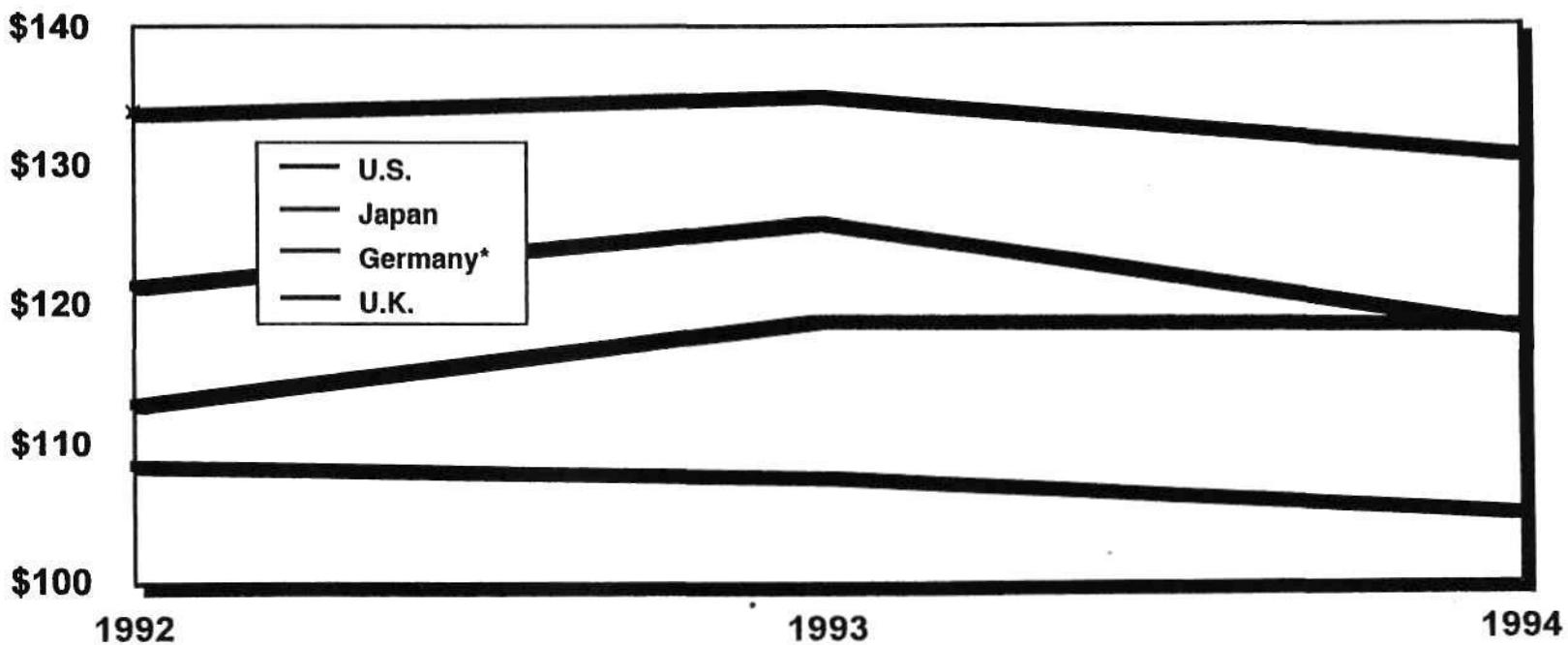
Increase in U.S. Nonfarm Productivity

17 Quarters After Recovery Began



Data: Bureau of Labor Statistics

Unit Labor Costs

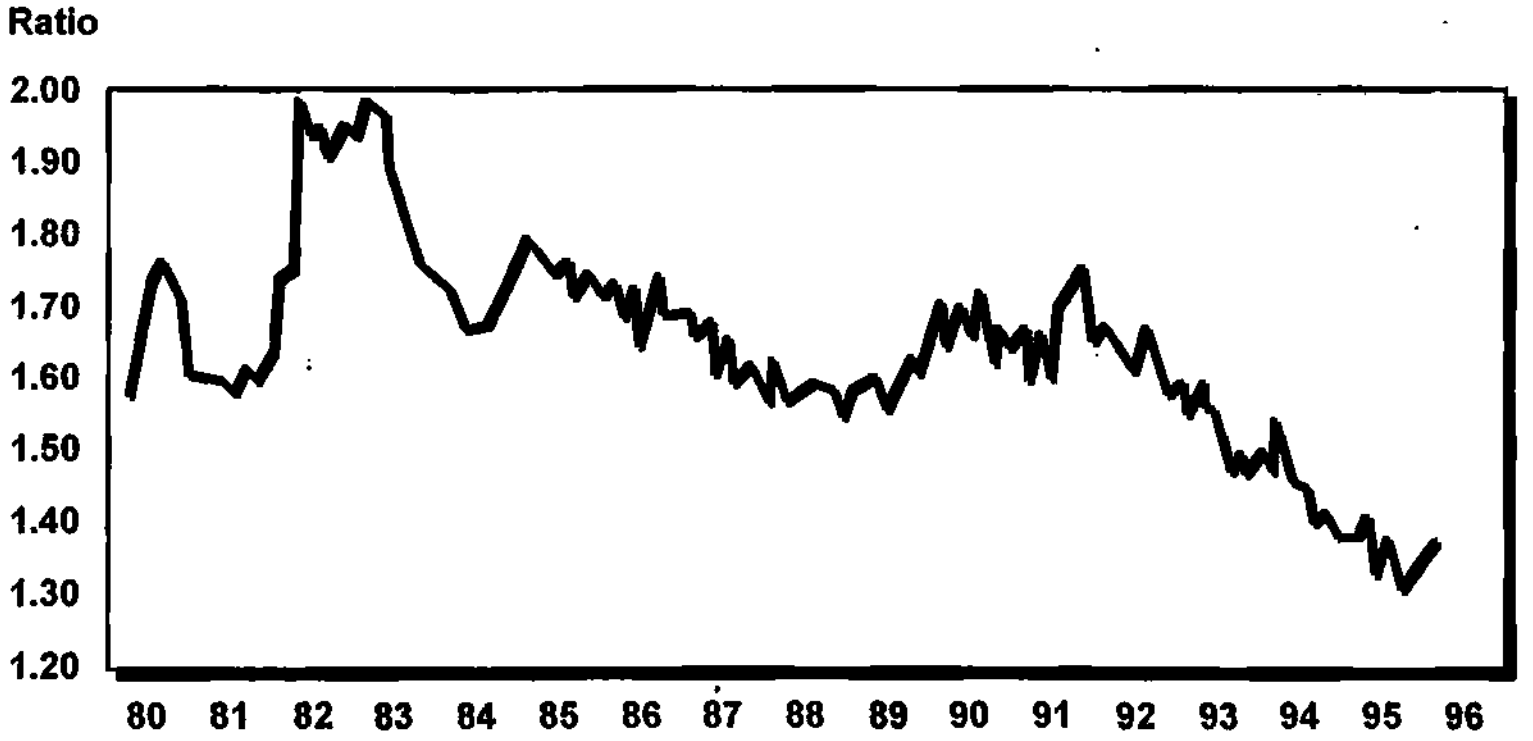


* Western Germany Only

Source: Datastream

Better Asset Management

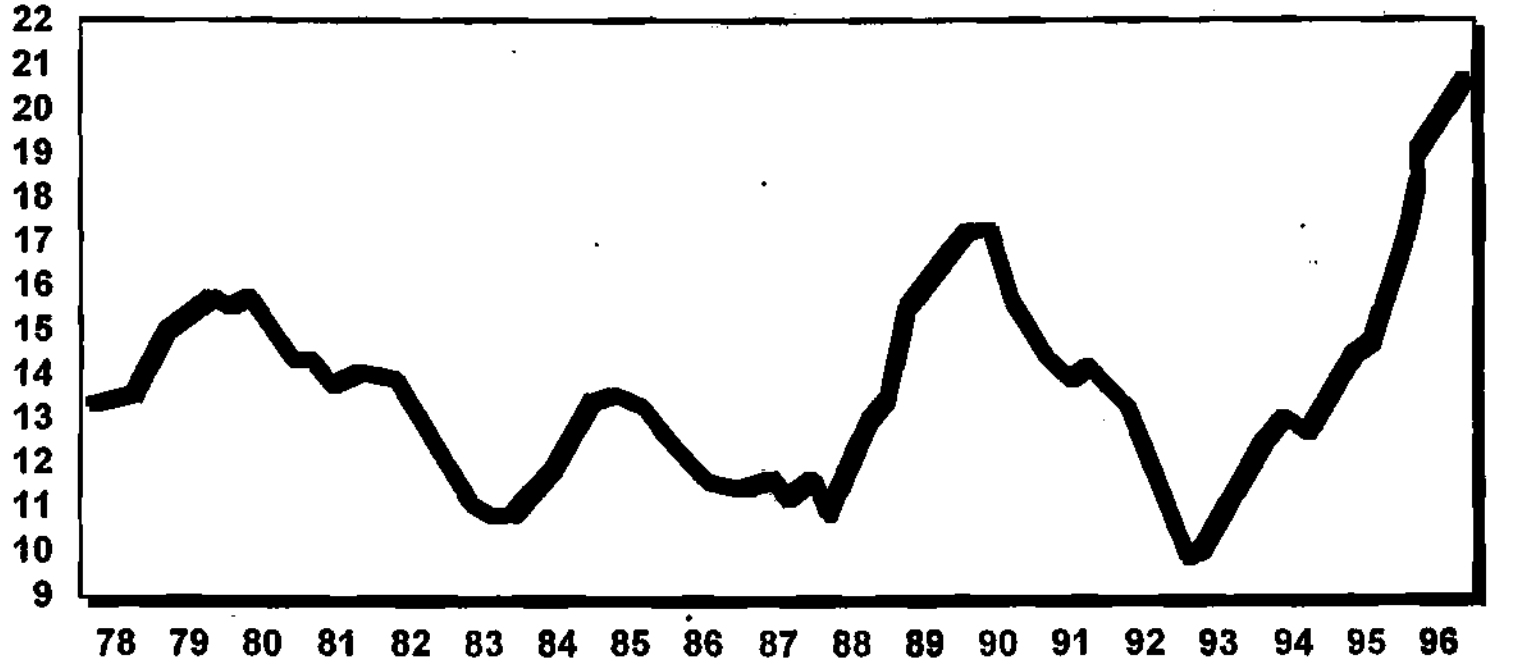
Manufacturing Inventory/Sales Ratio



Sources: Bureau of Census

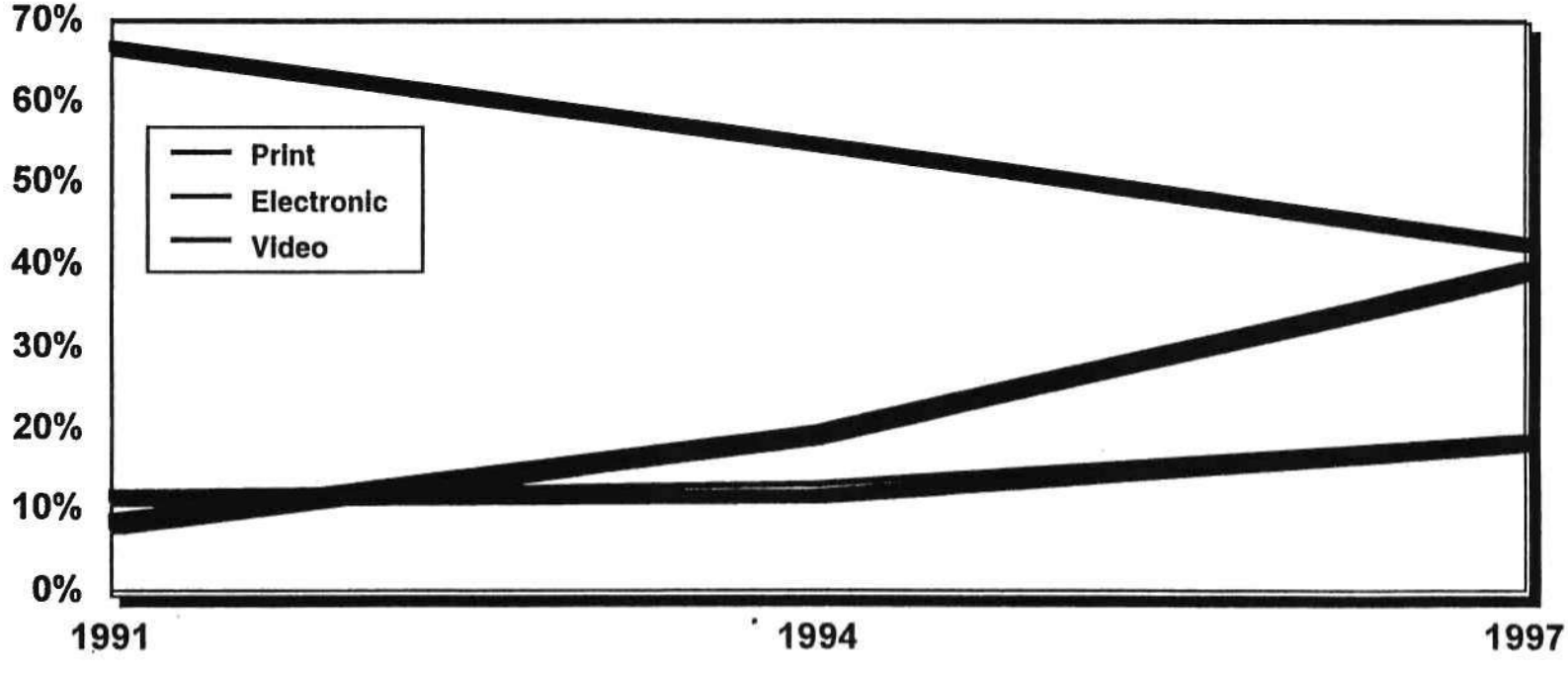
S&P 500 ROE at High Levels

Return on Equity (%)



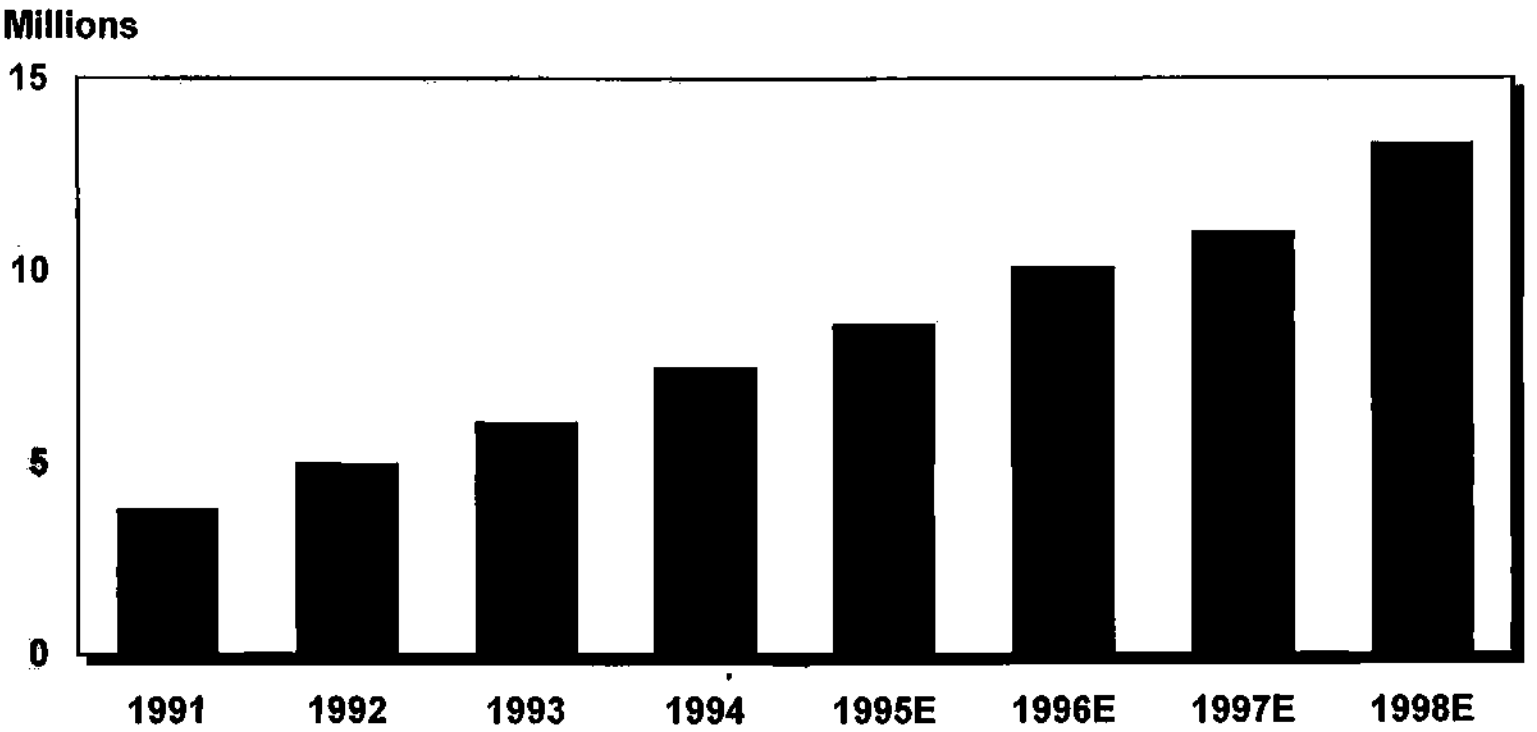
Sources: S&P, Goldman Sachs Portfolio Strategy

Total Employee Communications by Medium



Source: Cognitive Communications Inc.; Xerox Corporation

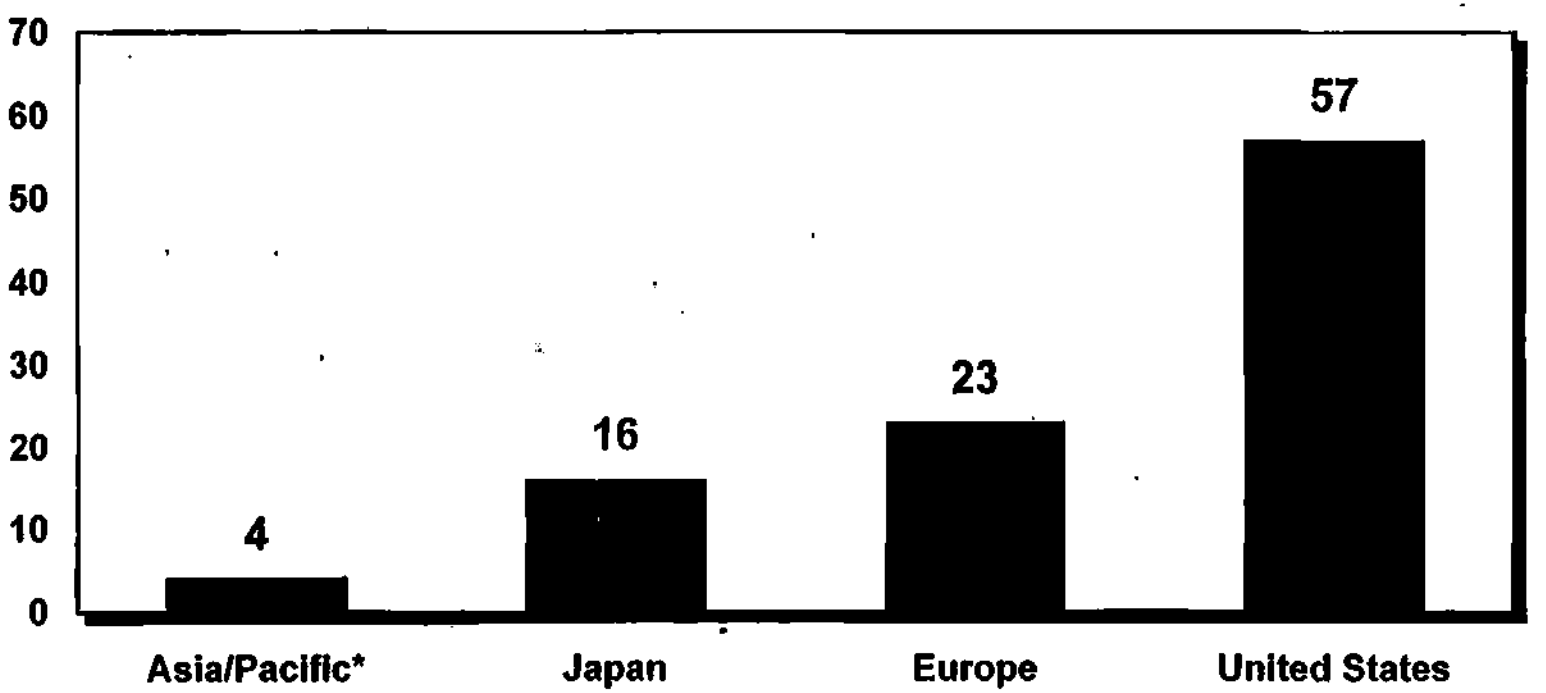
Annual U.S. Home PC Purchases



Source: Forrester Research Inc., Computer Intelligence InfoCorp

PC Catch-Up Effect

Personal Computers per 100 Workers: 1994

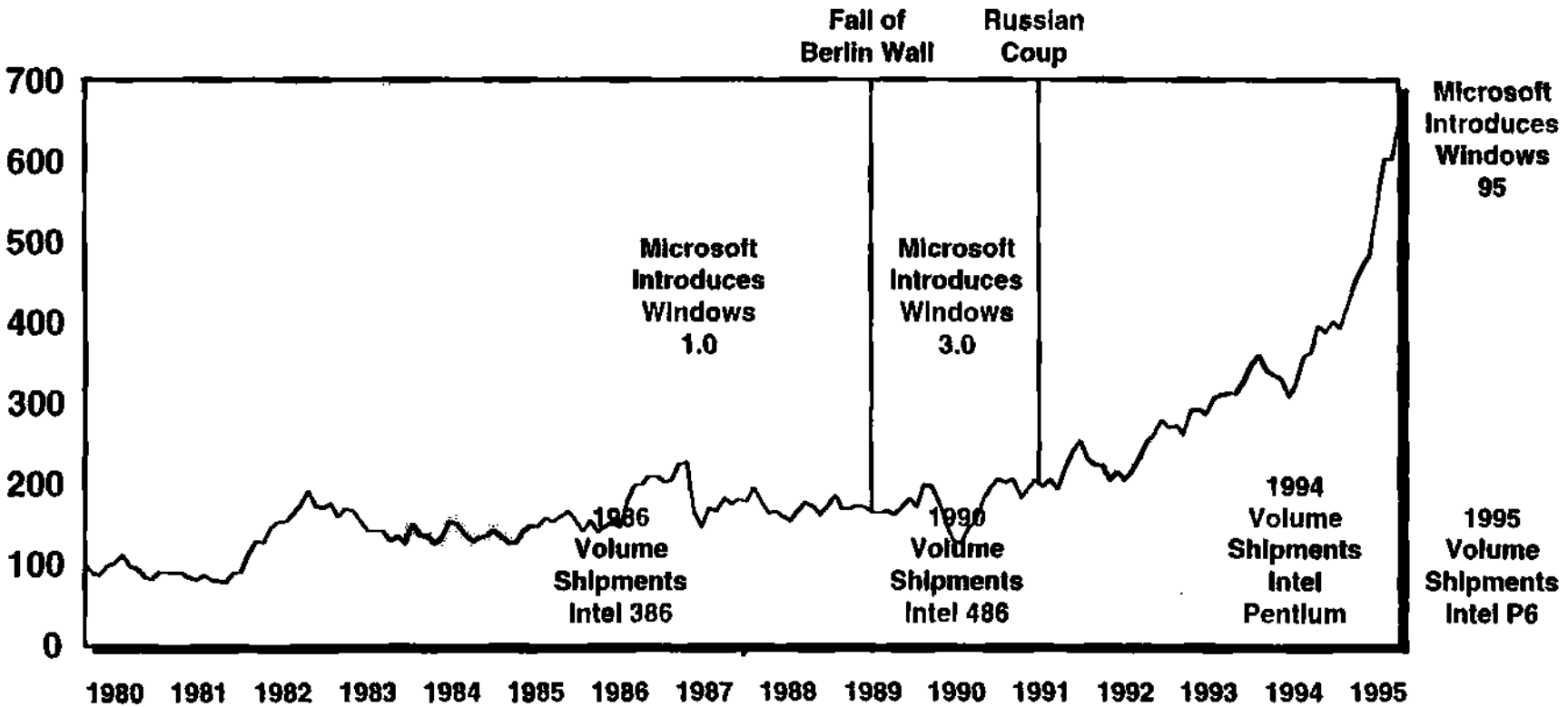


*Includes China but Excludes India

Source: Texas Instruments

Technology and Growth Stock Valuations

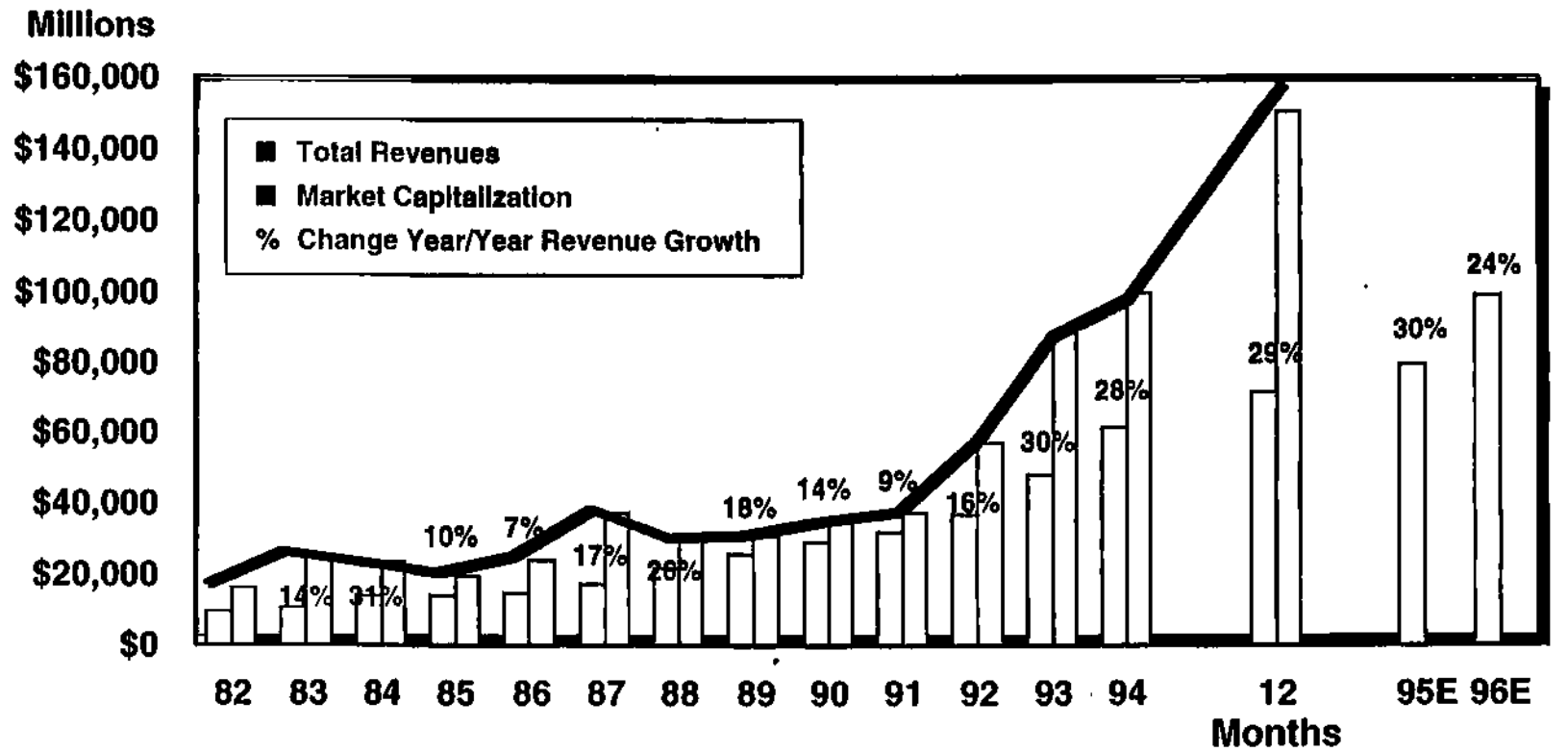
RS & Co. High-Tech Composite Index - 10/6/95



The RS & Co. High-Tech Composite Index Consists of 209 High-Technology Stocks of All Sizes.
The Maximum Market Cap Weighting of Any Stock Is $1.5 Billion.

Total Revenues and Market Capitalization

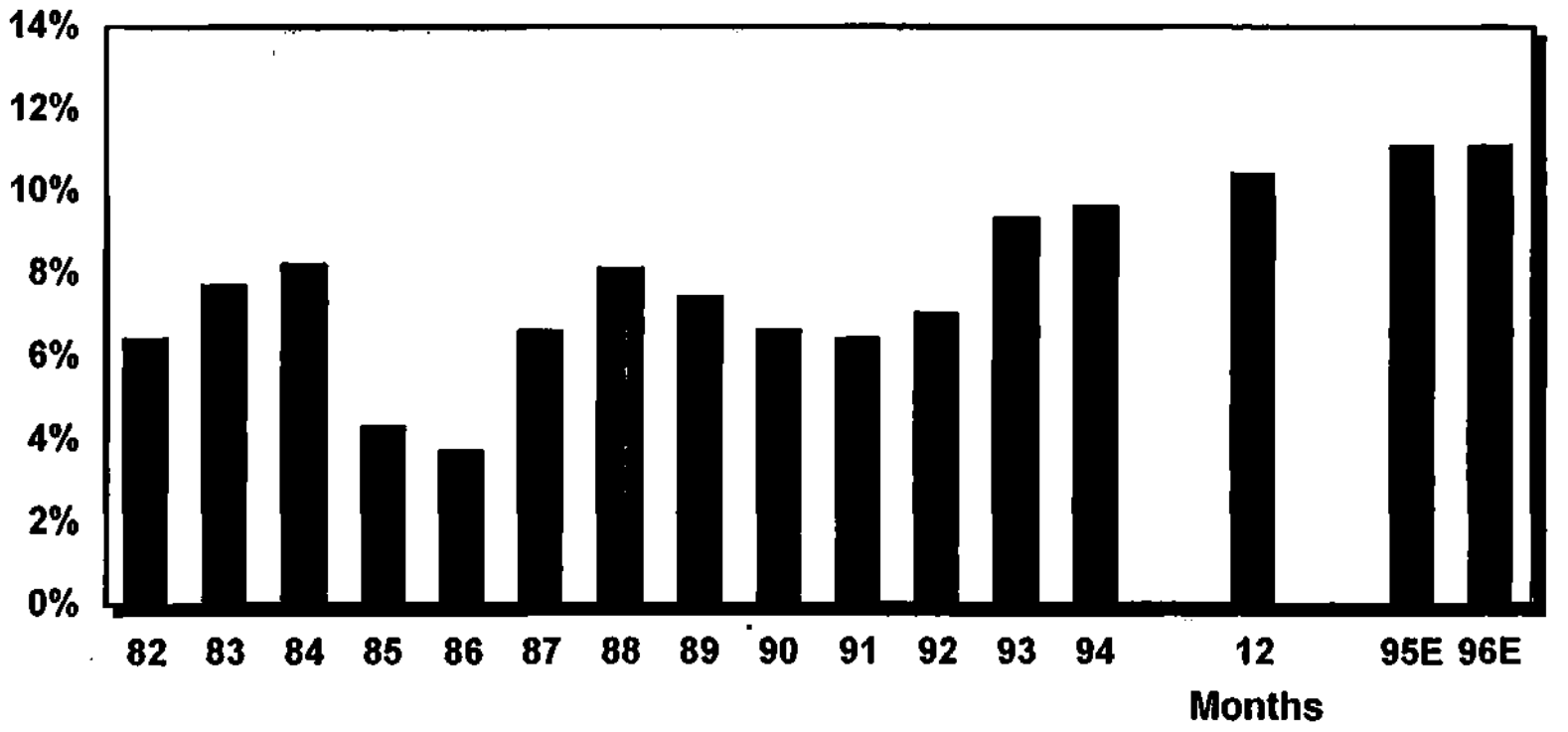
Analog Devices, Applied Materials, Hewlett-Packard, Intel and Motorola - 10/6/95



Source: Value Line; Robertson, Stephens

Net Profit Margins

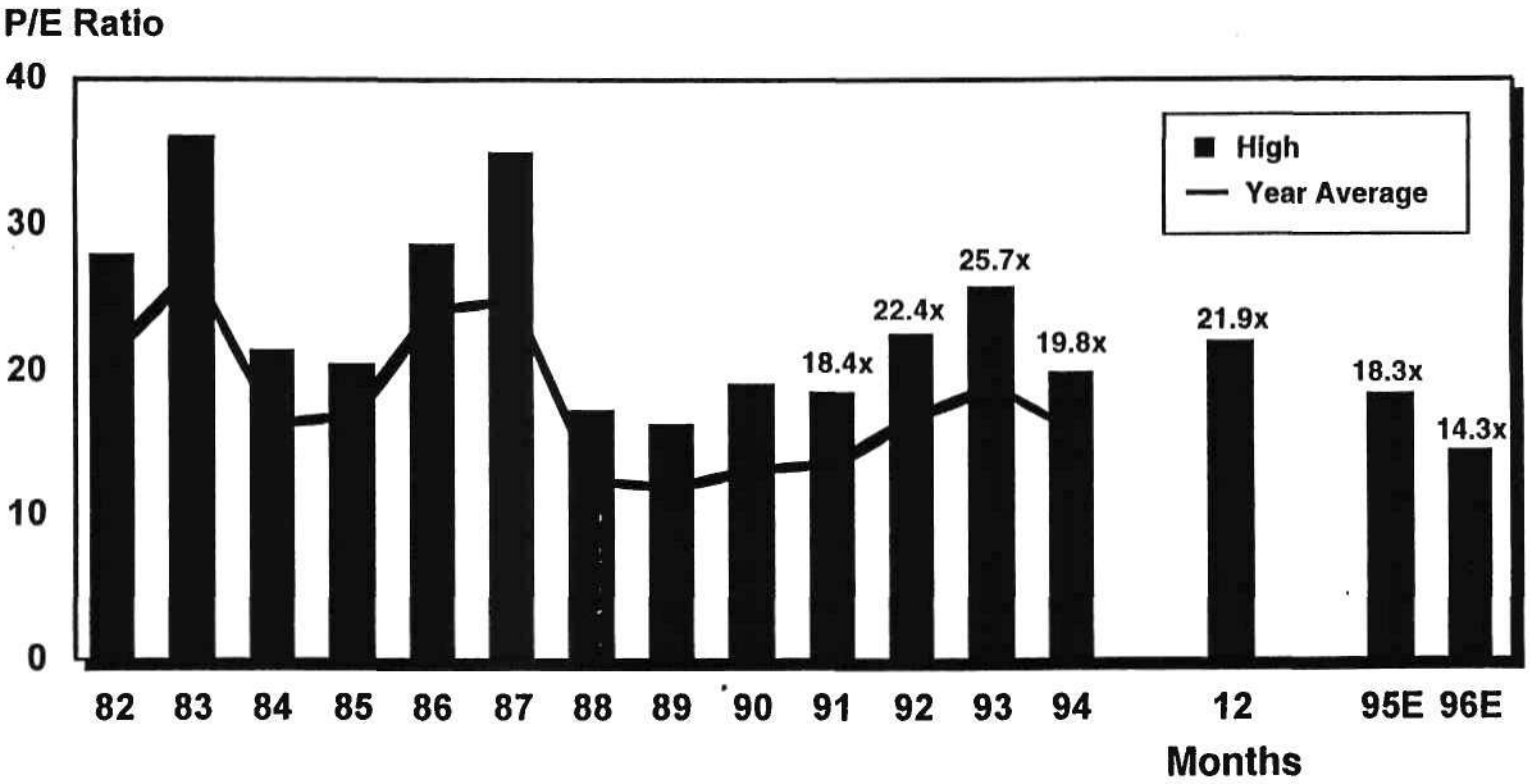
Analog Devices, Applied Materials, Hewlett-Packard, Intel and Motorola - 10/6/95



Source: Value Line; Robertson, Stephens

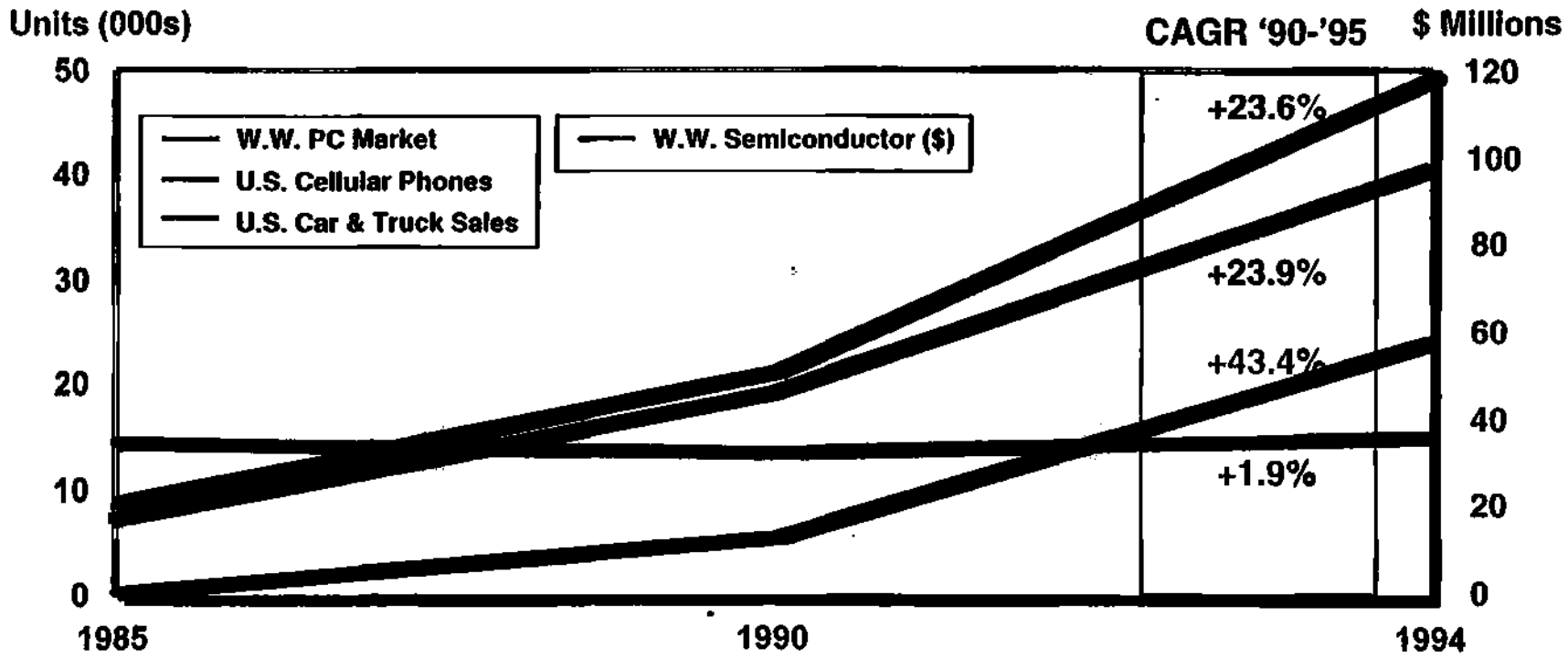
Yearly High and Average P/E Ratio

Analog Devices, Applied Materials, Hewlett-Packard, Intel and Motorola - 10/6/95



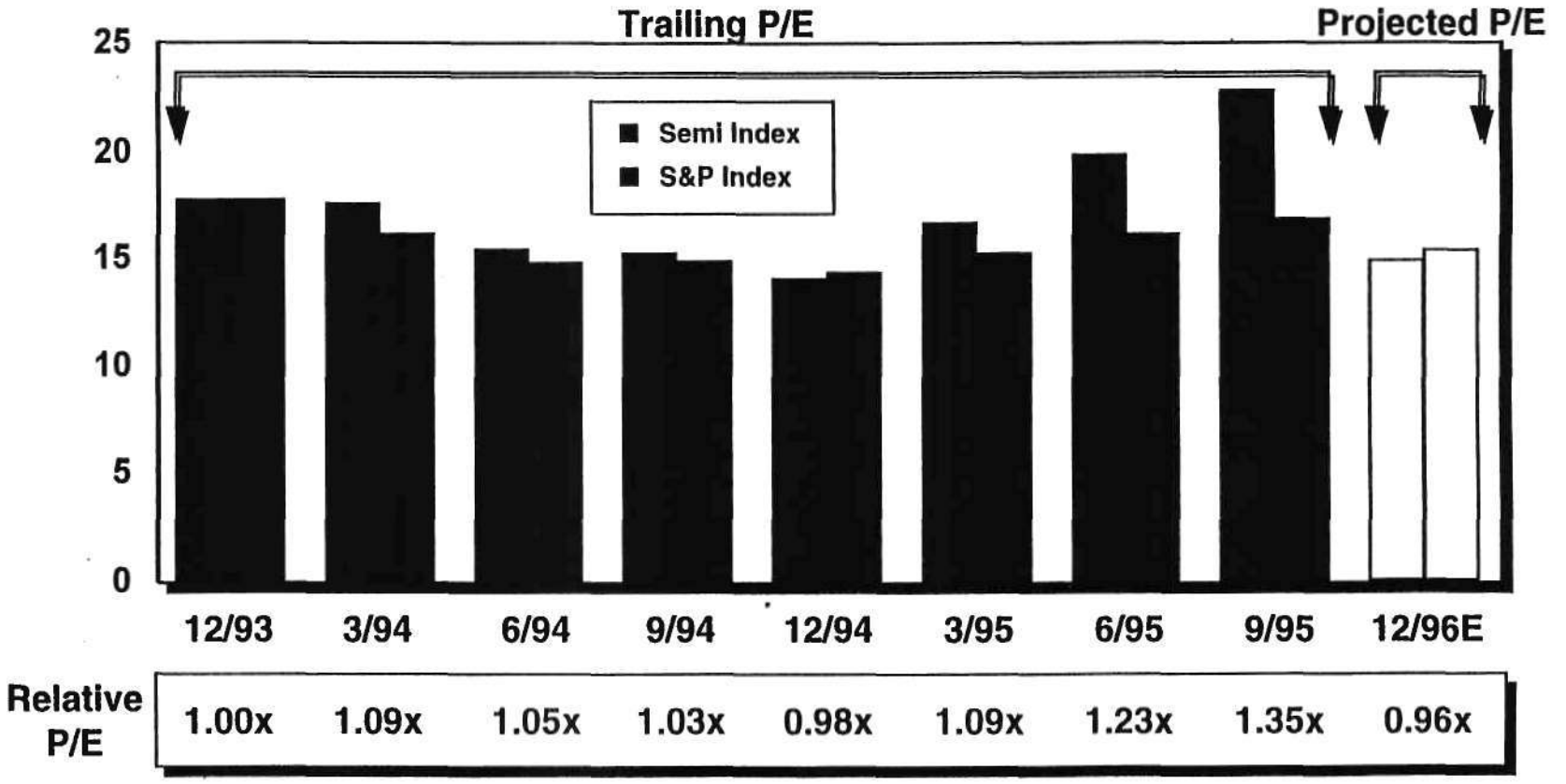
Source: Value Line; Robertson, Stephens

Technology Is a Growth Market



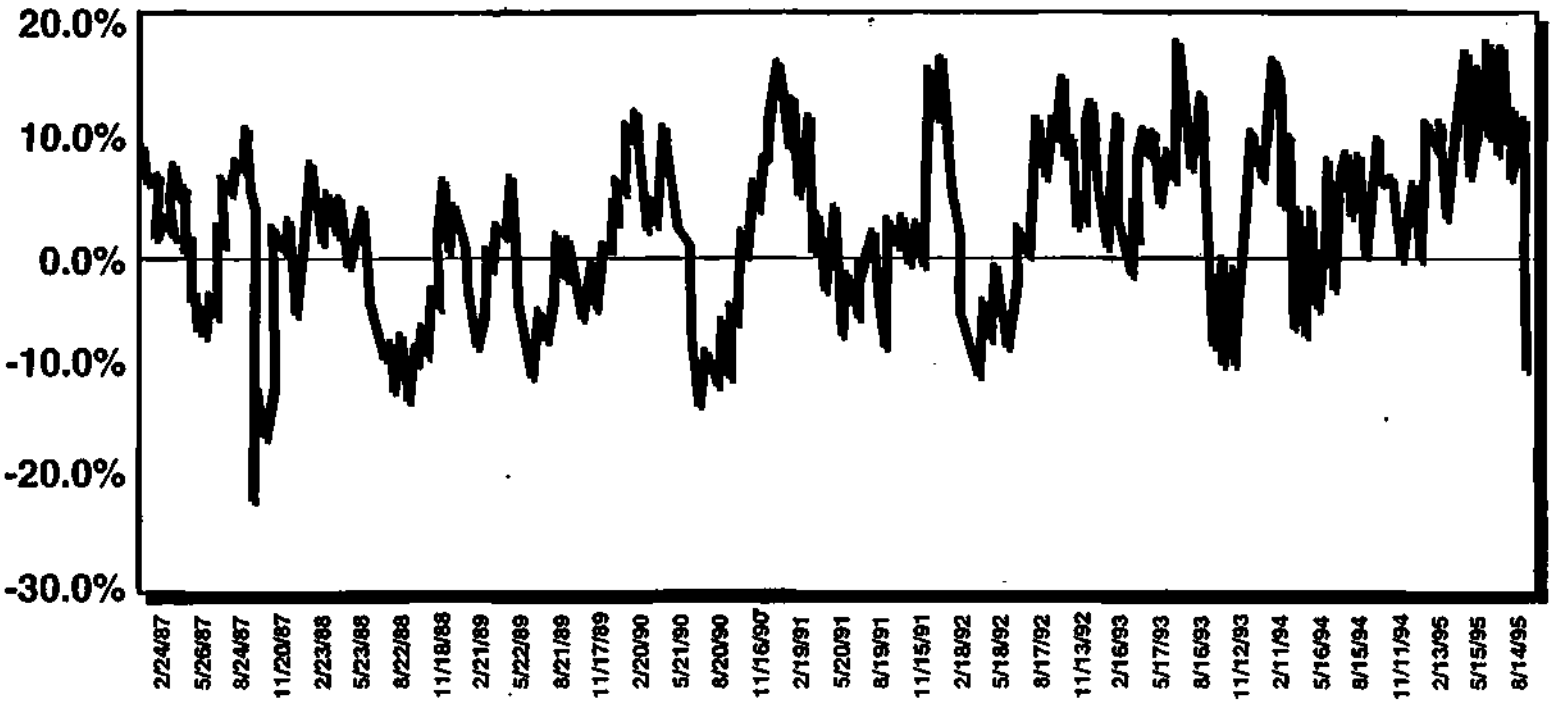
Steady Growth Drives Higher Multiples

Semiconductor Industry P/E Expansion
(Applied Materials, Intel, LSI Logic, Micron, Texas Instruments)



Current Investment Opportunity - 10/4/95

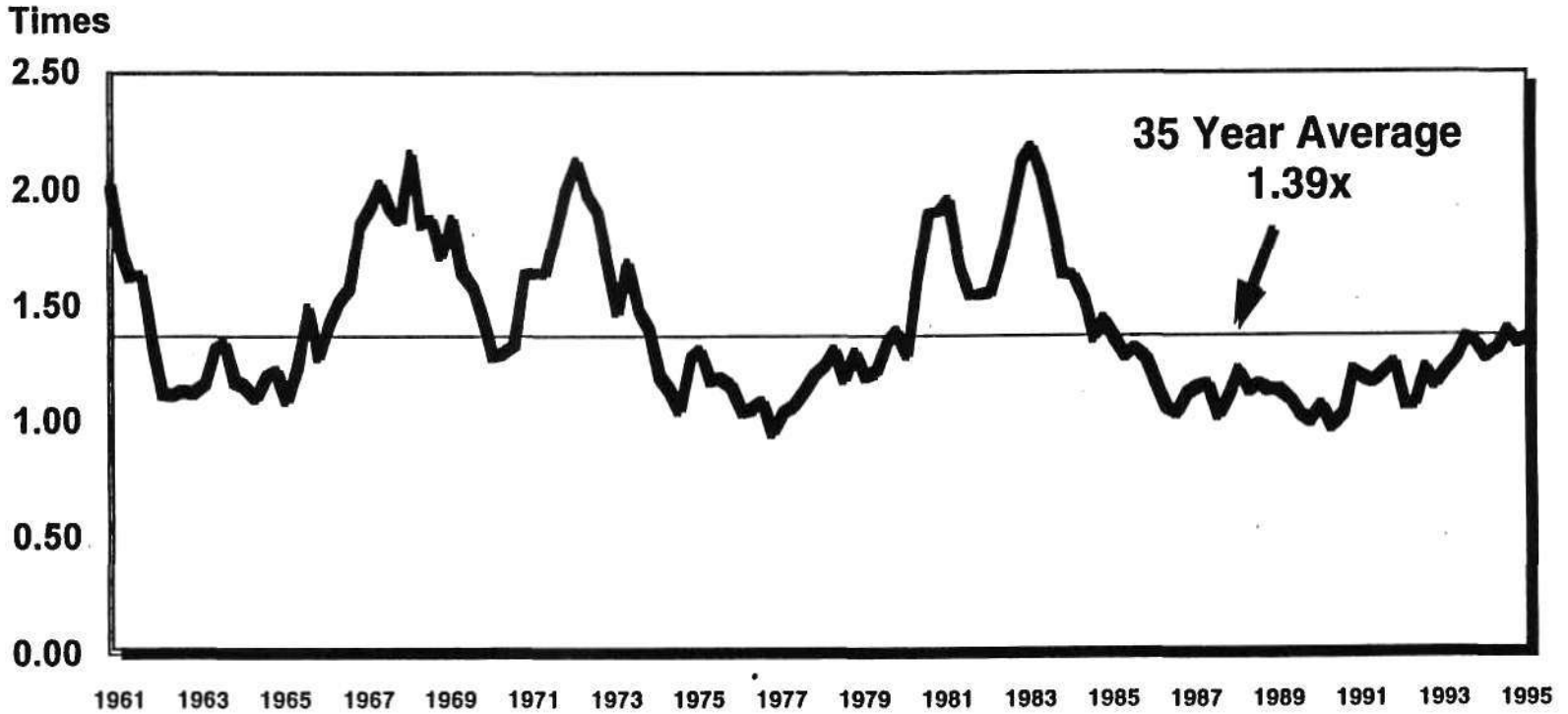
RS & Co. Electronics Index/S&P 500, 65 Day Moving Average



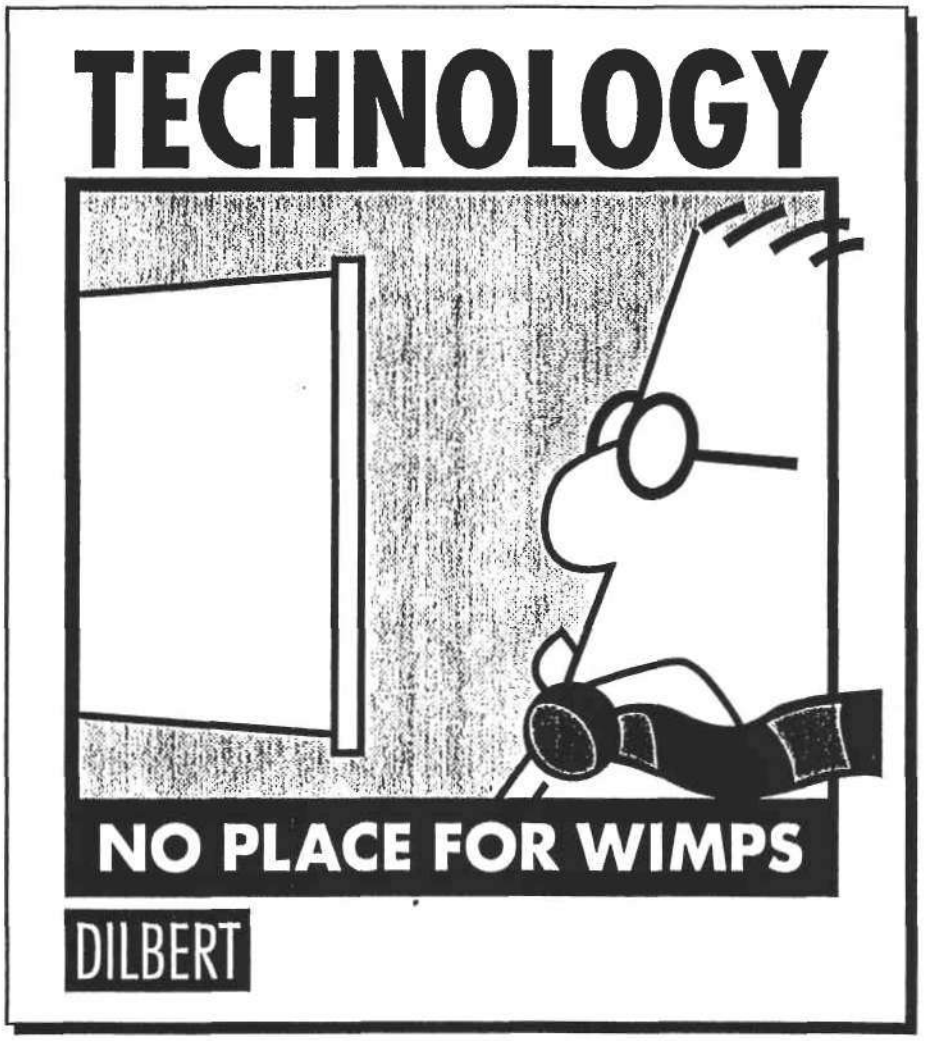
Source: Robertson, Stephens & Co.

Growth Stocks Historical Relative P/E Ratio

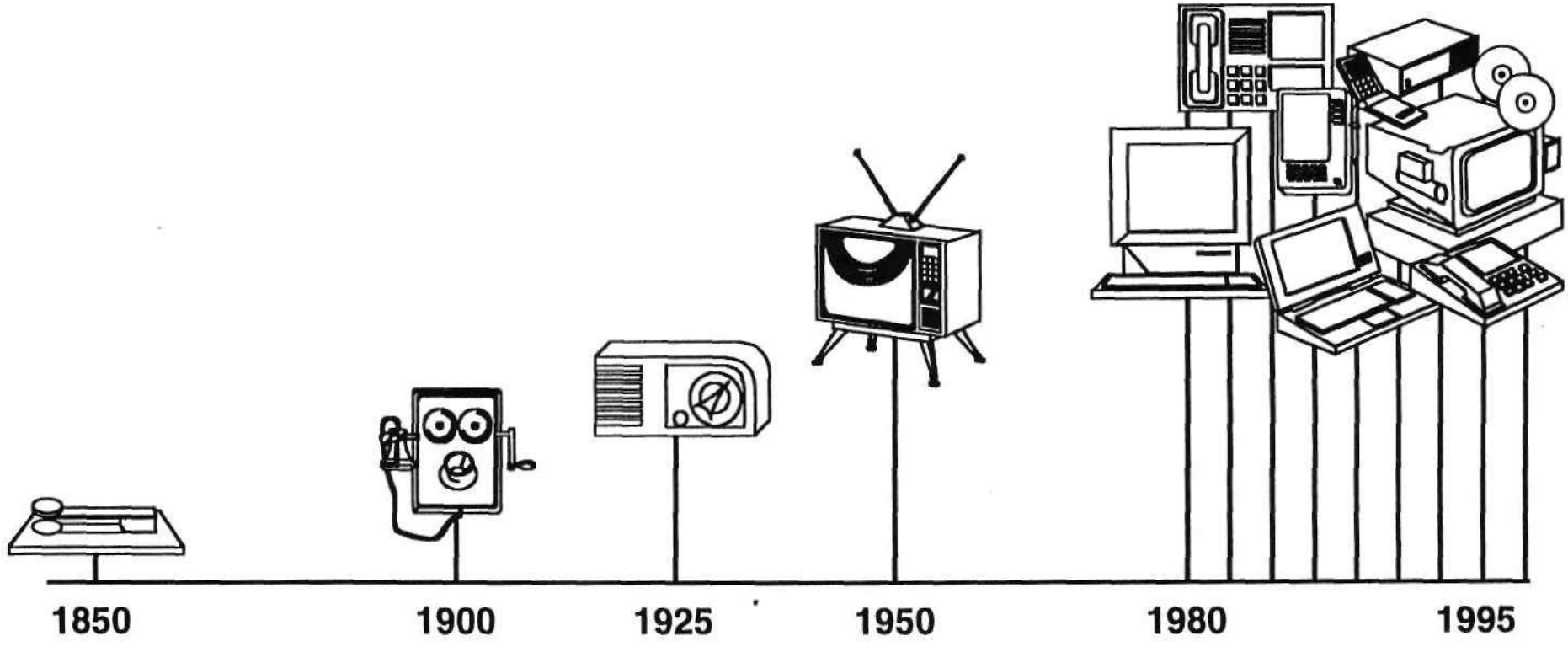
New Horizon Fund P/E Relative to the S&P 500

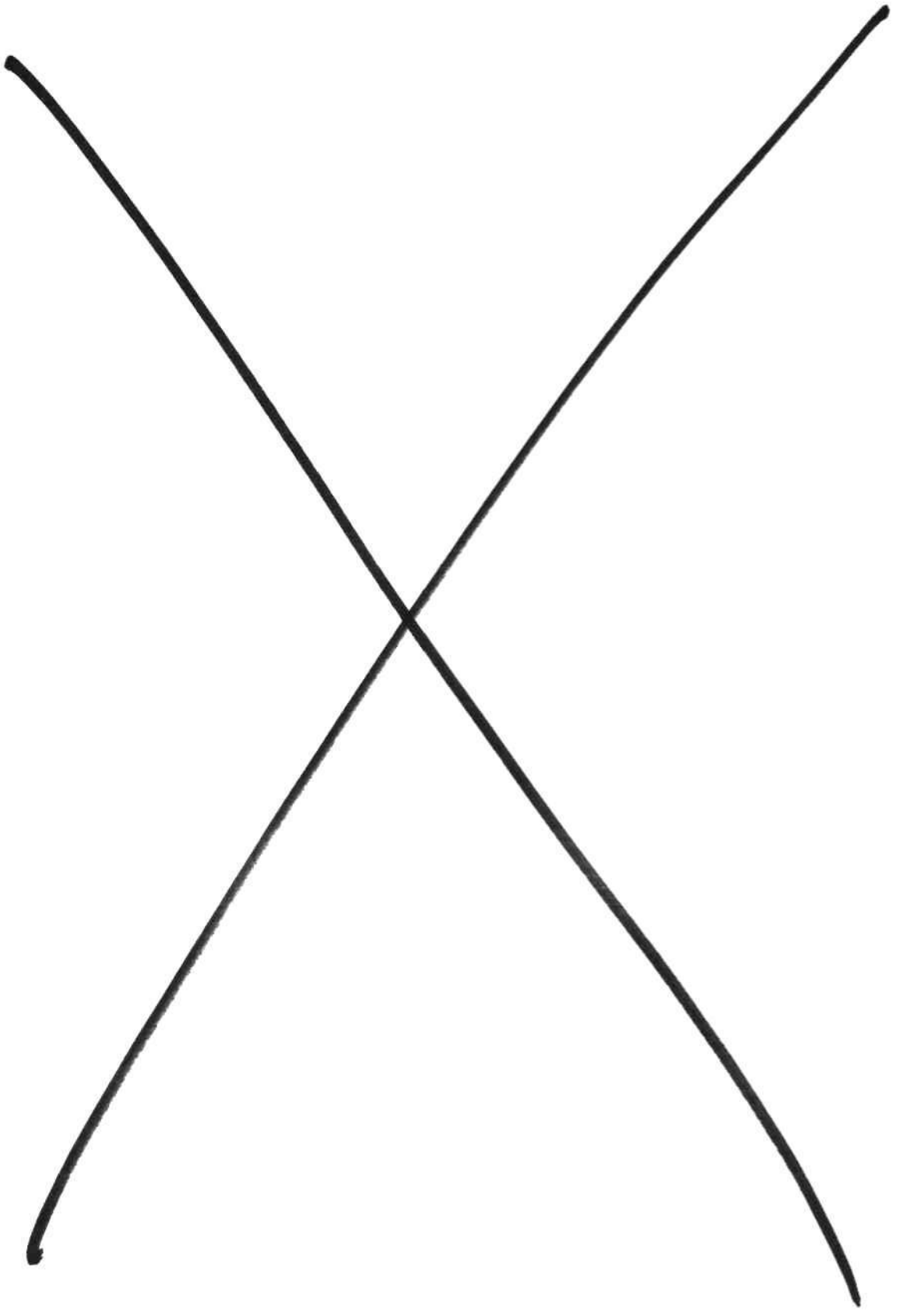


Source: T. Rowe Price


TECHNOLOGY
NO PLACE FOR WIMPS
DILBERT

Any Questions?





On the Cusp of the Flat Panel Display Revolution

Moderator

Jack Roberts
Director and Principal Analyst, Dataquest Incorporated

Panelists

Joel Pollack
Senior Product Marketing Manager, Sharp Electronics Corporation

Peter H. Goebel
Executive Vice President and COO, Ulvac Technologies Inc.

Harry Marshall
Chairman and CEO, Silicon Video Corporation

Douglas J. Bartek
President, Visual and Systems Interface Company, Cirrus Logic Inc.

Malcolm J. Thompson, Ph.D.
Chief Technologist and Director, Xerox Palo Alto Research Center

Moderator: On the Cusp of the Flat Panel Display Revolution

Jack Roberts

Director and Principal Analyst
Graphics and Displays Industry Program
Computer Systems and Peripherals Worldwide
Dataquest Incorporated

Mr. Roberts is Director and Principal Analyst of Dataquest's Graphics and Displays industry program. His responsibilities include directing the day-to-day market research and analysis for all segments of the graphics and displays industry as well as serving as the principal analyst responsible for following the graphics processors and network stations markets. In addition, he routinely participates in custom research projects and provides cross-industry support to Dataquest clients that utilize his broad industry knowledge.

Prior to joining Dataquest, Mr. Roberts spent more than 20 years in the industry including significant management positions with Motorola Inc., Memorex Corporation, and ITT Corporation. Most recently, he was Vice President and cofounder of a start-up, high-performance data communications networking company. His specific expertise covers most segments of the computer industry, office automation, data communications, and software. Mr. Roberts is frequently quoted in leading industry and business publications. He has spoken at numerous industry conferences, exhibitions, and trade shows. In addition, he has been interviewed in appearances on PBS, CNBC, and NHK (Japan) radio and television.

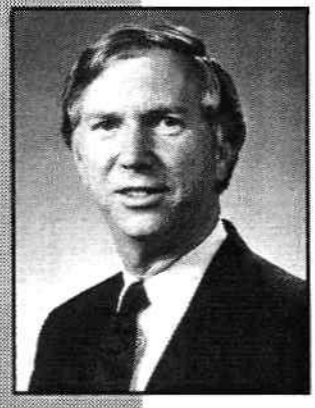
Mr. Roberts received a B.S. degree in industrial engineering from Auburn University and an M.B.A. degree in finance from Georgia State University.

jroberts@dataquest.com

Panelist: On the Cusp of the Flat Panel Display Revolution

Joel Pollack

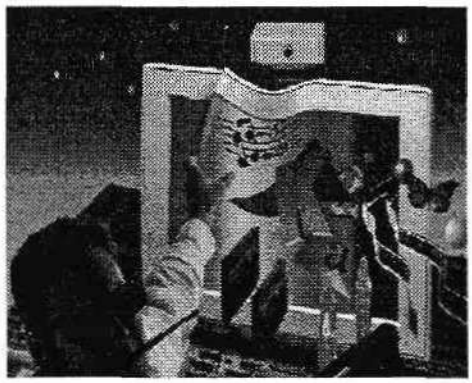
Senior Product Marketing Manager
Displays
Sharp Electronics Corporation



Mr. Pollack is the Senior Product Marketing Manager for Displays for Sharp Electronics in Camas, Washington. He joined Sharp in 1991 and has had marketing responsibility for Sharp's display products in North America.

Mr. Pollack's display experience began as a physicist working in the Xerox Webster Research Center, involved in LCD display research since 1969. Subsequently, he managed the Device Engineering group at Tektronix for the development of the PI Cell Color Shutter and Stereo Shutter.

A View of the Future

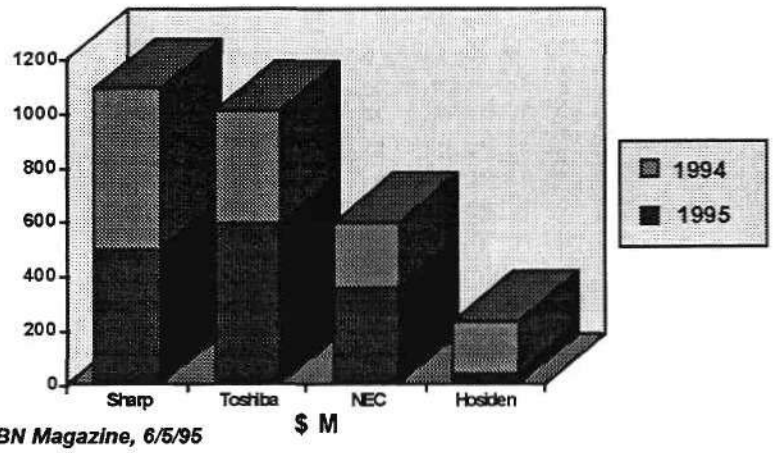


Joel Pollack
Sharp Electronics Corp.

SHARP

Investment

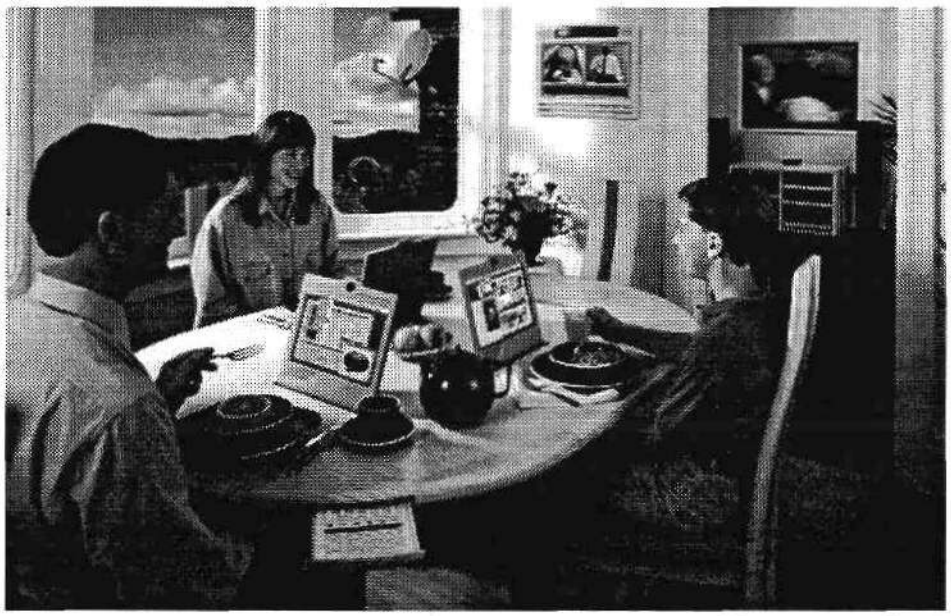
Japanese Investment in LCD Production



Source: EBN Magazine, 6/5/95

SHARP

On the Cusp of the Flat Panel Display Revolution



SHARP

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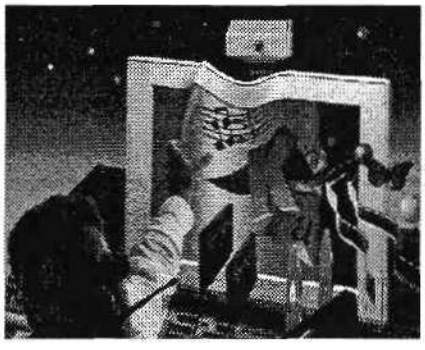
SHARP

On the Cusp of the Flat Panel Display Revolution

SHARP

SHARP

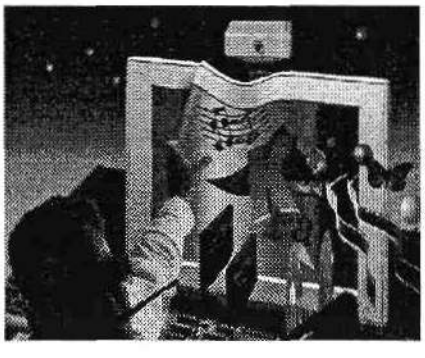
LCD Trends



- Significantly lower power
- Brighter for outdoor viewing
- Wider viewing angles (120º cone)
- SVGA → XGA → EWS

SHARP

Enabling Technologies and Developments



- RF linked computing
- Plastic LCDs
- Low temperature poly-silicon devices

SHARP

Notes:

Panelist: On the Cusp of the Flat Panel Display Revolution

Peter H. Goebel

Executive Vice President and Chief Operating Officer
Ulvac Technologies Inc.

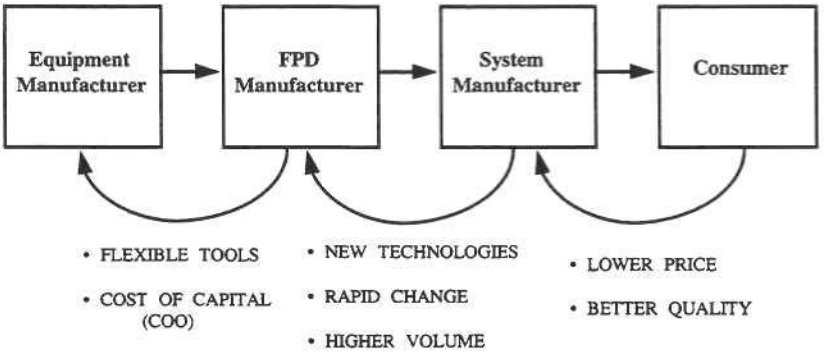
Mr. Goebel, Executive Vice President and Chief Operating Officer of Ulvac Technologies, has been involved with ULVAC Japan since 1985 when he was responsible for establishing joint-venture companies between BTU International and ULVAC. During this time he was Vice President and General Manager of Semiconductor Operations for BTU International.

Previously Mr. Goebel held various management positions with Motorola Inc., the last of which was Director of Engineering and Manufacturing for Motorola Europe.

Mr. Goebel holds a B.S.E.E. and an M.S.E.E. degree from the University of Michigan and Northeastern University, respectively.

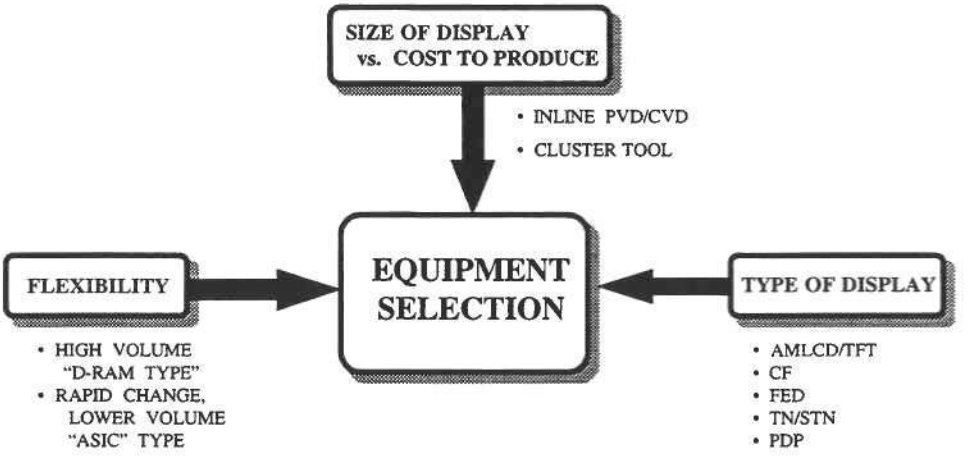
ULVAC

"FOOD" (SUPPLY) CHAIN IN FPD



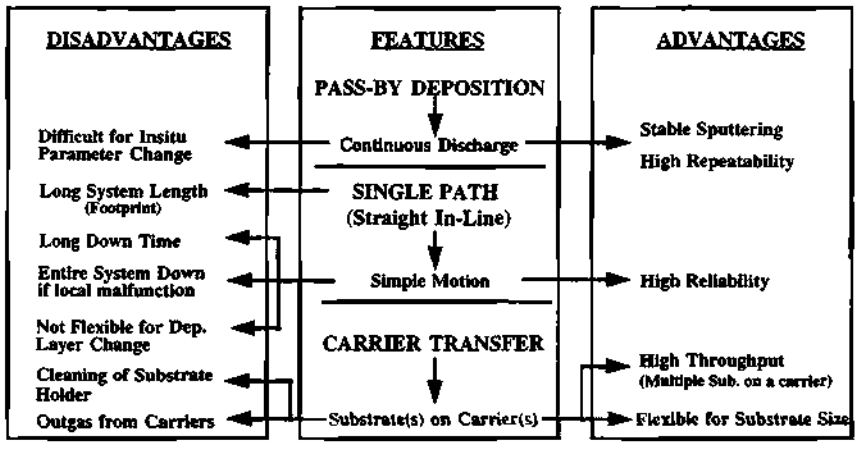
ULVAC

Forces Influencing Equipment Selection



ULVAC

ADVANTAGES AND DISADVANTAGES OF IN-LINE SPUTTERING SYSTEM



ULVAC

IN-LINE SPUTTERING TECHNOLOGY

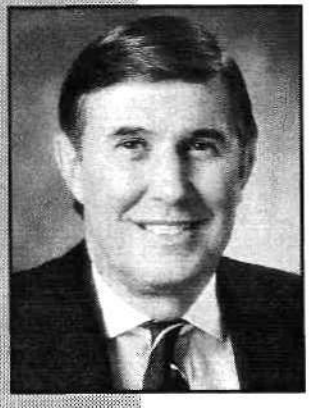
STATUS QUO	FUTURE DEVELOPMENT FOCUS
• Low Resistivity ITO Film for STN *Lower than 1.32 x 10^{-4} Ω cm at ≥ 350°C*	Lower Resistivity *Lower than 1.0 x 10^{-4} cm*
• High Rate Sputtering of Low Reflective Cr/CrOx Film for Black Matrix *Lower than 6% of Reflectivity*	Development of New BM Material without using Cr, but with Low Reflectivity and Wide Wavelength Band
• High Target Utilization Cathode, ™ULMAG (40%)	
• High Target Utilization Cathode for Low Resistivity ITO Film, α - Cathode (40%)	
• Low Resistivity ITO Film on Color Filter *Lower than 2.0 x 10^{-4} Ωcm at 215°C*	Lower Resistivity *Lower than 1.5 x 10^{-4} Ωcm at 215°C*
• Anti-Reflective : SiO_2, TiO_2, ITO Multi-Layers on CRT *Less than 0.6%*	

Notes:

Panelist: On the Cusp of the Flat Panel Display Revolution

Harry A. Marshall

Chairman and Chief Executive Officer
Silicon Video Corporation



Mr. Marshall joined Silicon Video Corporation (SVC) as Chairman of the Board in June 1993. He assumed the role of Chief Executive Officer in January 1993 after a long career in the venture capital business and operating roles in several electronics companies. During his 25-year business career, Mr. Marshall has been a founding investor of numerous start-up companies that today generate over $3 billion in combined revenue and employ more than 3,000 people worldwide.

Mr. Marshall joined J. H. Whitney & Co. as a General Partner to help establish the firm's West Coast operation from its newly opened Menlo Park, California, office in September 1983. J. H. Whitney was established in 1946 and has been among the most active and successful venture capital firms in the business. Prior to J. H. Whitney, Mr. Marshall was a Senior Partner with Hambrecht & Quist for five years where he closed over $700 million of equity financing for technology-based companies, including public offerings and private placements, and was a key participant in the firm's venture capital investments.

Before joining Hambrecht & Quist, Mr. Marshall had over 10 years of operating experience within the electronics industry, principally in product development and marketing with Hewlett-Packard and in various executive positions in marketing, corporate finance, and development at Four-Phase Systems (which became Motorola Computer Systems). Mr. Marshall was also previously associated with McKinsey & Company Inc., an international management consulting firm, for three years.

Mr. Marshall received a B.S. degree in electrical engineering with a concentration in computer science and microelectronics from the University of Florida in 1966, and an M.B.A. from Stanford Graduate School of Business in 1970. He also served in the U.S. Marine Corps.

SVC

Silicon Video Corporation

Harry Marshall
Chairman & Chief Executive Officer

SVC

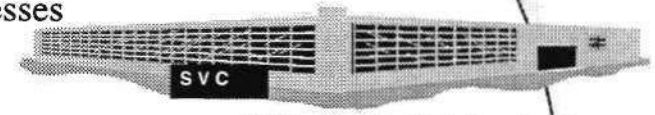
SVC Keys To Success

- Committed customer-partners
  - H-P drives product requirements
    - Forces you to address system architecture issues early
    - Keeps you from falling in love with your technology
  - Partners provide equity, patents, engineers
  - Dilemma - 1 yr design-in vs. 1 yr factory build - solved
- Target mainstream, high volume segment
  - HP & Compaq driving notebook Thin CRT definition
  - Single path to real cost reduction and a secure beachhead

SVC

SVC Keys To Success

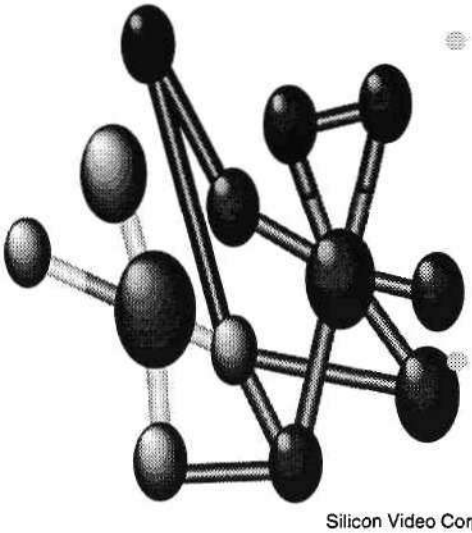
- High throughput development line
  - Rapid parallel learning to address process integration issues
  - More than 750 substrates in process, 20+ tubes out per week
- Vertical integration of all key technologies
  - Ceramics, cathode, faceplate, vacuum assembly
  - Ability to rapidly re-engineer key components & processes



70K Sq. Ft. Cathode Engineering Line
Operational in San Jose, CA

SVC

SVC Keys To Success

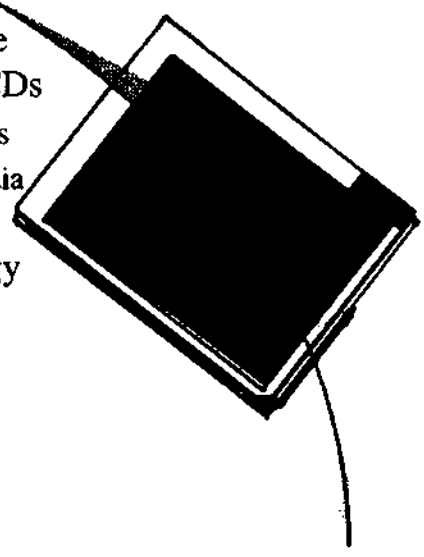


- Critical mass
  - 145 people with more than 30 PhDs & manufacturing specialists
  - Broad financing - $95 million committed
  - 30 additional engineers from our partners
    - Leverage their technical strengths
    - SVC centrally pools technology
- Experience taking new technology into production
  - 85% SVC tools and processes come from existing infrastructure

SVC

Our Keys To Success

- Thin CRT will exhibit decisive price performance advantage over AMLCDs
  - "Stepperless" process with fewer layers
  - Designed for power efficient multimedia applications
- A manufacturable display technology
  - Demos prove you can make one
  - The key is learning rates *i.e.* lot turns



Panelist: On the Cusp of the Flat Panel Display Revolution

Douglas J. Bartek

President
Visual and Systems Interface Company
Cirrus Logic Inc.

Mr. Bartek is the President of Cirrus Logic's Visual and Systems Interface Company. He has executive responsibility for directing and managing a growing portfolio of technologies and products for personal computers. These products include PCMCIA and IDE host adapters, integrated circuits for graphics and video, and systems logic functions.

Under Mr. Bartek's leadership, the Cirrus Logic Visual and Systems Interface Company has become a dominant player in several markets and has extended its presence into such new markets as LCD panel drivers and core logic chipsets. He has overseen the acquisition of several critical technologies required for next-generation products, such as 3-D graphics.

Mr. Bartek joined Cirrus Logic in 1992 as a result of the merger of Acumos Inc., where he was President and CEO. Before joining Acumos, he was a Senior Vice President and General Manager of VLSI Technology Inc., responsible for directing all the business, technical, and operational activities for five product divisions. In a previous position at VLSI, Mr. Bartek started, managed, and grew the company's core logic and peripherals chipset business. Prior to VLSI, he held various engineering, marketing, and management positions at Honeywell Inc. and Motorola Semiconductor Products in Austin, Texas. Mr. Bartek holds a patent in data encryption work performed while at Honeywell.

Mr. Bartek earned his B.S. degree in electrical engineering, summa cum laude from the University of Texas at Austin, and successfully completed the M.S.E.E. and M.B.A. programs at Arizona State University in Tempe.

CIRRUS LOGIC

Douglas J. Bartek
President, Visual & Systems
Interface Company

Flat Panel Display Revolution

- **Color TFT LCDs**
  - **Increasing Capacity / Lower Prices**
  - **Larger viewing areas**
  - **Higher resolutions**
  - **256K colors becoming standard (for multimedia applications)**
- **Color STN LCDs**
  - **Lower pricing & new features driven by color TFT LCDs**

Flat Panel Display Revolution

- **Multimedia in Premium and Value notebooks (mainstream, high-volume markets)**
  - **Driven by: Business & Entertainment Applications**
  - **Enabled by:**
    - **Software Codecs**
    - **Hardware Codecs**
    - **New Driver Technology**
    - **New Controller Technology**

CIRRUS LOGIC

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Example of New Semiconductor Driver Technology Cirrus Logic 6-bit Column Driver Family

- **Superior display quality**
  - **256K colors**
  - **Excellent color uniformity**
- **Cost-effective**
  - **201 --> 240 >> 309 outputs per driver**
  - **10 --> 8 drivers for 640x480 LCD**
  - **12 --> 10 --> 8 drivers for 800x600 LCD**
  - **16 --> 14 --> 10 drivers for 1024x768 LCD**
- **Increased display: module area ("bezel-less display")**
  - **TCP --> COG drivers enable 11.8" diagonals**
  - **Smallest die size**
- **Reduced power consumption**
  - **Weighted resistor-string DACs**

CIRRUS LOGIC

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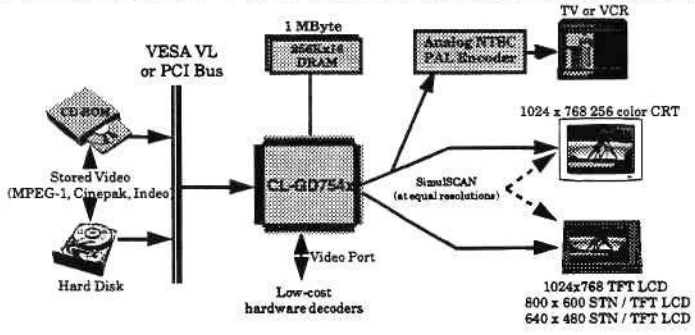
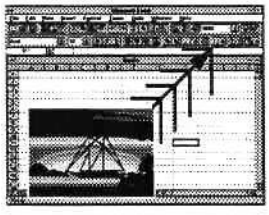
Example of New Semiconductor Controller Technology
Cirrus Logic's LCD/CRT VGA with MotionVideo Acceleration





CIRRUS LOGIC

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Notes:

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Panelist: On the Cusp of the Flat Panel Display Revolution

Malcolm J. Thompson, Ph.D.

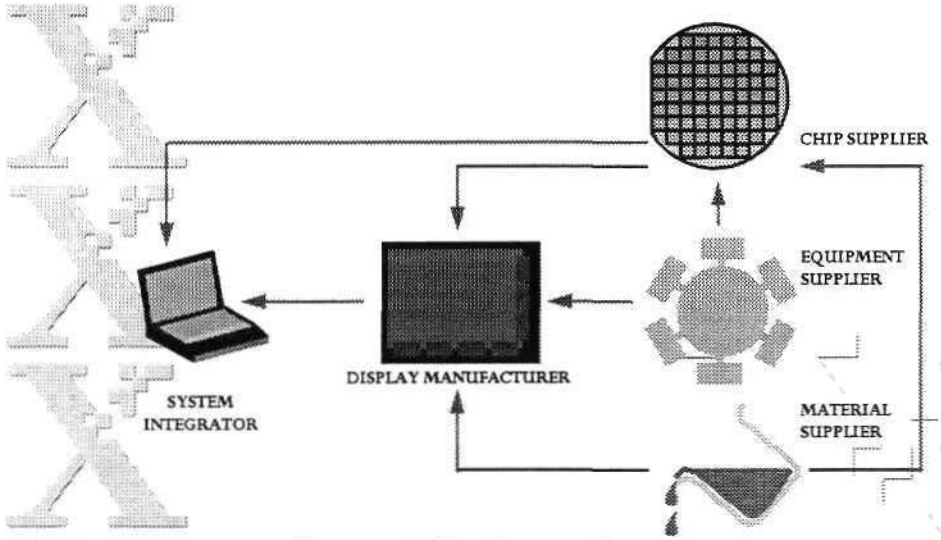
PARC Chief Technologist and Director
Electronic Imaging Laboratory
Xerox, Palo Alto Research Center

Dr. Thompson is PARC Chief Technologist and the Director of the Electronic and Imaging Laboratory at Xerox, Palo Alto Research Center. They have recently developed the world's highest pixel count active matrix liquid crystal display (AMLCD) which has an image quality superior to laser printers. He is also Chairman of the Board of the newly formed United States Display Consortium. This is an industry-government consortium whose primary mission is to develop U.S. manufacturing infrastructure in flat panel displays.

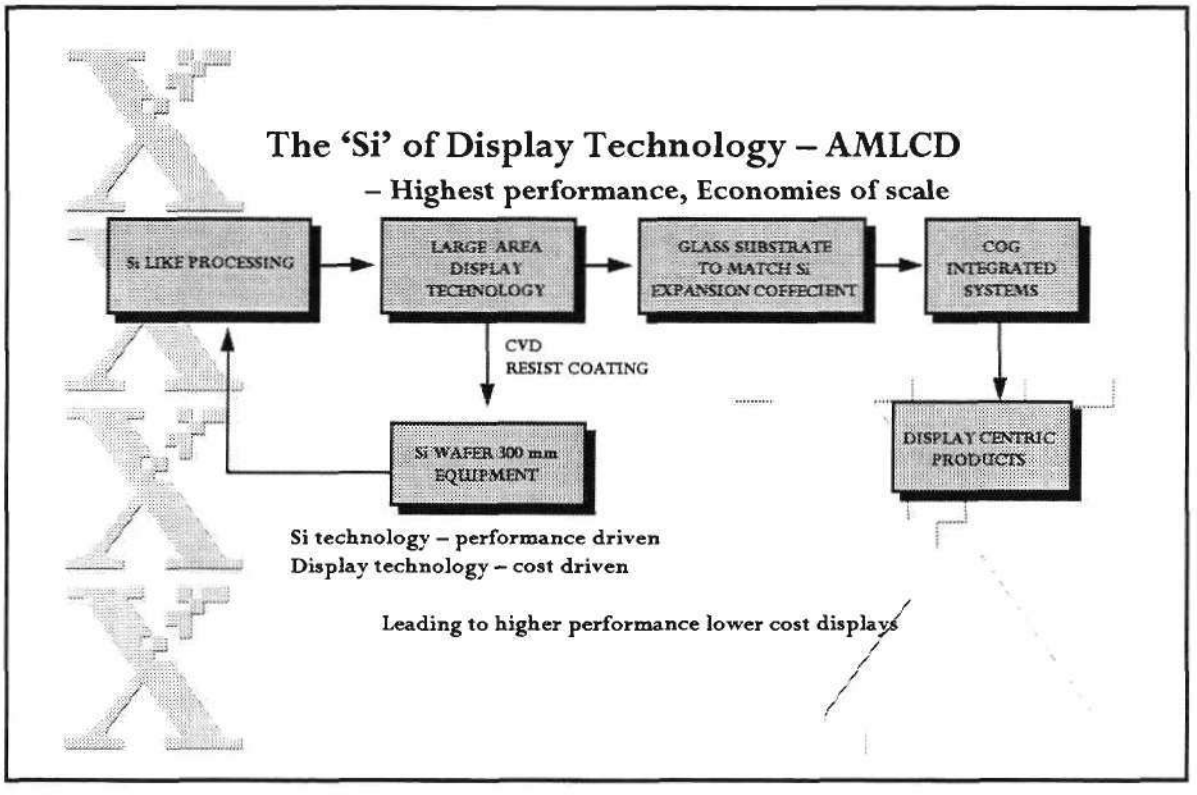
Dr. Thompson has had extensive experience in semiconductor technology and has pioneered the development of amorphous Si and poly-Si thin film transistors on glass that form the critical element of flat panel AMLCDs. He has over 100 publications and patents and has managed projects in Europe, Japan, and the United States. He is also on the board of several Silicon Valley Companies.

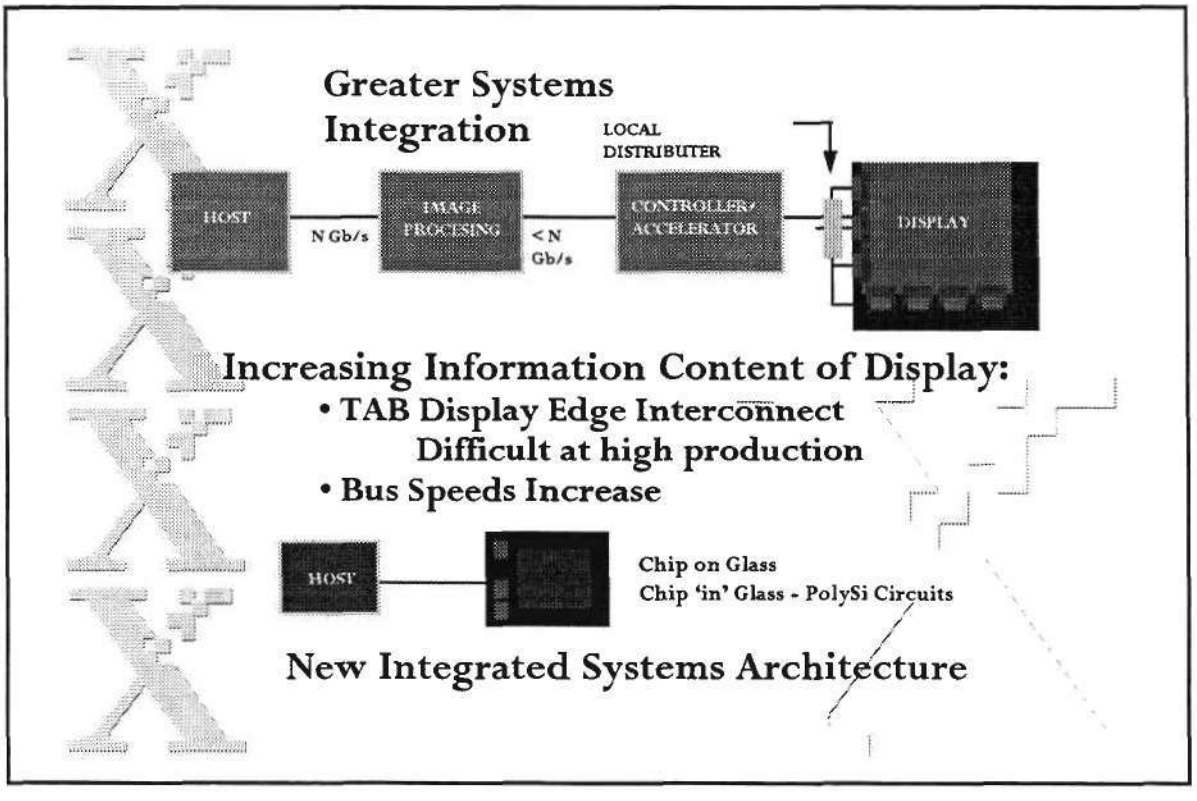
What Will LCD/FPD Technology Mean to the Systems, Semiconductor, and Supporting Industries?

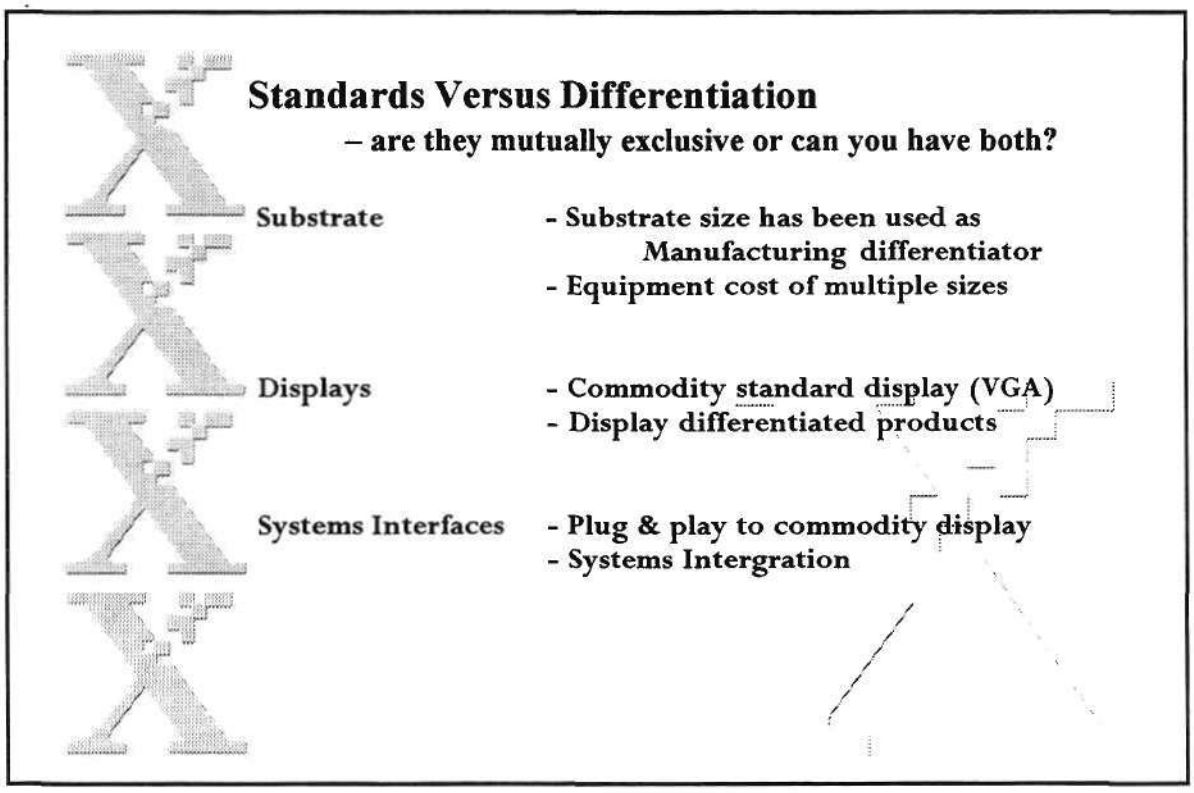
Malcolm J. Thompson
Chief Technologist of Xerox PARC
and Chairman of the Board of USDC



Suppliers – Display – Systems
Collaborative Developments e.g. USDC


The 'Si' of Display Technology – AMLCD
– Highest performance, Economies of scale
Si LIKE PROCESSING
LARGE AREA DISPLAY TECHNOLOGY
GLASS SUBSTRATE TO MATCH Si EXPANSION COFFECIENT
COG INTEGRATED SYSTEMS
CVD
RESIST COATING
Si WAFER 300 mm EQUIPMENT
DISPLAY CENTRIC PRODUCTS
Si technology – performance driven
Display technology – cost driven
Leading to higher performance lower cost displays


Greater Systems Integration
LOCAL DISTRIBUTER
HOST
N Gb/s
IMAGE PROCESING
< N Gb/s
CONTROLLER/ ACCELERATOR
DISPLAY
Increasing Information Content of Display:
• TAB Display Edge Interconnect
Difficult at high production
• Bus Speeds Increase
HOST
Chip on Glass
Chip 'in' Glass - PolySi Circuits
New Integrated Systems Architecture


Standards Versus Differentiation
– are they mutually exclusive or can you have both?
Substrate
- Substrate size has been used as Manufacturing differentiator
- Equipment cost of multiple sizes
Displays
- Commodity standard display (VGA)
- Display differentiated products
Systems Interfaces
- Plug & play to commodity display
- Systems Intergration

Notes:

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Reaching $300 Billion in Semiconductor Revenue by the Year 2000: What's It Going to Take?

Moderators

Stan Bruederle
Vice President and Principal Consultant, Dataquest Incorporated

Clark Fuhs
Director and Principal Analyst, Dataquest Incorporated

Panelists

Roger D. McDaniel
Chief Executive Officer, MEMC Electronic Materials Inc.

David N.K. Wang, Ph.D.
Senior Vice President, Applied Materials

Wei-Shan Lin
President, Tatung Company

Marcus T. Wilson
Vice President and General Manager, Intel Corporation

James J. Kim
Founder, Chairman, and CEO, AMKOR Electronics Inc.

Moderator: Reaching $300 Billion in Semiconductor Revenue by the Year 2000—What's It Going to Take?

Stanley A. Bruederle

Vice President and Principal Consultant
Consulting Group
Dataquest Incorporated

Mr. Bruederle is Vice President and Principal Consultant for Dataquest. His primary responsibility is to develop and manage consulting projects for Dataquest clients whose research requirements exceed the scope of our Semiconductor industry services.

Prior to joining Dataquest, Mr. Bruederle was Manager of Corporate Strategic Planning for Signetics (now Philips Semiconductor). He also held positions as Division Marketing Manager for Signetics' Bipolar LSI Division and other marketing management positions at Signetics and Motorola Semiconductor.

Mr. Bruederle received his B.S. degree in electrical engineering from the University of Wisconsin. He has also completed work toward an M.B.A. program at Arizona State University and completed course work in topics related to Telecommunications Engineering from the University of California at Berkeley Extension.

sbruederle@dataquest.com

Moderator: Reaching $300 Billion in Semiconductor Revenue by the Year 2000—What's It Going to Take?

Clark J. Fuhs

Director and Principal Analyst
Semiconductor Equipment, Manufacturing, and Materials Program
Semiconductors Group
Dataquest Incorporated

Mr. Fuhs is Director and Principal Analyst for Dataquest's Semiconductor Equipment, Manufacturing, and Materials (SEMM) program in the Semiconductors group. He is responsible for research and analysis of semiconductor materials and trends in IC manufacturing techniques along with forecasting capital spending and the wafer fab equipment market. He is also responsible for directing worldwide research activities in semiconductor manufacturing including foundry, fab capacity, and silicon supply and demand.

Prior to joining Dataquest, Mr. Fuhs was Strategic Marketing Manager for Genus Inc., a manufacturer of advanced chemical vapor deposition (CVD) and high-energy ion implantation equipment. During his 10 years at Genus, he held positions of Product Manager, several responsibilities in Product Marketing, and Process Engineer in the metal CVD group. In his most recent position, Mr. Fuhs was responsible for correlating process techniques with demand for equipment and materials. He has been involved with the Modular Equipment Standards Committee of SEMI, a trade organization, as chairman of a task force, authoring a standard. His experience also includes Chevron Oil, where he was a Process Engineer in the Richmond, California, refinery responsible for the hydrogen manufacturing plant.

Mr. Fuhs earned a B.S. degree in chemical engineering from Purdue University in West Lafayette, Indiana, and received an M.B.A. degree from the University of California at Berkeley.

cfuhs@dataquest.com

Panelist: Reaching $300 Billion in Semiconductor Revenue by the Year 2000—What's It Going to Take?

Roger D. McDaniel

Chief Executive Officer
MEMC Electronic Materials Inc.

Mr. McDaniel is Chief Executive Officer of MEMC Electronic Materials Inc. MEMC manufactures and markets high-purity silicon worldwide for the electronics industry.

MEMC's majority shareholder is Hüls Corp., which also owns Hüls America Inc., a U.S. chemical company with $500 million annual sales. Mr. McDaniel served as CEO of Hüls Corp., Hüls America, and MEMC until May 1995. Prior to joining the organization, Mr. McDaniel was Vice President of Operations for Monsanto Electronic Materials Company.

Mr. McDaniel joined Monsanto in 1962 and held positions in engineering, manufacturing, commercial development, marketing, finance/planning, and international operations. In February 1988, he was appointed Vice President of Operations for Monsanto Electronic Materials, a position he held at the time Hüls AG acquired the business from Monsanto. Mr. McDaniel was appointed President and CEO of MEMC Electronic Materials Inc. in April 1989 at the time the company was formed.

Mr. McDaniel is Chairman of the Board of Directors of SEMI, an international industry association of material and equipment manufacturers serving the semiconductor industry. He previously served as a board member for United Way of Santa Clara County, California, and Greely Community Center in St. Louis, Missouri.

Panelist: Reaching $300 Billion in Semiconductor Revenue by the Year 2000—What's It Going to Take?

David N. K. Wang, Ph.D.
Senior Vice President
Worldwide Business Operations
Applied Materials

Dr. Wang was named Senior Vice President of Applied Materials' Worldwide Business Operations in January 1994. He is globally responsible for managing and driving the company's business including account management, installed base support services, customer satisfaction, and sales and corporate marketing. Prior to his current assignment, Dr. Wang was group vice president responsible for the Applied Materials CVD and Etch Technologies group, as well as general manager for the company's Asia-Pacific business operations. In addition, Dr. Wang has been a principal developer of the AME 8100 and 8300 plasma etch systems, the Precision 5000 CVD and etch systems, and the Centura HDP Dielectric Etch System.

Awarded numerous patents for his work in plasma etch and CVD technologies, Dr. Wang was also the recipient of the 1983 Semiconductor International Award for the Advancement of Semiconductor Technology for his work in the development of the hexode-type RIE etcher. In 1988, Dr. Wang was honored with the SEMMY award, presented annually by Semiconductor Equipment and Materials International, for creating a plasma etch standard for the semiconductor industry. Dr. Wang also received the SEMI lifetime achievement award in 1994 for his contributions to the semiconductor equipment industry. In 1993, he was recognized as a developer of the Precision 5000 at its induction as the first semiconductor manufacturing system to be placed in the permanent collection of the Smithsonian Institution in Washington, D.C.

Panelist: Reaching $300 Billion in Semiconductor Revenue by the Year 2000—What's It Going to Take?

Wei-Shan Lin
President
Tatung Company

Mr. Lin is President of the 78-year-old Tatung Company, based in Taipei, Taiwan. Tatung is a publicly owned corporation with more than 150,000 shareholders. The company has 30,000 employees including 10,000 overseas. It is a conglomerate with worldwide sales of $4 billion and manufactures and markets 300 different products including heavy electric apparatus, home appliances, electronics, computers, and telecommunications equipment. At present, computers and computer peripherals make the most important contribution to the company's revenue.

In order to make the most of competitive advantages of different countries, Tatung has operations in Japan, Korea, the United States, the United Kingdom, Thailand, Malaysia, Singapore, Indonesia, Germany, Canada, Australia, and Hungary.

Now, the 48-year-old president is concentrating on developing Tatung's high-technology capabilities. The company has become a major supplier of computer peripherals to a number of famous brands in the United States. Mr. Lin travels frequently to the United States to visit companies in the Silicon Valley so he can develop technologies and markets for products and components in the computer hardware and software fields.

An article in the October 1991 issue of *Asian Business* identified Mr. Lin as the man best suited to turn Tatung into "a major international player in the 1990s."

To do this, Mr. Lin is working to establish strategic business alliances with high-tech companies in the United States, Europe, and Japan.

Panelist: Reaching $300 Billion in Semiconductor Revenue by the Year 2000—What's It Going to Take?

Marcus T. Wilson

Vice President and General Manager
Semiconductor Products Group
Intel Corporation

Mr. Wilson is Vice President within the Semiconductor Products Group (SPG) and General Manager of Group Marketing. He is responsible for the overall strategy and synergy of marketing programs for all divisions of SPG (Embedded Microcontroller Division, Embedded Processor Division, Memory Components Division, and Military and Special Products Division).

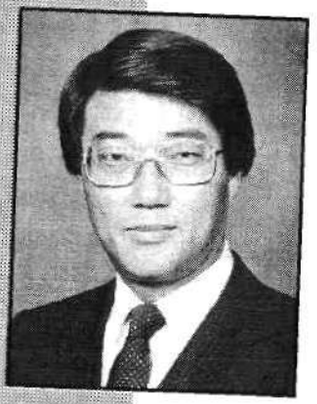
Before becoming the Group Marketing Manager in August 1994, Mr. Wilson served as the General Manager of the Embedded Microcontroller Division (EMD). There he was responsible for embedded control products including the 8- and 16-bit microcontrollers and the Intel 186 and Intel 386tm embedded microprocessors. Prior to becoming General Manager of EMD in 1991, Mr. Wilson served as the General Manager of the Automotive Division, which develops, manufactures, and sells microcontrollers to the automotive industry. Prior to that he was the Director of Corporate Strategic Accounts, where he developed a worldwide sales strategy and coordination of Intel's top 20 customers.

In his first eight years with Intel, Mr. Wilson held several positions in field sales including Southern Region Sales Manager, District Sales Manager, and Field Sales Engineer. Before joining Intel in 1978, he served as a Field Sales Engineer for the Texas Instruments Semiconductor Division.

Mr. Wilson earned his M.S. degree in management in 1978 from Rollins College in Orlando, Florida, and his B.S. degree in electrical engineering technology in 1973 from Mississippi State University. He sits on the Phoenix Zoo Board of Directors and is an advisor on the Education and Strategic Planning Committees. He also is a member of the Advisory Council for Engineering at the University of Texas-Pan American.

Panelist: Reaching $300 Billion in Semiconductor Revenue by the Year 2000—What's It Going to Take?

James J. Kim, Ph.D.
Founder, Chairman, and CEO
Amkor Electronics Inc./Anam Group



In January 1992, Dr. Kim became Chairman of the Anam Group in Korea. He founded Amkor Electronics Inc. in 1968, incorporating in March 1970, and has guided its dramatic growth and diversification as Chairman and CEO. Amkor, headquartered in West Chester, Pennsylvania, has established its reputation as a leader in semiconductor assembly, testing, packaging, and technology, using the facilities of Anam Industrial Co. Ltd. of Seoul and Amkor/Anam Pilipinas Inc. in Manila.

Dr. Kim was assistant professor of economics at Villanova University from 1964 to 1970, where he taught economics theory and conducted seminars. From Villanova, he took a leave of absence to participate in an Agency for International Development project in Korea. In the fall of 1977, Dr. Kim founded The Electronics Boutique Inc., beginning operations with one kiosk-type store in the King of Prussia Plaza shopping mall in Pennsylvania. This was a new concept in the retail sale of electronic products and has been outstandingly successful, growing from the one kiosk to 400 in-line stores, all except one in Manhattan in shopping malls. This expansion has included most of the 48 contiguous states, as well as Puerto Rico, Canada, and recently Great Britain. In 1984 he relinquished the presidency; he now serves asChairman and CEO.

Dr. Kim was born in Seoul, Korea, in 1936 and came to the United States as a student in 1955. He became a citizen in 1971. He resigned from Seoul National University (Korea) College of Law to enroll in the Wharton School of Finance and Commerce at the University of Pennsylvania. He received a B.S. degree in economics in 1959 and an M.A. degree in economics from the Graduate School of Arts and Sciences in 1961, and completed his doctoral studies in economics (except dissertation) in 1963.

Dr. Kim serves as a director of VLSI Technology Inc., of San Jose, California, and of the CFM Technology Corporation, West Chester, Pennsylvania. He is a past chairman of both the Korean Athletic Association of Philadelphia and the Korean Association of Greater Philadelphia. Dr. Kim is listed in "Who's Who in America" and "Who's Who in the World." He is a member of the Board of Overseers of the School of Arts and Sciences at the University of Pennsylvania, of the Villanova University Development Council, and of the Union League of Philadelphia. He was awarded an honorary degree of Doctor of Commercial Science by Villanova University in 1990.

ASSEMBLY SUPPORT FOR $300B

• Total Semi Sales	+119%	(137B to 300B)
• Total Semi # Sales	+ 43%	(206B to 295B)
• Total Semi ASP	+ 40%	(.59 to .83)
• Assembly Activity	+ 90%	

Defining Tomorrow's Technology Today

ASSEMBLY SUPPORT FOR $300B (continued)

• Factory productivity	+ 40%	(7%/year)
• Package material content	+ 10%	(30% to 40%)
• Current # of Factories	200	(40M Sq. Ft.)
• New factories required	80	
• New factories started/announced	35	
• Additional factories required	45	

Defining Tomorrow's Technology Today

ASSEMBLY SUPPORT FOR $300B (continued)

- New factory investment required $ 2.0B (20M Sq. Ft.)
- Productivity investment required $ 2.0B
- Equipment investment required $ 9.3B
- Total investment required $ 13.3B

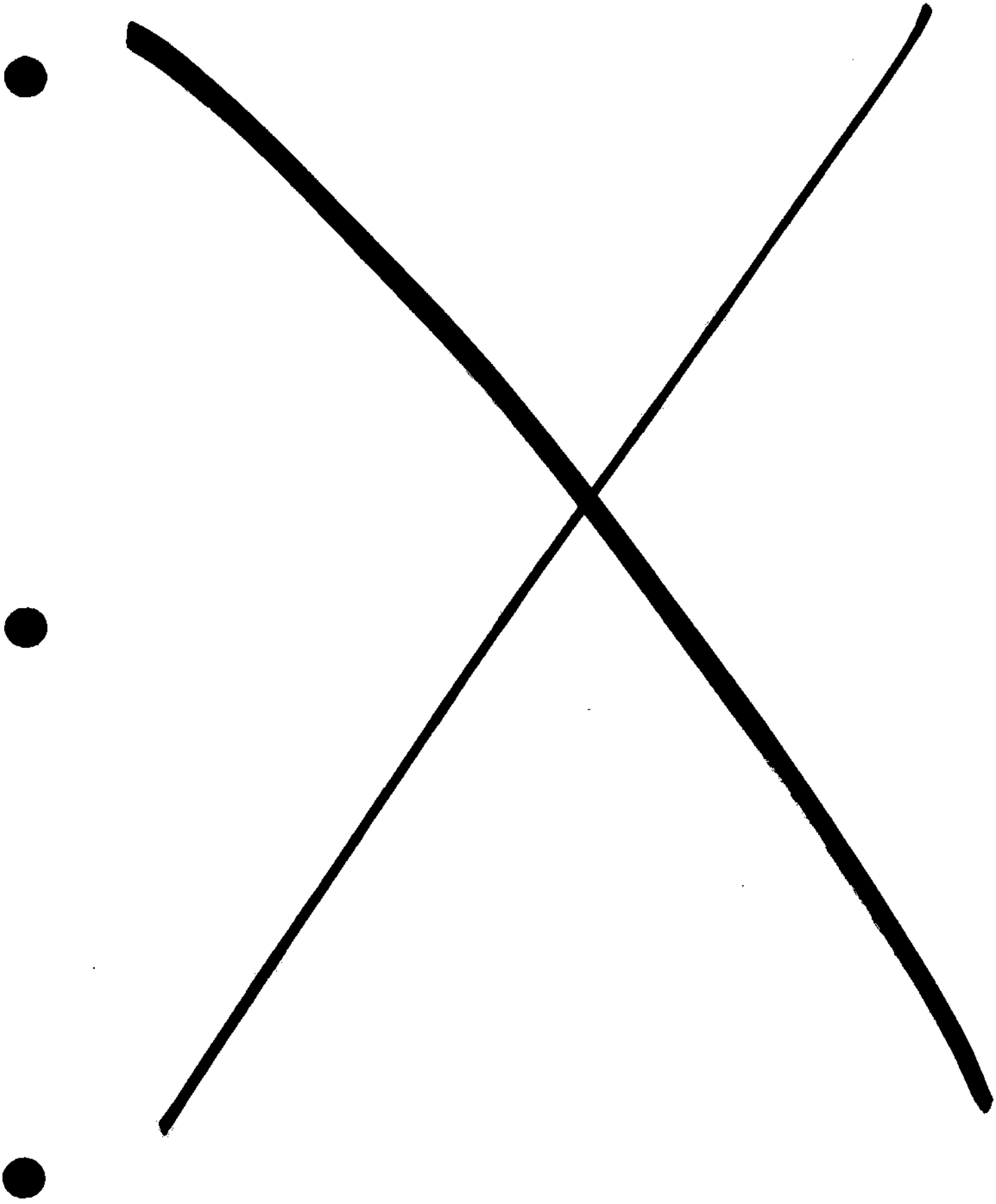
Defining Tomorrow's Technology Today

ASSEMBLY SUPPORT FOR $300B (continued)

- Most challenging areas:
  - Assembly equipment suppliers
  - Leadframe/Substrate suppliers
  - Upgrading existing factories
  - Significant packaging technology challenges

Defining Tomorrow's Technology Today

Notes:



The Next Step in High-Speed Interface Technology

Geoff Tate

President and Chief Executive Officer
Rambus Inc.

Mr. Tate joined Rambus as President and CEO in 1990 during the company's first year of operation.

Mr. Tate previously held the position of Senior Vice President and Corporate Officer of Advanced Micro Devices (AMD) responsible for all microprocessors and peripherals including the Intel-compatible (x86) and 29000 microprocessor families. He was with AMD for over 10 years. His earlier positions included managing the Bipolar Gate Array business unit, the PAL business unit, and the Microcomputer Systems business unit.

Mr. Tate has a B.S. degree in computer science from the University of Alberta, and an M.B.A. degree from Harvard, and completed M.S.E.E. course work at Santa Clara University.

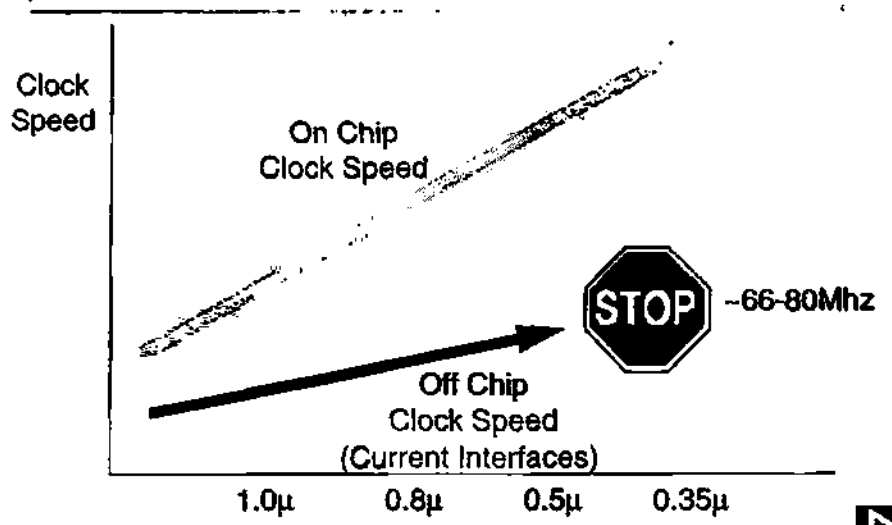
The Next Step in High Speed Interfaces

Dataquest Conference
October 1995

More Performance at Lower Cost

- Major trends
  - ↘ 0.8µ → 0.5µ → 0.35µ
  - ↗ MPU performance
  - ↗ Multimedia performance
  - ↗ PC and consumer multimedia shipments
- More speed from less chips at less cost

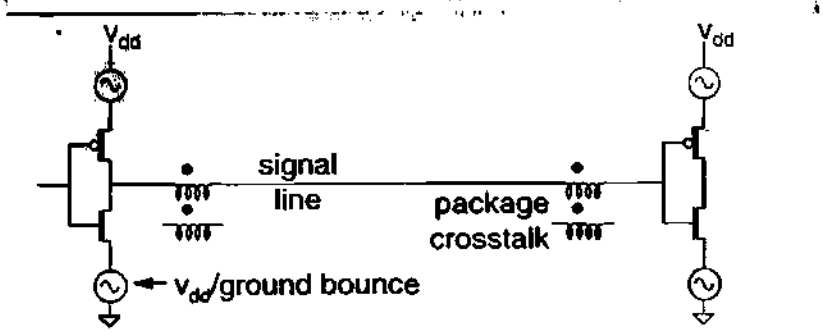
On Chip vs. Off Chip Speed



Off Chip I/O Hurdles

- ✗ CMOS I/O
- ✗ Non-transmission line thinking
- ✗ Noise: SSO, cross talk, faster edge rates
- ✗ Skew
- ✗ Big package ⇒ large lead frame ⇒ more capacitance, inductance, cross talk
- ✗ Large sockets for wide buses
- ✗ Variable capacitive loads

Problems with CMOS I/O

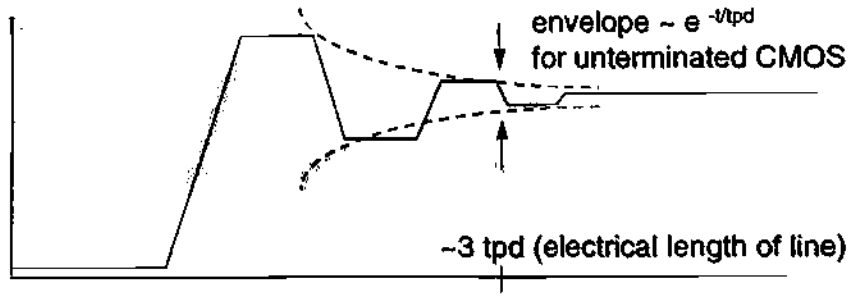


- Package bounce & crosstalk affect I/O levels
- Noisy outputs: rail-to-rail, fast edges
- Not well suited for transmission lines

Noise

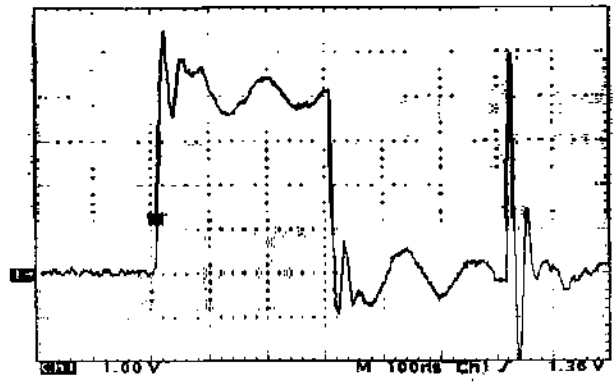
- SSO (simultaneous switching outputs)
- Cross talk: leadframe, printed circuit board
- Made worse by
  - Bigger swings
  - Bigger packages with larger leadframes
  - Faster edge rates
  - Faster clock speeds

Transmission Lines



- Typical PC memory bus
  - 10" ⇒ tpd ≈ 4 ns
  - tcycle ≥ 3 tpd ≈ 12 ns ⇔ ~80 Mhz max
  - Not including skew, noise, etc.
- Termination and impedance control needed

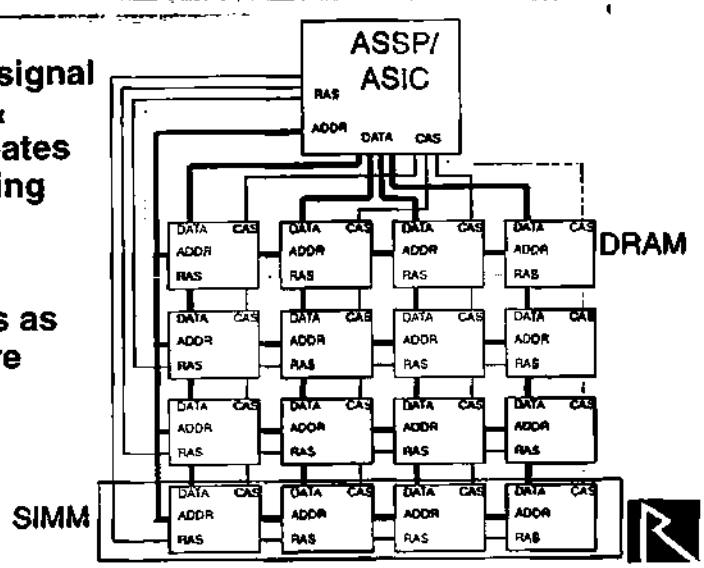
Typical CMOS Signal



- Scope photo from Pentium-based PC

Traditional Memory System

- Unequal signal lengths & loads creates large timing skew
- Skew increases as SIMMs are added



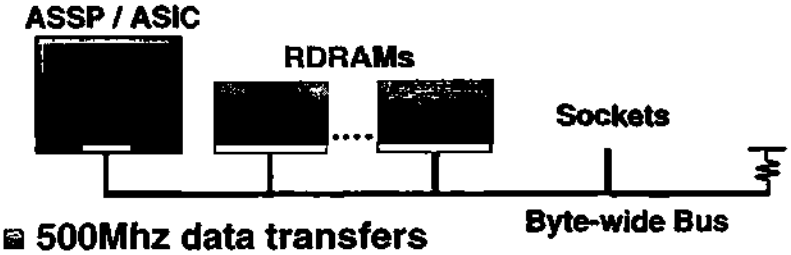
New Interface Approach

- Engineer as a total solution
- PCI bus
  - I/O bus for PC's
  - 33Mhz data transfer rate
  - Constrained CMOS I/O
  - Constrained board layout requirements
  - Transmission line design
  - Equal loading on signals
  - Expansion strategy: connectors, modules

Rambus Design Objectives

- ✓ High bandwidth memory subsystem
- ✓ Low cost
  - ✓ Minimum signals, pins
  - ✓ Standard CMOS
  - ✓ Plastic packaging
  - ✓ Standard printed circuit board
- ✓ Total solution
  - ✓ drivers, receivers, layout, expansion

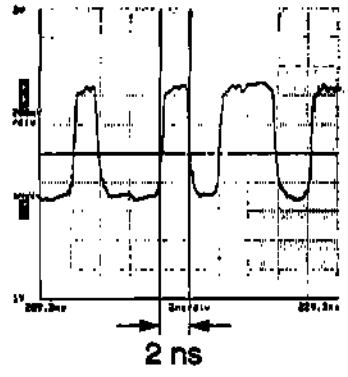
Rambus Channel



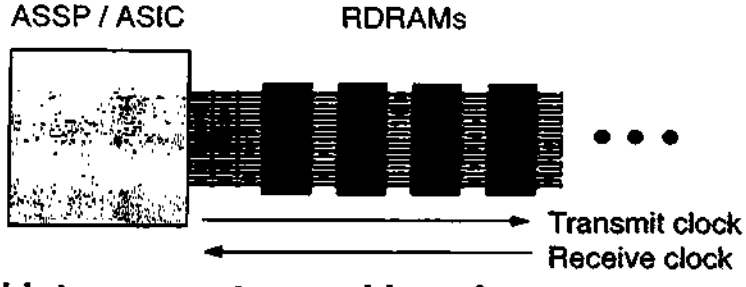
- 500Mhz data transfers
- Small signal swing (≤ 1V)
- Transmission line environment
- Multiplexed data, address, control bus
- Low pin count

Low Swing Signals

- ≤1V swings
- Terminated transmission line
- Drivers/receivers optimized for buses: 1 RDRAM or dozens

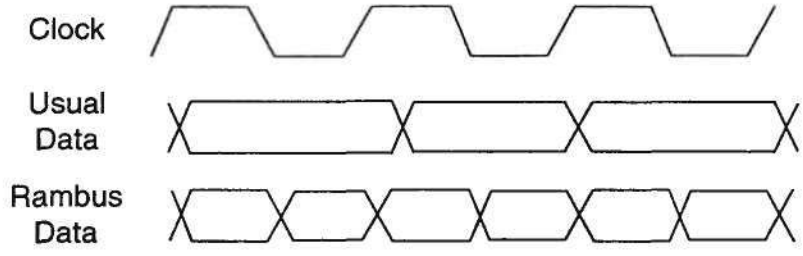


Minimize Skew



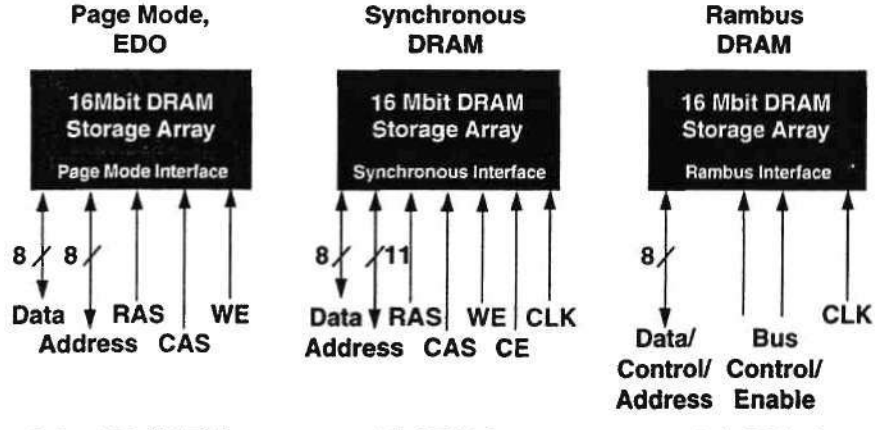
- All interconnects equal length
- RDRAM lead frame: short, equal length
- Skew very, very low
- Clock and data travel together

Data Transfers on Both Clock Edges



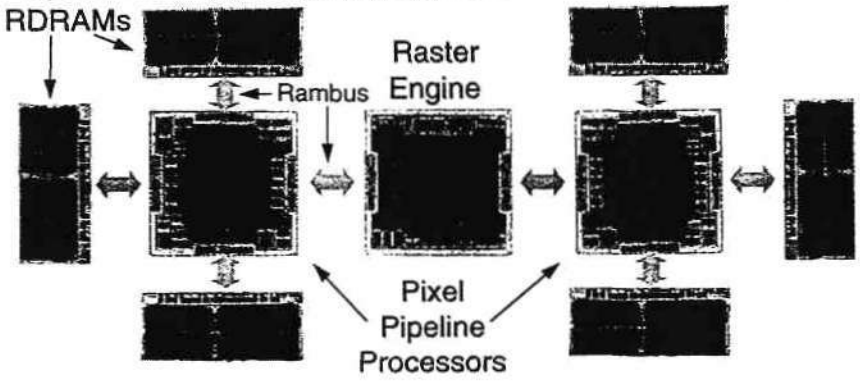
- Doubles data bandwidth
- Achieved by advanced skew control including phase-locked loops

What a difference an interface makes



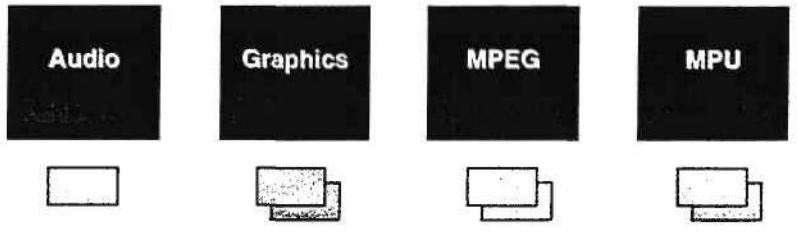
33~50 MB/s **66 MB/s** **500 MB/s**

SGI Indigo2 IMPACT 3D Engine

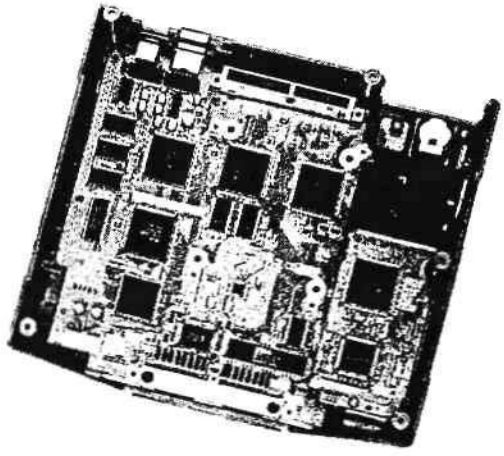


- 3 Gigabytes/second bandwidth
- Rambus ASIC-to-ASIC data transfer

1st Generation Consumer Multimedia

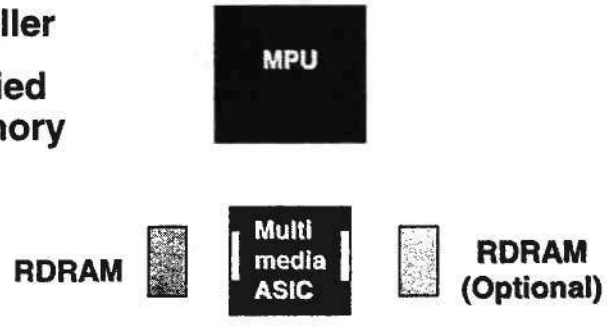


Current Generation Game System

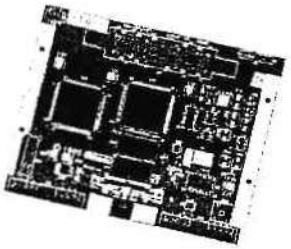


2nd Generation Consumer Multimedia

- Faster
- Cheaper
- Smaller
- Unified memory

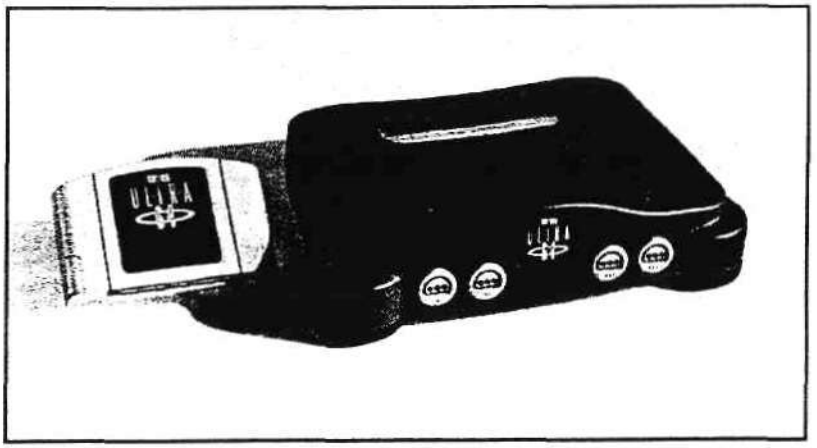


Nintendo Ultra 64 Game System

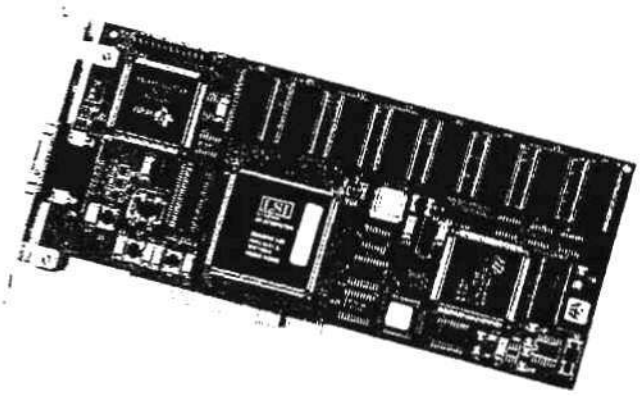


- 2 layer printed circuit board
- Unified (graphics, video & main) memory
- Consumer external memory upgrade

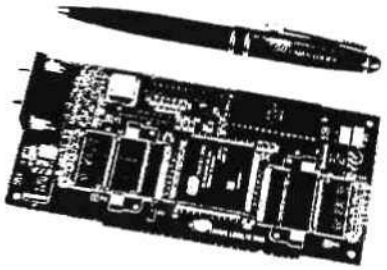
Nintendo Ultra 64



Current Generation Fast PC Graphics



Cirrus GD5462 Visual Media Accelerator



- > VRAM performance: 208 PQFP + 1 RDRAM
- Up to 1600x1200; 3 video windows at 30 fps
- 1996 version: 1 GB/s in same footpint

Notes:

Programmable ICs—Beyond Microprocessors

Wes Patterson
President
Chromatic Research Inc.

Mr. Patterson is President of Chromatic Research Inc.

Mr. Patterson was formerly Chief Operating Officer and Executive Vice President of Xilinx Inc. He joined Xilinx in 1985 as Senior Vice President of Marketing and was promoted to Chief Operating Officer in 1990. Before joining Xilinx, Mr. Patterson was at VLSI Technology Inc. for four years as Director of Standard Cell Operations.

Prior to VLSI, Mr. Patterson spent seven years at Motorola Semiconductor and six years at Honeywell Information Systems in various management and engineering positions.

Programmable ICs: Beyond Microprocessors

Wes Patterson
President
Chromatic Research, Inc.

Agenda

- The Programmable Logic Market
- Extending the Market
- Chromatic / Mpact

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Two Kinds of Logic ICs

- **Fixed**
  - What you see is what you get
- **Programmable**
  - What you program is what you get

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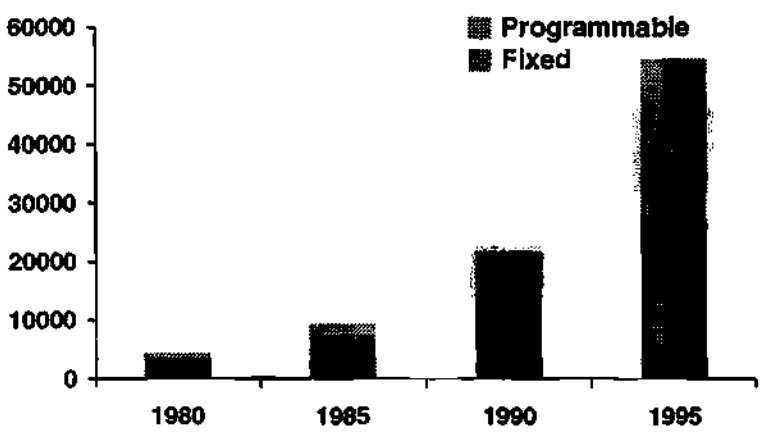
The Logic Market



Source: Dataquest 1995

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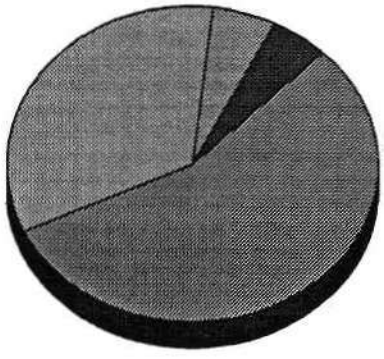
Programmable Logic Categories

MPU

MCUs

PLDs

DSP



1990 - 1995 CAGR 30%

Source: Dataquest 1995

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Origins of Programmable Architectures

CPUs → MPU

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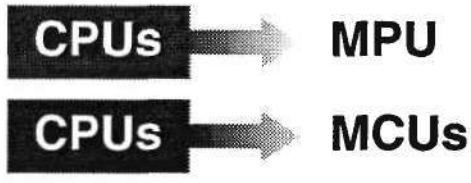
Origins of Programmable Architectures



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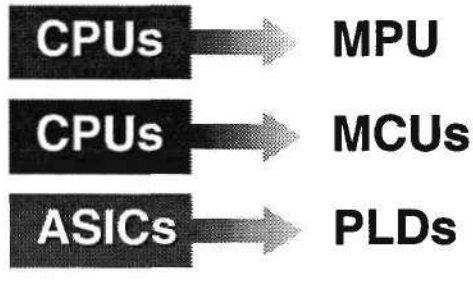
Origins of Programmable Architectures



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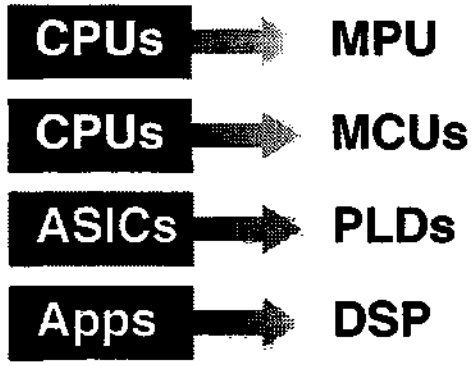
Origins of Programmable Architectures



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Market Forces

- Performance
- Price
- Programmability

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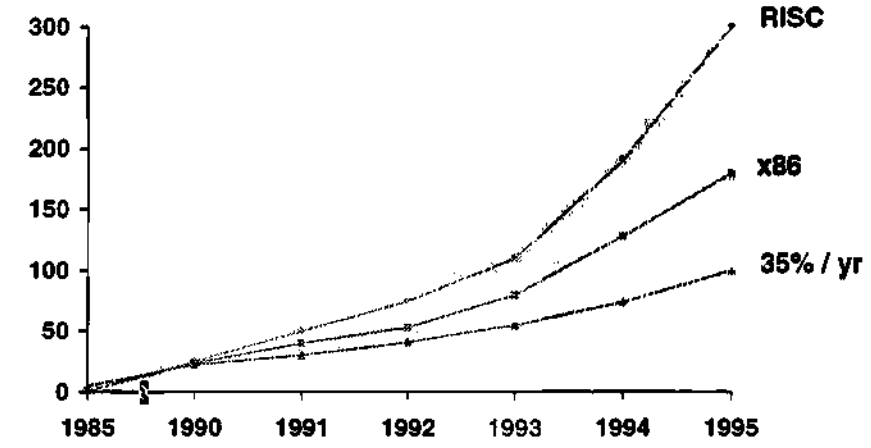
Performance



Source: William N. Joy, Sun Microsystems, Inc. 1995

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Performance

- **Electrical advances**
  - **Smaller geometry processes**
  - **Advanced circuit design techniques**
- **Architecture**
  - **Microprocessors**
  - **Digital Signal Processors**
  - **Programmable Logic Devices**

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Pricing

- Transistor re-use
- Exploit VLSI densities
  - Complexity
  - Return on design investment
- High production volumes
  - More applications
  - Longer lifetimes

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Programmability

- New and evolving technologies / applications
- Product differentiation
- Time to market
  - Reduced verification time
  - Reduced production ramp up

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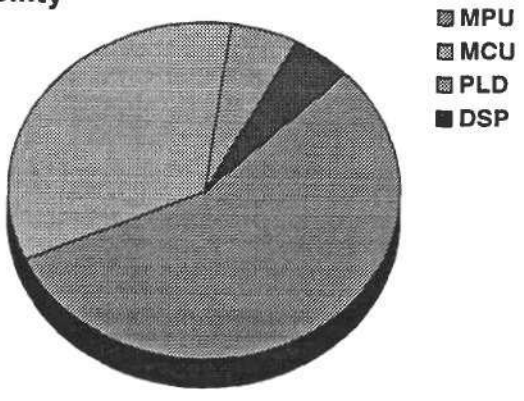
Programmability

Strong correlation between market size and ease of programmability



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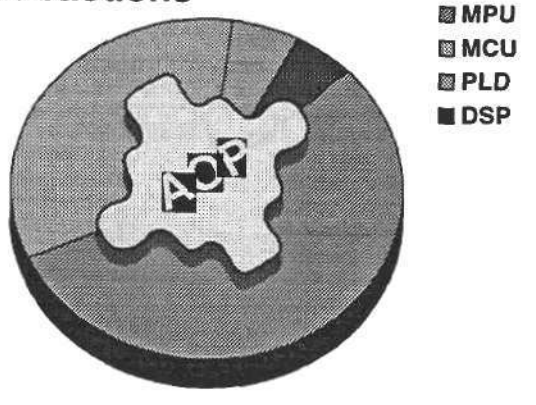
Programmability

Higher Levels of Design Abstractions



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AOP: A New Programmable Category

- Programmable ICs
- High-performance architectures
- Optimized for specific applications

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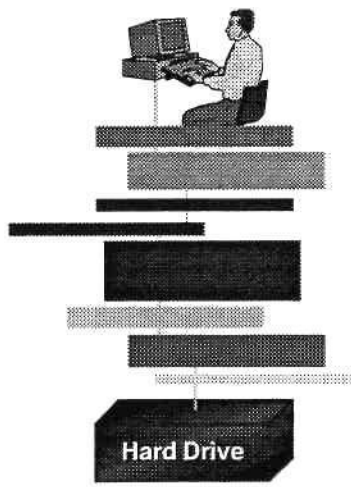
AOP: Benefits

Current Model



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AOP: Benefits

- **Integration**
  - **Eliminates some interfaces**
  - **Simplifies others**

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AOP: Benefits

- Integration
  - Eliminates some interfaces
  - Simplifies others
- **Reduced design verification time**
  - **Fast simulation**
  - **Design documentation**
  - **Formal verification**

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AOP: Business Environment

- AOP is not a universal solution for the logic market
  - $700M or larger OEM market
  - $100M Fab model
  - $10M Design model

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AOP: Implications

- Blurring of software and hardware boundaries
- Blurring of programmable architectures
- Blurring of manufacturing and design

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AOP: Example

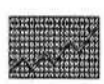
Mpact™ Media Engine from Chromatic

CHROMATIC

Seven Multimedia Functions

1 

Video
- MPEG-1 real-time encode
- MPEG-1 decode
- MPEG-2 decode

2 

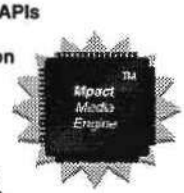
2D Graphics
- Windows GUI acceleration
- 1280 x 1024 x TrueColor, 75Hz

3 

3D Graphics
- Windows 95 gaming APIs
- Texture mapping
- Perspective correction

4 

Audio
- MPEG audio
- Dolby AC-3 audio
- Wavetable synthesis
- Waveguide synthesis
- 3D sound and effects
- General MIDI
- FM synthesis



5 

FAX/Modem
- 28,800 baud (V.34)
- Simultaneous voice and data

6 

Telephony
- Speakerphone
- Caller ID
- Voicemail

7 

Videoconferencing
- H.320 (ISDN)
- H.324 (POTS)

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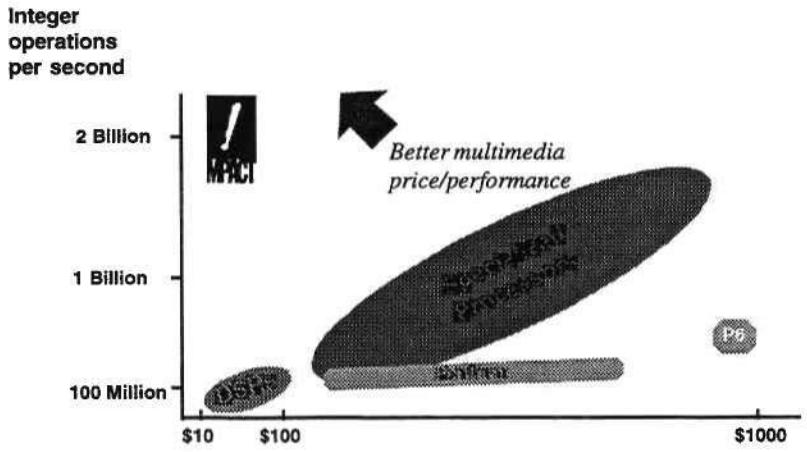
The Fastest Multimedia Processor



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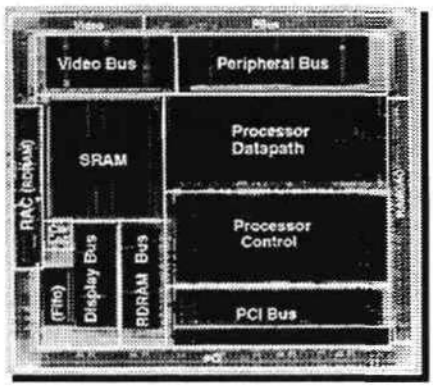
Mpact Multimedia Processor

- **High Bandwidth**
  - 792-bit bata path
  - 500 Mbps interface to Rambus DRAMs
- **Advanced Architecture**
  - SIMD
  - VLIW
  - Vector Processor



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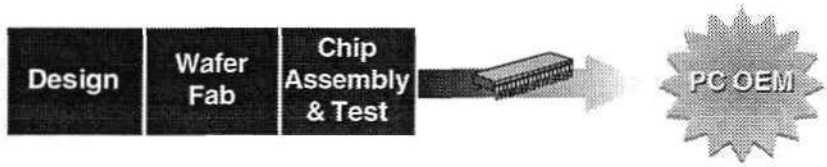
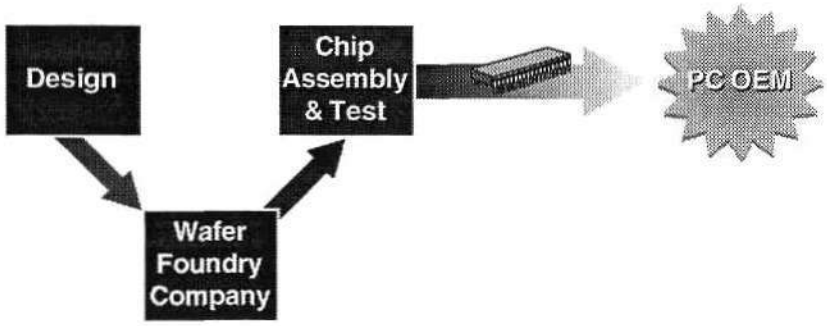
Traditional Semiconductor Business Model



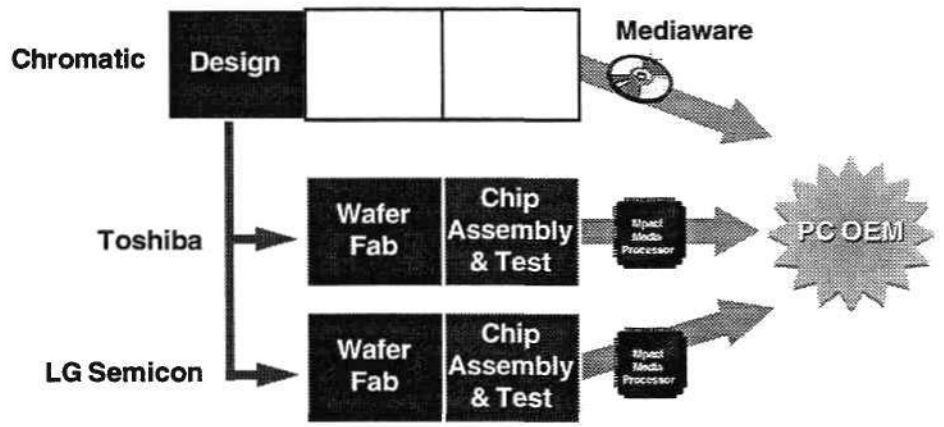
CHROMATIC

Fabless Semiconductor Business Model



CHROMATIC

Chipless Semiconductor Business Model



CHROMATIC

AOP: Conclusions

- Shift towards programmable logic
- Creation of new class of applications
- New way of doing business

CHROMATIC

Notes:

Notes:

Micromachines: What Are They and Where Do They Fit?

Jerry Curtis
Vice President and General Manager
Sensor Products Division
Semiconductor Products Sector
Motorola Inc.

Mr. Curtis is Vice President and General Manager of the Sensor Products Division of Motorola's Semiconductor Products Sector. This division was formed last September as a result of Motorola's commitment to semiconductor-based sensing technology.

Mr. Curtis has been with Motorola for 23 years, serving in a variety of increasing responsibility positions in wafer manufacturing and business operations for discrete, IC, and optoelectronic semiconductors. Most recently he was general manager of the Signal Products Division, which contained the sensor business prior to creation of the new division. In his current assignment he is chartered to lead the market technology and product development efforts of semiconductor-based sensors and actuators for Motorola. These products use micromachining as an enabling technology.

Semiconductor 95

Micromachines

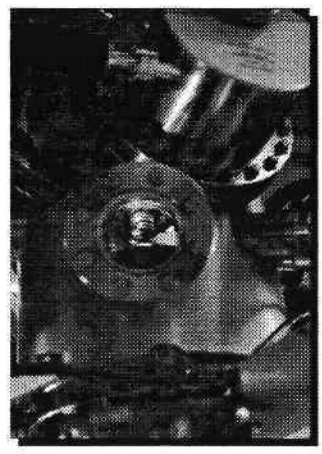
What Are They?

Where Do They Fit?

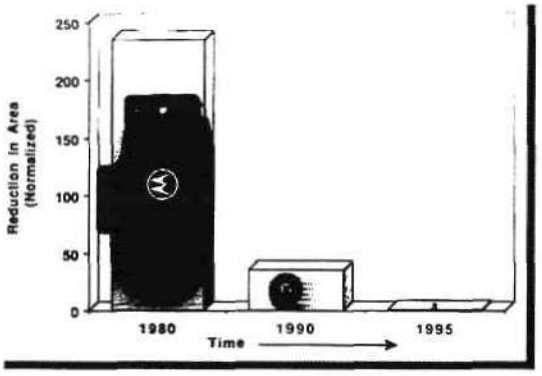
What's In The Future?

MOTOROLA

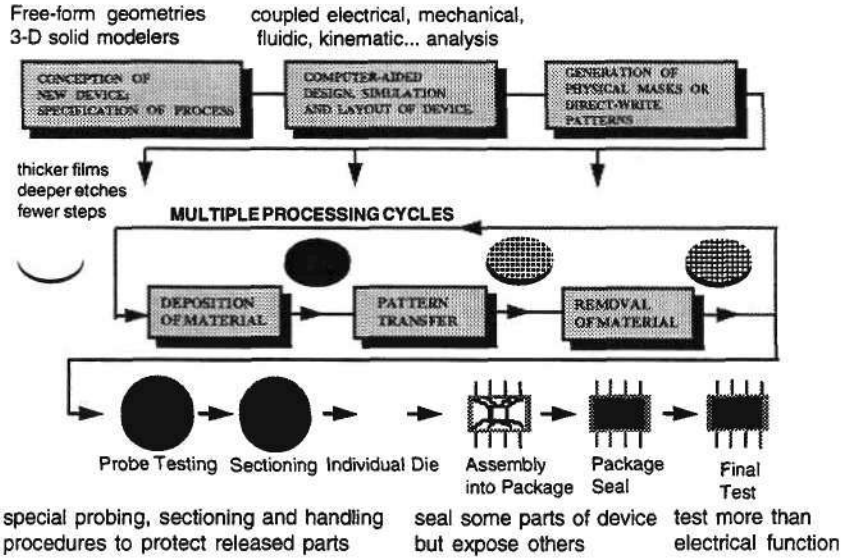
Micromachining is a Powerful Fabrication Technology



Micromachining is Making a Significant Difference to Making Devices Smaller with More Capabilities at Less Cost.



MEMS Builds on Microelectronics Manufacturing

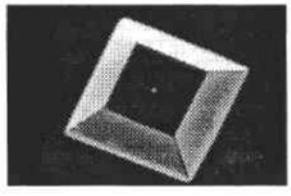


Bulk vs. Surface Micromachining Chart

Bulk vs. Surface Micromachining

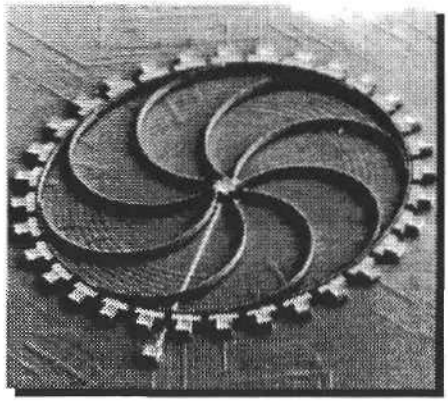
Features	*Bulk Micromachining*	*Surface Micromachining*
Core Material	Silicon	Polysilicon
Sacrificial layer	———	PSG, (SiO_2)
Size	Large (typical cavity dimensions are several hundred μm)	Small (high precision controlled by thickness of the film; typical dimensions are several μm)
Processing factors	Single or double side processing (front and back side) Selectivity in material etching Etching: anisotropic (depends on crystal orientation) Etch stops Patterning	Single side processing (front side) Selectivity in material etching Etching: isotropic Residual stress in films (depends on deposition, doping, annealing)

Typical silicon diaphragm used in pressure sensors (bulk micro-machining)



Motorola's accelerometer G-cell (surface micromachined)

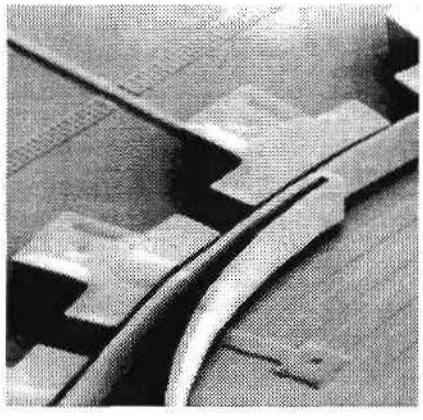
Ring Style Gyroscope



Produced using LIGA

DELCO

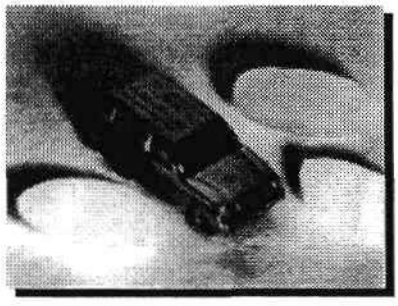
Close Up of the LIGA Produced Capacitive Diodes at the Perimeter of the Gyroscopic Ring.

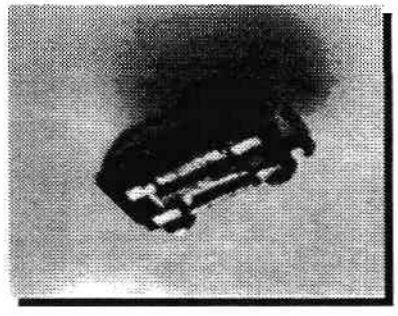


Semiconductor 95

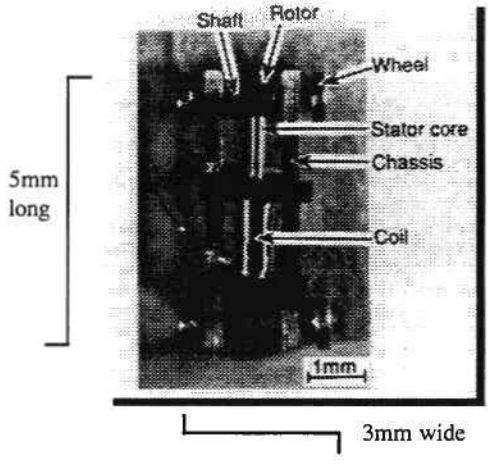
"Micromachining for Locomotion and Performance"

Nippondenso Microcar Compared to Grains of Rice Viewed from the Top and Bottom.



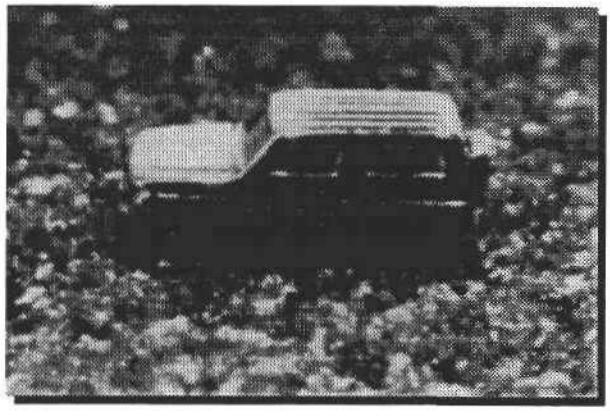


Top View of Chassis



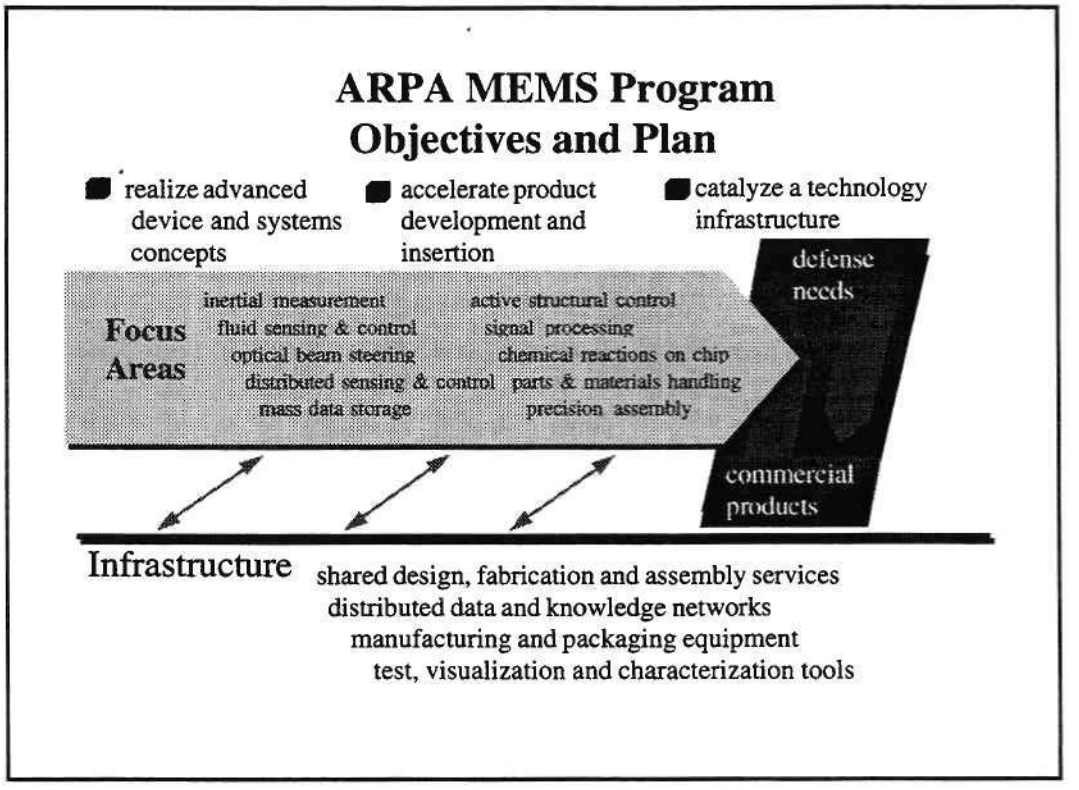
With microstep motor, wheels and shaft.

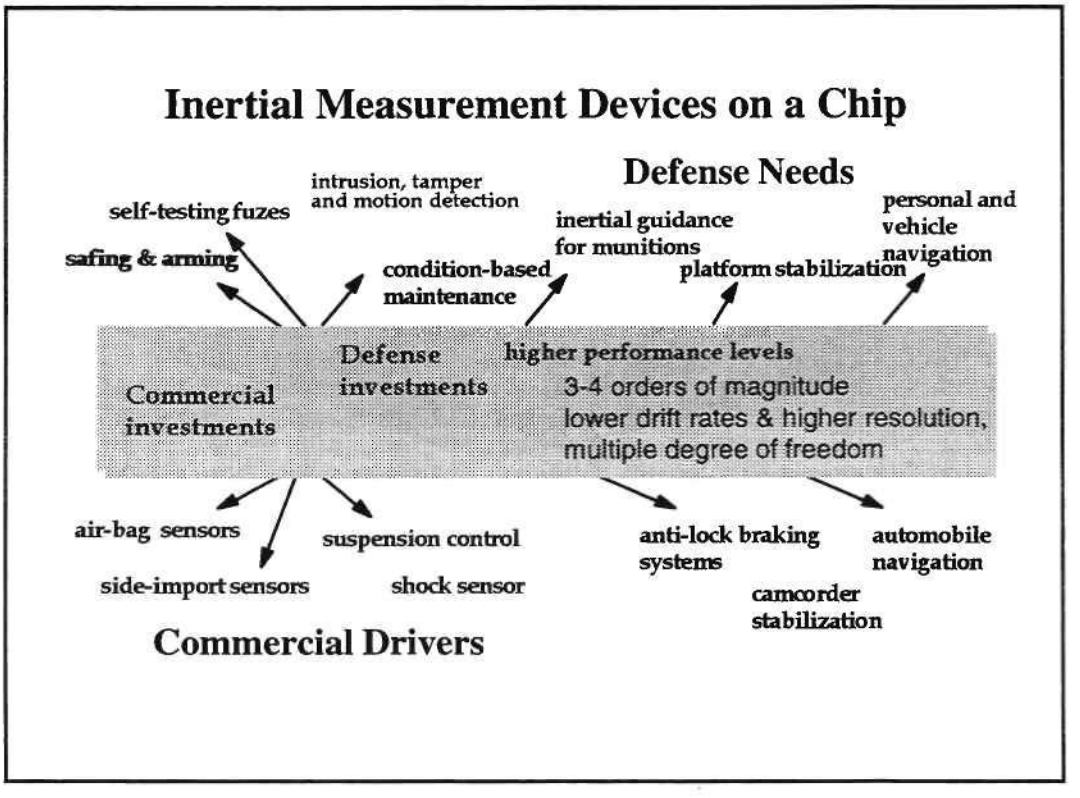
The Microcar Runs Across a Sandpaper Track at 100mm/sec.



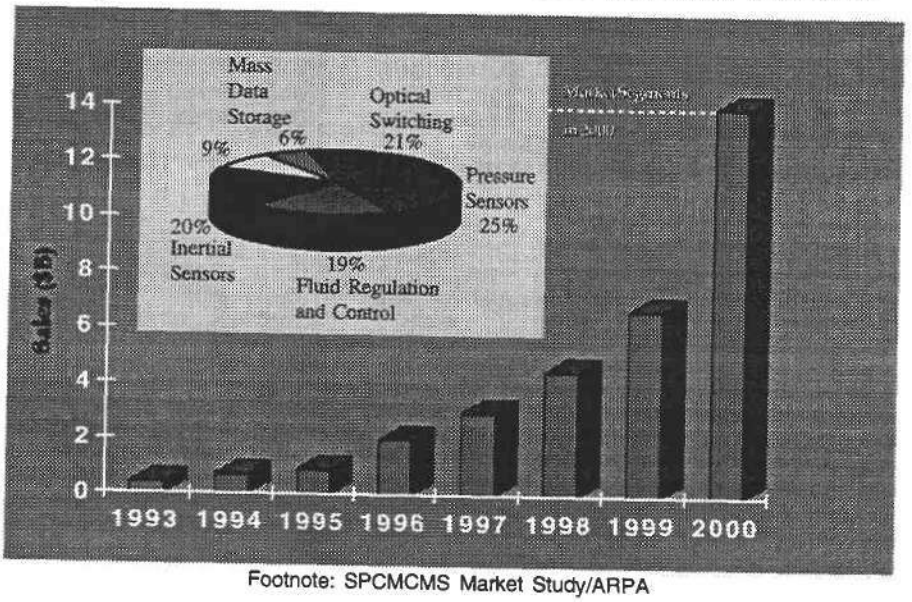
Semiconductor 95

"Out of the Lab and Into Fab"


ARPA MEMS Program
Objectives and Plan
realize advanced device and systems concepts
accelerate product development and insertion
catalyze a technology infrastructure
Focus Areas
inertial measurement
fluid sensing & control
optical beam steering
distributed sensing & control
mass data storage
active structural control
signal processing
chemical reactions on chip
parts & materials handling
precision assembly
defense needs
commercial products
Infrastructure
shared design, fabrication and assembly services
distributed data and knowledge networks
manufacturing and packaging equipment
test, visualization and characterization tools

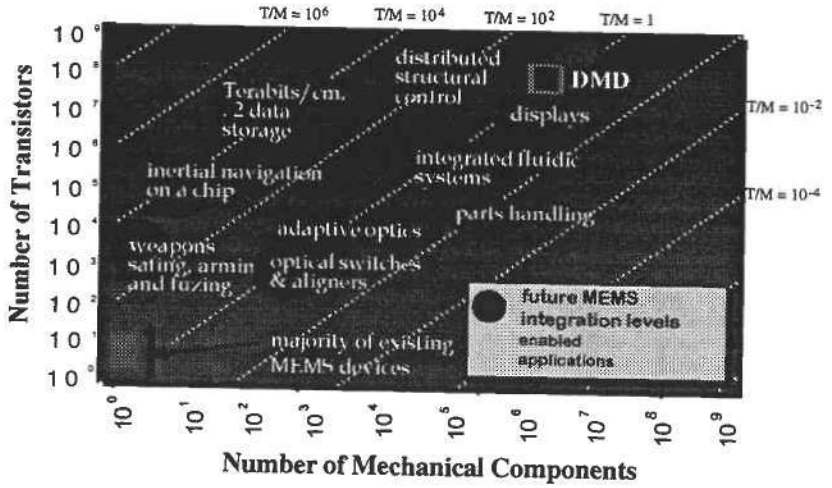

Inertial Measurement Devices on a Chip
Defense Needs
self-testing fuzes
intrusion, tamper and motion detection
inertial guidance for munitions
personal and vehicle navigation
safing & arming
condition-based maintenance
platform stabilization
Commercial investments
Defense investments
higher performance levels
3-4 orders of magnitude lower drift rates & higher resolution, multiple degree of freedom
air-bag sensors
suspension control
anti-lock braking systems
automobile navigation
side-import sensors
shock sensor
camcorder stabilization
Commercial Drivers

Projected Growth of Worldwide MEMS Market



Footnote: SPCMCMS Market Study/ARPA

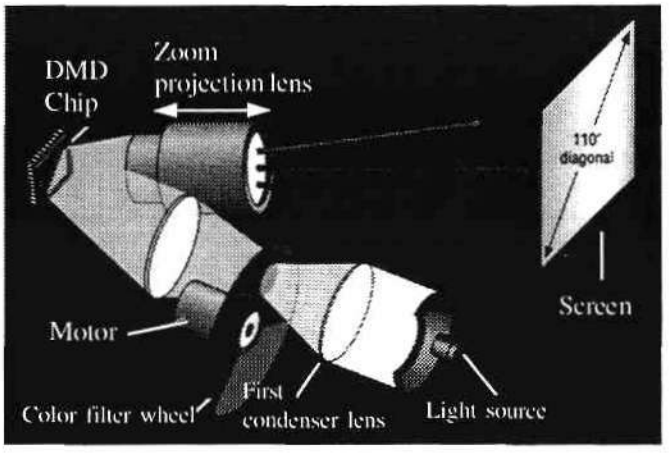
MEMS Technology Trend and Roadmap



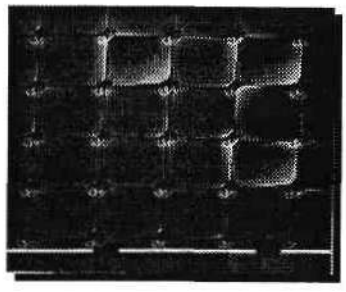
Semiconductor 95

"What Does This Mean To Business?"

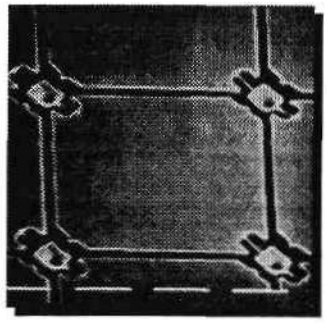
Texas Instrument's Large Screen Projection System



A Close Up View of the MEMS Devices used in Texas Instruments Large Screen Projector

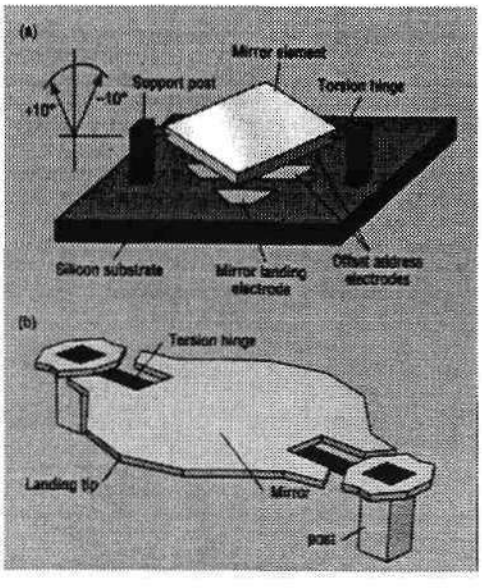


Digital Micromirror Device (DMD) array.



Individual Micromirror Structure.

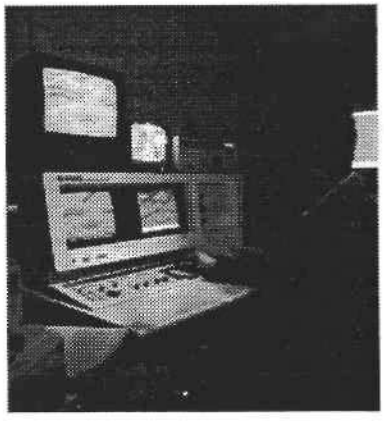
Texas Instruments



Entirely micromachined, the digital micromirror element features conventional torsion hinge suspension.

Micromachined Sensor Products and Systems

Sensors:
Devices that provide a useful output to a specified measurand



Actuators:
Part of an open or closed loop control system that connects the electronic control unit with a process.

senseon

Total Sensor Market

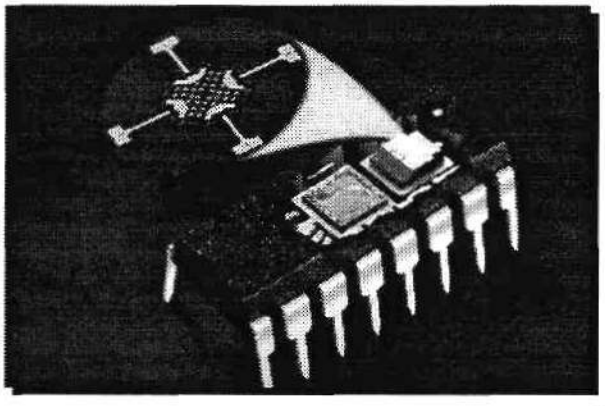
1994 TOTAL SENSOR TAM $ 9.0 B

SENSOR		APPLICATION
PRESSURE		MAP / BAP / HVAC / MEDICAL MICROPHONE / SPEAKER
ACCELERATION		AIRBAG / ABS / RIDE GYRO
SPEED	OPTO SILICON	MOTOR CONTROL / HVAC AUTO
POSITION	OPTO SILICON	MOTOR CONTROL ROBOTICS / AUTO
MASS FLOW		PROCESS CONTROL HVAC
GAS		CO / CH4 ENVIRONMENT / SAFETY
LIQUID		ENVIRONMENTAL PROCESS CONTROL
BIOCHEMICAL		MEDICAL
THERMAL		PROCESS CONT. / MEDICAL HABITAT / BATTERY CONT.
MAGNETIC		PROCESS CONTROL MEDICAL / SAFETY
RADIATION		PROCESS CONTROL ENVIRONMENTAL

2005 TOTAL SENSOR TAM $ 23 B

senseon

The MMAS40G Accelerometer Applies Both Surface Mount and Bulk Micromachining.



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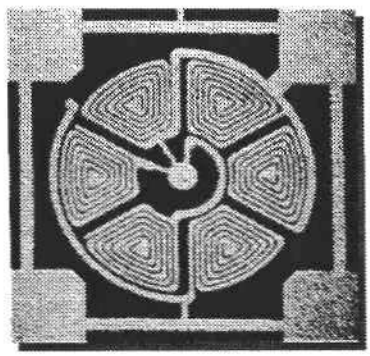
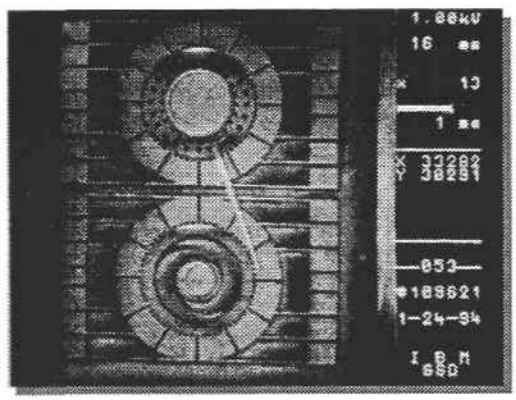
"MEMS Applications for Tomorrow"

Sample Micromotors that could have Medical Applications



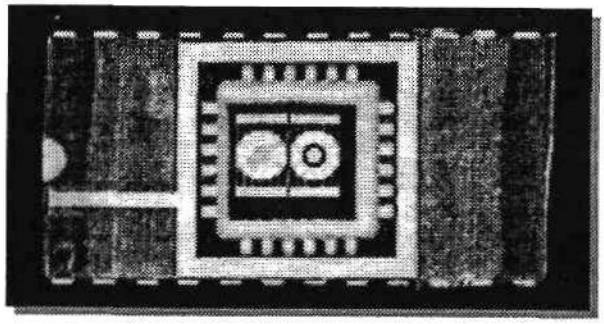
SEM Micrograph of a Fully-Integrated Mechanical Platform for Data Storage

(IBM)

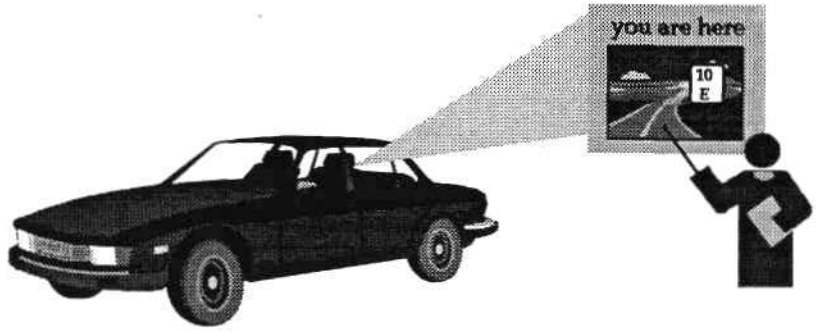


Photograph of a MEMS Mechanical Platform for Data Storage. The chip is Packaged in a Standard 24-pin DIP.

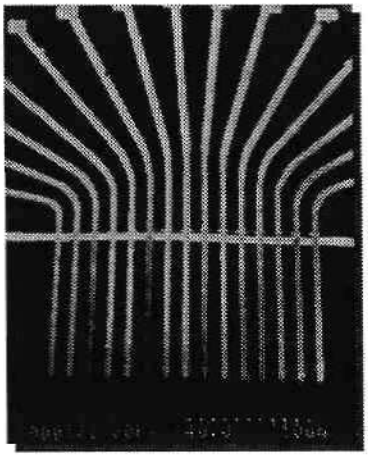
(IBM)



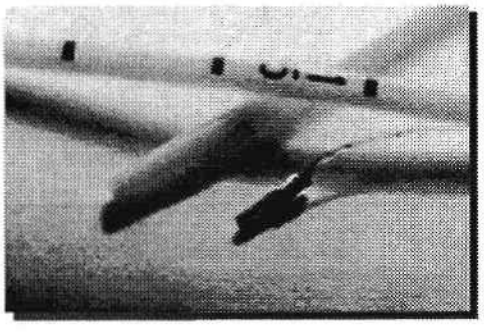
Low Cost, Gyro-Based Navigation Systems will be Found in Automotive Systems by 1998.



SEM of Metallic Probes for Neural Simulation and Recording



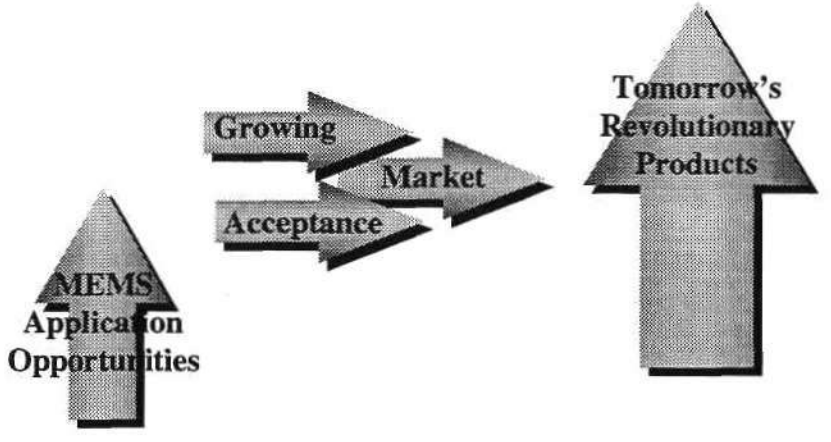
This Cathader has a Built in Sensor Chip to Assess Potassium, Glucose & Lactate



Tiny medical devices depend upon micromaching for functionality.

Semiconductor 95

MEMS Technology is Exciting, It's Real and It is Enabling a New Industrial Revolution.



Notes:

Digital Imaging: Reflecting the Future

Randall D. Ledford, Ph.D.
Vice President
Deputy General Manager
Digital Imaging Group
Texas Instruments Incorporated

Dr. Ledford joined TI's corporate Digital Imaging Group in 1994 and is Vice President and Deputy General Manager responsibile for commercializing imaging products utilizing the Semiconductor Digital MicroMirror Device (DMD-TM).

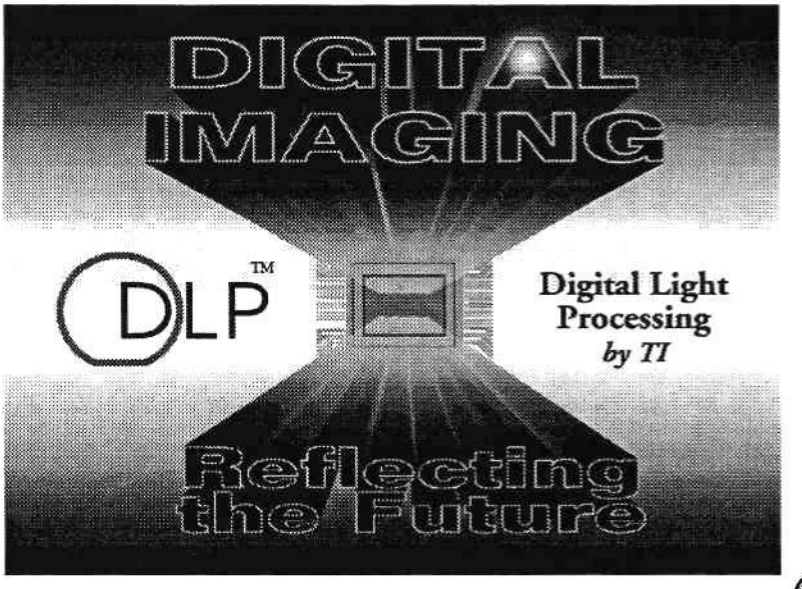
He joined Bell Labs in 1976 in the Network and Central Office Services Group. He was a Member of the Technical Staff and later was promoted to supervisor of Software Design for Switching Systems.

In 1980 Dr. Ledford joined Texas Instruments (TI) in the Appliance Controls Product-Customer Center (PCC) in Johnson City, Tennessee, as Section Manager for Integrated Circuits and Software Development. Later, he became the engineering manager for the PCC. In 1982, he joined the Industrial Automation Division, where he was responsible for developing design automation and implementing CAD/CAM systems and later assumed responsibility for the IAD systems engineering and architecture. He then joined the Advanced Products Development Department, which developed TI's first UNIX-based product. While there, he held various positions including Division Engineering Manager and Marketing Manager.

In 1990, Dr. Ledford became General Manager of the Process Automation Systems Division in ITG. This comprised two divisions that TI acquired from Rexnord Automation. He became Deputy Manager of the Industrial Automation Division the same year. He was elected ITG Vice President in 1991.

From 1992 through 1994, Dr. Ledford was General Manager of ITG's Enterprise Solutions Division (ESD), with responsibility for management and manufacturing software applications systems and solutions, telecommunications voice applications, and process automation systems.

DIGITAL IMAGING



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DIGITAL IMAGING

Agenda

➤**Introduction - Digital Information Infrastructure**

- What is a DMD?
  (Digital MicroMirror Device)
- What is DLP?
  (Digital Light Processing)
- How Does it Work?
- What are its Applications?
- What are the Markets?
- Conclusions

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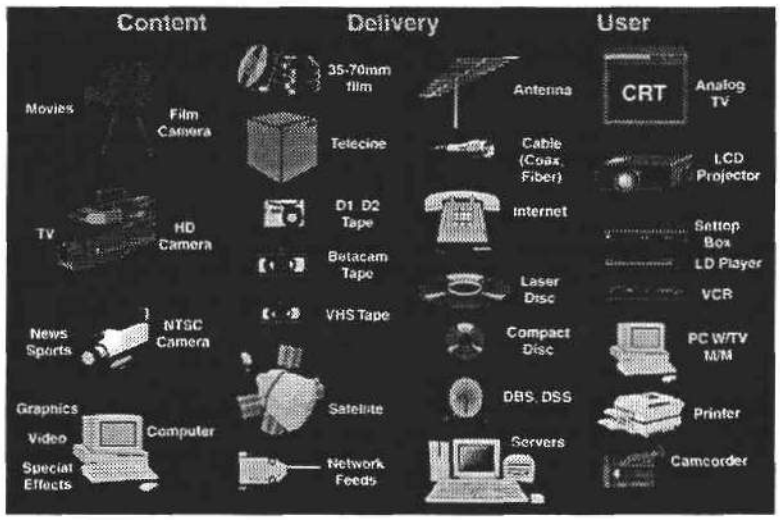
Information Infrastructure



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Digital Information Environment

- We are in the Digital Information Revolution (Information Anytime, Any Place)
  - Larger, brighter, realistic displays
  - High quality, multimedia capable Hardcopy and Displays
  - Extension into the home
  - Rapid growth of Color Hardcopy use in office
  - "Print on Demand" -- offset quality color
  - Knowledge-Rich Transactional Services (pay-per, on-demand)
- Greater Demand on the Human Interface

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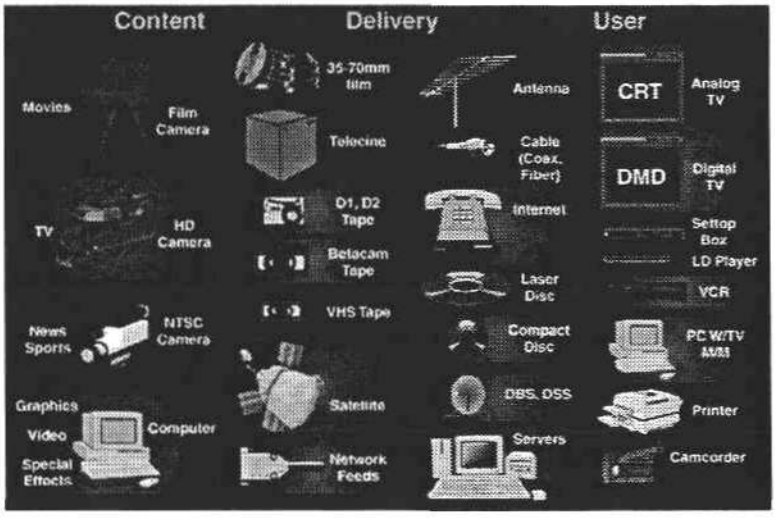
Information Infrastructure with Digital Impact



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DIGITAL IMAGING

Agenda

- Introduction - Digital Information Infrastructure
- **➤What is a DMD?**
  (Digital MicroMirror Device)
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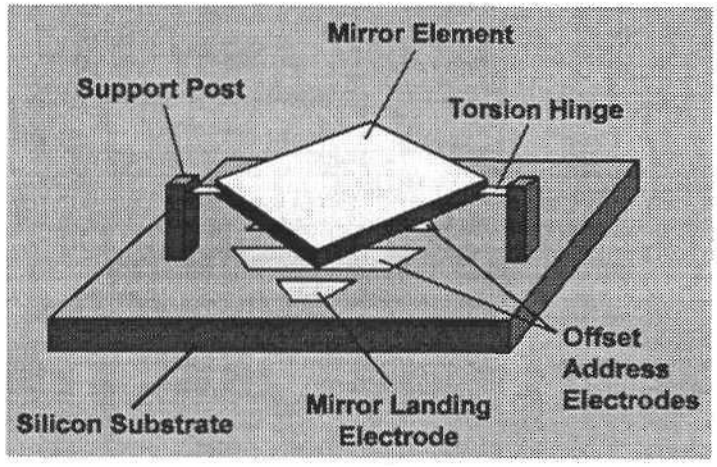
Digital Micromirror Display Pixel



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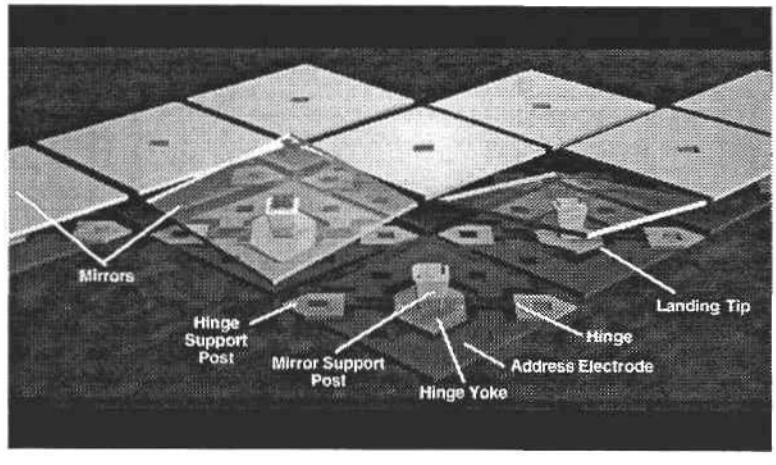
DIGITAL IMAGING

DMD Hidden Hinge Pixel

Hidden Landing Tip Version (HH-II)



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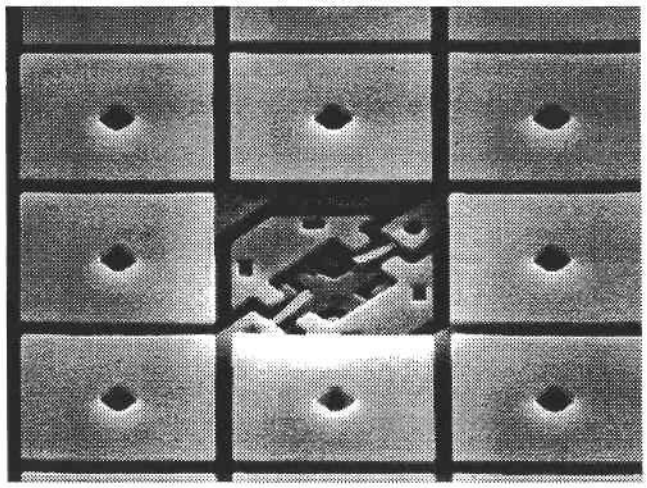
DIGITAL IMAGING

HIDDEN HINGE DMD PIXEL ARRAY

Mirror Removed to Show Underlying Structure



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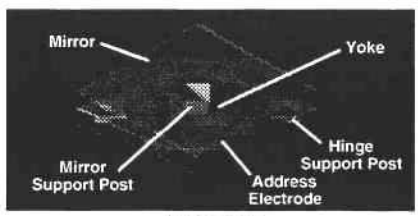
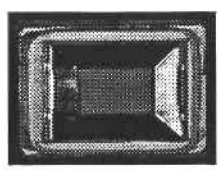
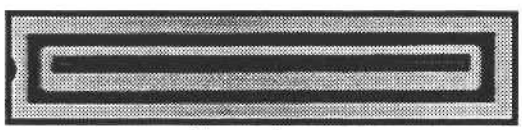
DMD™ Configurations



Element



Area Array



Linear Array

CVP2781

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DIGITAL IMAGING

Agenda

- Introduction - Digital Information Infrastructure
- What is a DMD?
  (Digital MicroMirror Device)
- **➤What is DLP?**
  (Digital Light Processing)
- How Does it Work?
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- Conclusions

CVP2782

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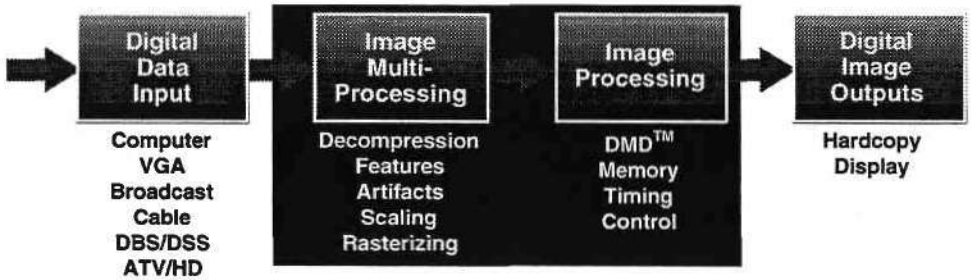
DIGITAL IMAGING

A Totally Digital Approach to Imaging
Digital Light Processing™



DIGITAL LIGHT PROCESSING *by TI*

CVP2783

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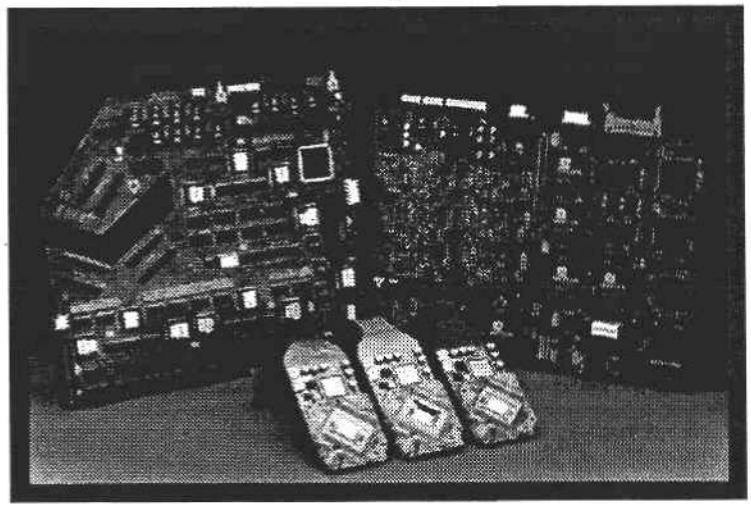
DIGITAL IMAGING

Video Subsystems



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Business Relationship

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DIGITAL IMAGING

Agenda

- Introduction - Digital Information Infrastructure
- What is a DMD?
  (Digital MicroMirror Device)
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  (Digital Light Processing)
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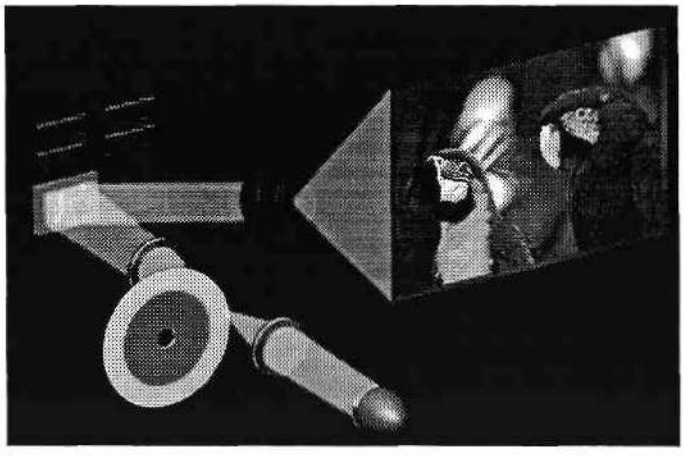
DIGITAL IMAGING

Display-How it Works



CVP2787

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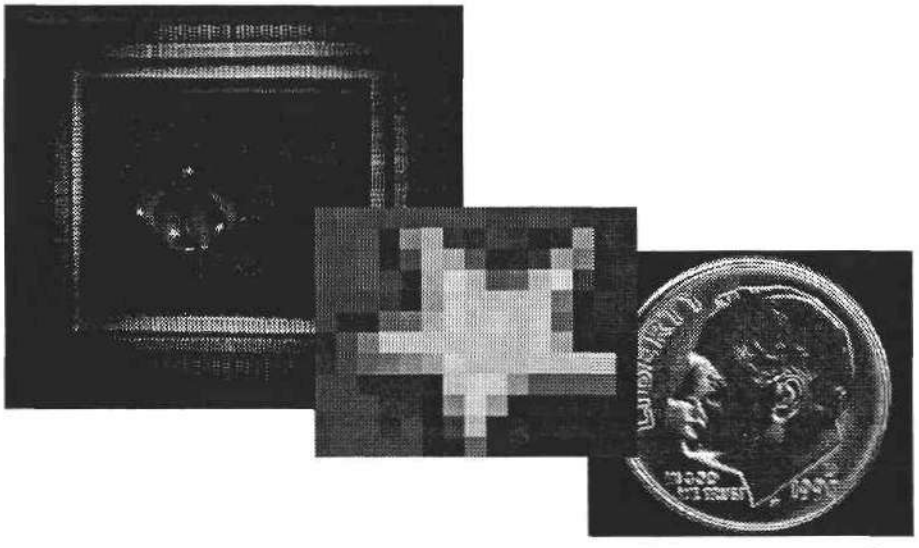
DIGITAL IMAGING



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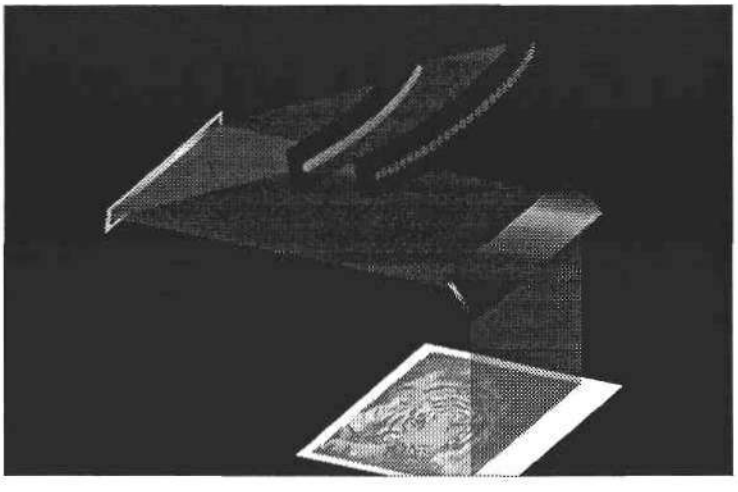
DIGITAL IMAGING

Hardcopy-How it Works



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DIGITAL IMAGING

Agenda

- Introduction - Digital Information Infrastructure
- What is a DMD?
  (Digital MicroMirror Device)
- What is DLP?
  (Digital Light Processing)
- How Does it Work?

➤**What are its Applications?**

- What are the Markets?
- Conclusions

CVP2790

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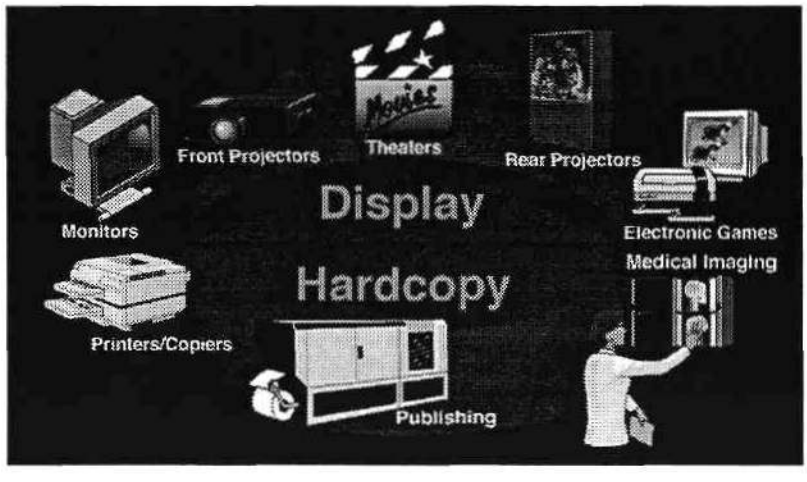
DIGITAL IMAGING

Display and Hardcopy Opportunities



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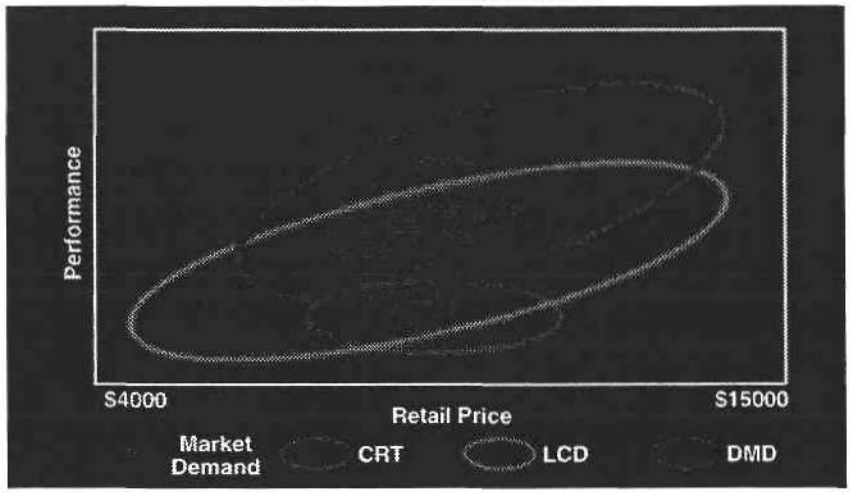
DIGITAL IMAGING

Business Projectors
Competitive Comparisons



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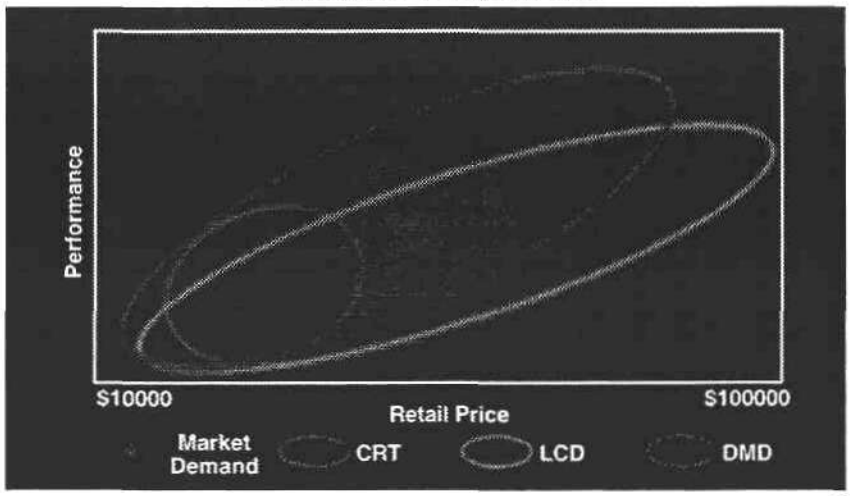
DIGITAL IMAGING

Professional Projectors
Competitive Comparisons



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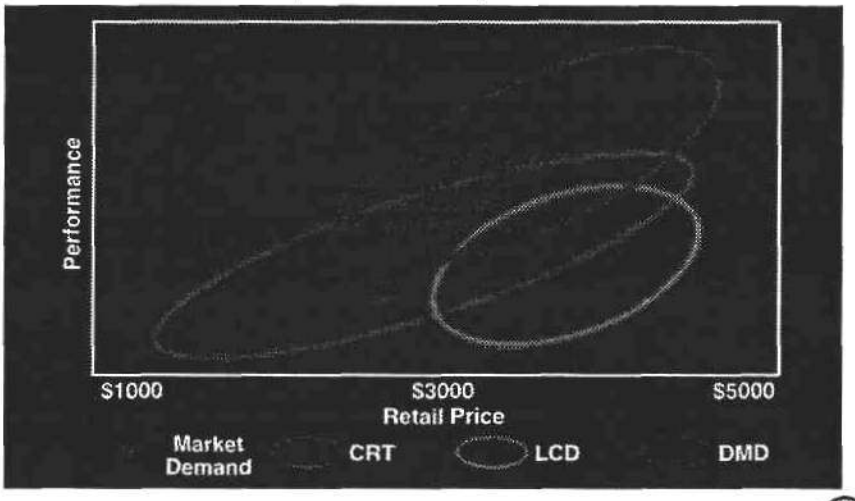
DIGITAL IMAGING

Rear Projection Television

Competitive Comparisons



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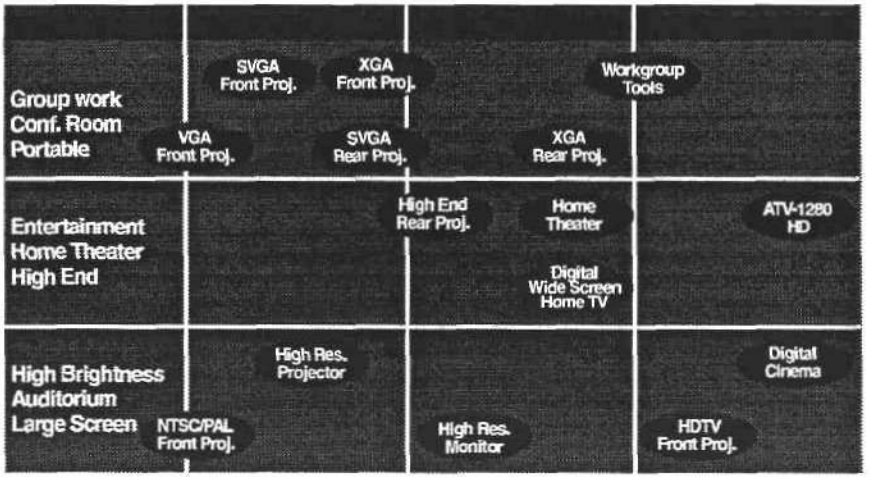
DIGITAL IMAGING

Video Products Roadmap



CVP2795

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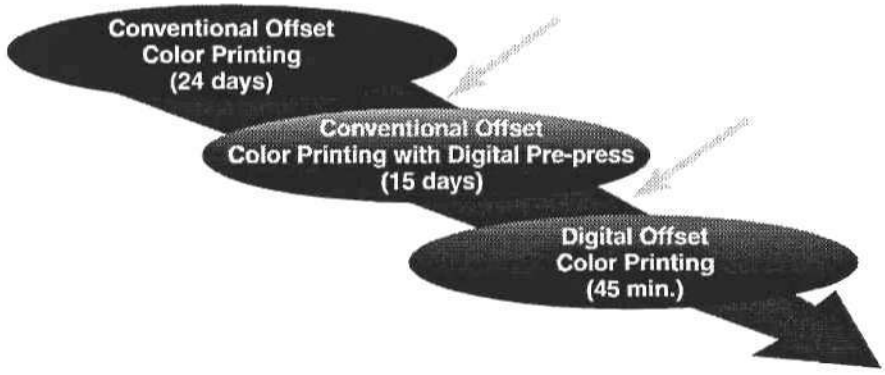
DIGITAL IMAGING

The Evolution of Offset Color Printing



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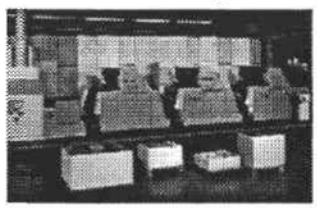
Current Offset Color Printers

Heidelberg

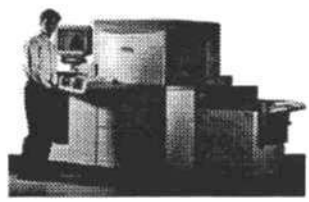


- Equipment cost $400,000
- Full time operator
- Industrial environment

Chromapress (Xeikon)

- Equipment cost $350,000
- Full time maintenance support
- Industrial environment

Indigo



- Equipment cost $400,000
- Full time operator, two machine minimum
- Industrial environment

CVP2797

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DIGITAL IMAGING

On Demand Printing Barriers

High equipment cost (>300K)
High Maintenance cost
Industrial environment required

TI DLP™ Hardcopy Solutions

Lower equipment cost (>50K)
High reliability, user serviceable
Office environment compatibility

and high speed offset print quality

CVP2798

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DIGITAL IMAGING

Agenda

- Introduction - Digital Information Infrastructure
- What is a DMD?
  (Digital MicroMirror Device)
- What is DLP?
  (Digital Light Processing)
- How Does it Work?
- What are its Applications?

➤**What are the Markets?**

- Conclusions

CVP2799

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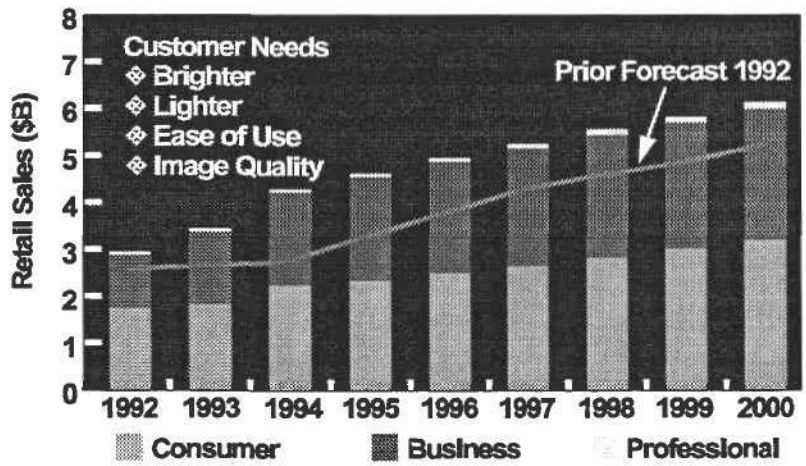
DIGITAL IMAGING

Worldwide Projection Display Market



Source: Stanford Resources 1994

CVP2800

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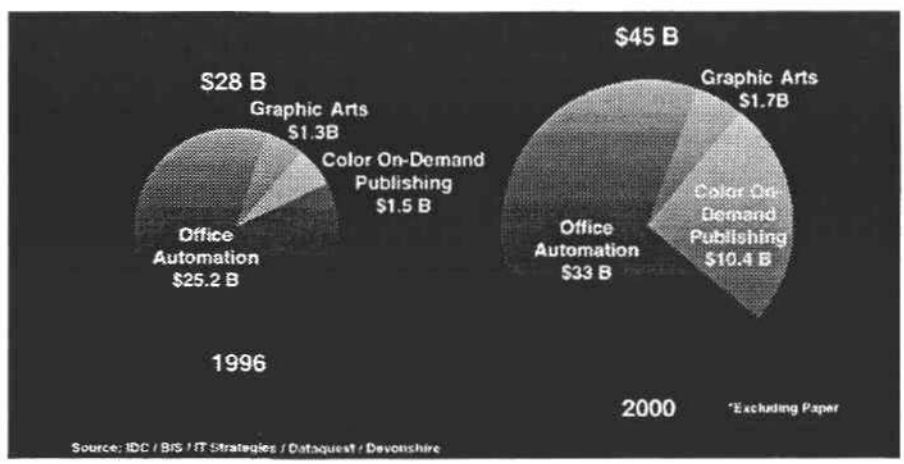
DIGITAL IMAGING

Total U.S. Digital Printing Market (TAM)



CVP2801

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DIGITAL IMAGING

Agenda

- Introduction - Digital Information Infrastructure
- What is a DMD?
  (Digital MicroMirror Device)
- What is DLP?
  (Digital Light Processing)
- How Does it Work?
- What are its Applications?
- What are the Markets?
- ➤**Conclusions**

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DIGITAL IMAGING

Summary

- Enables True Digital Imaging for Displays and Hardcopy Products
- Large Compelling Displays
- Near Photographic Color on Plain Paper
- Cost Advantage Potential
- Multi-Billion Dollar Market Potential
- Enables the Digital Information Infrastructure

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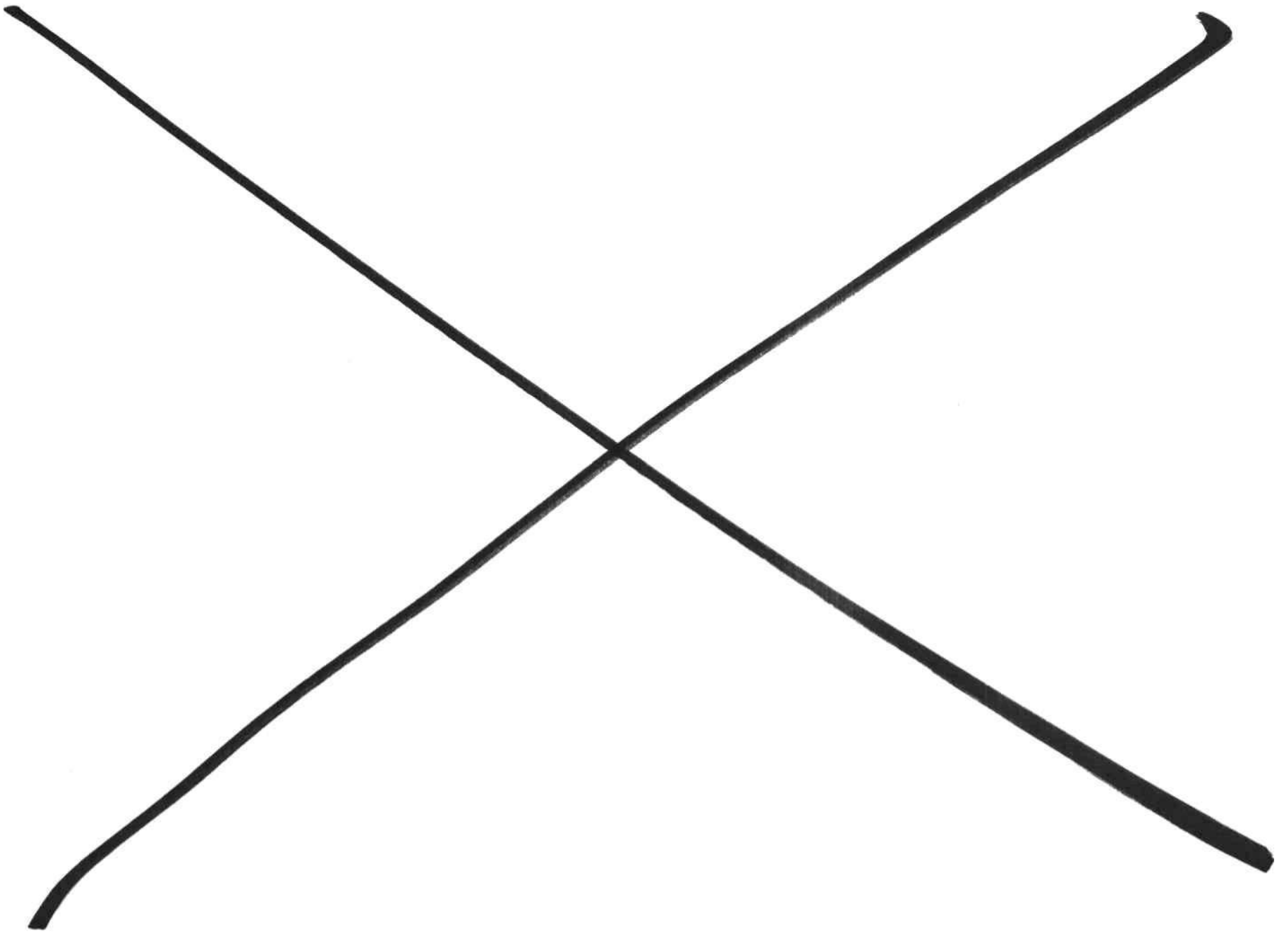
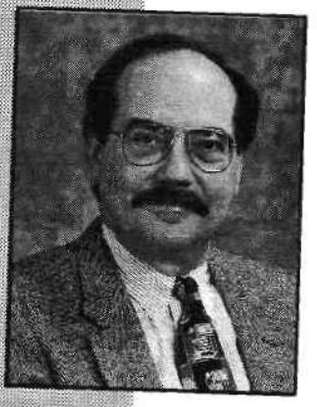
Notes:



Welcome

Joseph Grenier

Vice President and Director
Semiconductor Device and Applications Group
Semiconductors Worldwide
Dataquest Incorporated



Mr. Grenier is Vice President and Director of Dataquest's Semiconductor Device and Applications group. He is responsible for managing the research activities of the Semiconductor ASIC, Memories, Application Markets, Microprocessor, Communications and Semiconductor Markets, Directions in PCs, and PC Teardown programs. He is also responsible for promoting consulting activity and new product ideas for the Semiconductors Worldwide group.

Prior to joining Dataquest, Mr. Grenier was Product Marketing Manager at GCA Corporation, where he managed marketing activities for the reactive ion etch program. He was also International Marketing Manager at GCA and was responsible for the overseas marketing of wafer-processing equipment. Previously, he worked as a Product Manager at Varian Associates/ Instrument Division, as a Systems Engineer at the USAF Satellite Test Center, and as a Test Engineer at General Motors' Noise Vibration Laboratory.

Mr. Grenier received a B.S.E.E. degree from the University of Detroit and an M.B.A. degree from the University of Santa Clara.

jgrenier@dataquest.com

Presentation not available at time of publication

Notes:

Notes:

Achieving 0.1 Micron Technology: What Will It Take?

Jim Owens
Chief Operating Officer
SEMATECH

Mr. Owens joined SEMATECH in 1994 as Chief Operating Officer, on a three-year assignment from National Semiconductor. He is responsible for the consortium's R&D programs, including technical operation at its Austin, Texas-based facility and joint development and equipment improvement programs with U.S. suppliers. He previously served on SEMATECH's executive technical advisory board and as an alternate on the consortium's board of directors.

Prior to accepting the SEMATECH assignment, Mr. Owens served in numerous upper management positions at National Semiconductor, including Analog Operations, Corporate Quality and Strategic Operations, Worldwide Advance Technology and Manufacturing Operations, and Technology.

Mr. Owens earned a B.S. degree in physics from Stetson University, an M.S. degree in management from the University of Arkansas, and an M.S.E.E. degree from Georgia Tech.

Achieving 0.10µm Technology: What Will it Take?

Jim Owens
Chief Operating Officer
SEMATECH

Dataquest Semiconductor Conference
October 13, 1995

What Will it Take to Achieve 0.10µm?

Time

Engineering

Money

People

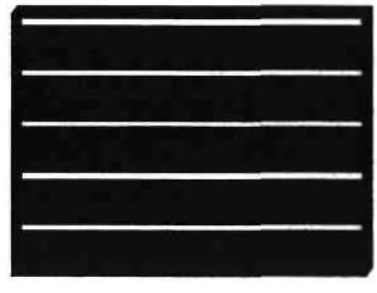
0.10µm

What is it?

Encyclopedias per Chip

~1/4 Encyclopedia Volume

16Mb
0.5µm



~8 30-Volume Encyclopedia Sets

16Gb
0.1µm

Achieving 0.10µm Technology: What Will It Take?

Time*

	16Mb	64Mb	256Mb	1Gb	4Gb	16Gb
	0.5µm	0.35µm	0.25µm	0.18µm	0.13µm	0.10µm
	64Mb	256Mb	1Gb	4Gb	16Gb	64Gb
	0.35µm	0.25µm	0.18µm	0.13µm	0.10µm	0.07µm
	256Mb	1Gb	4Gb	16Gb	64Gb	256Gb
	0.25µm	0.18µm	0.13µm	0.10µm	0.07µm	0.05µm

* Based on the National Technology Roadmap for Semiconductors

Time*

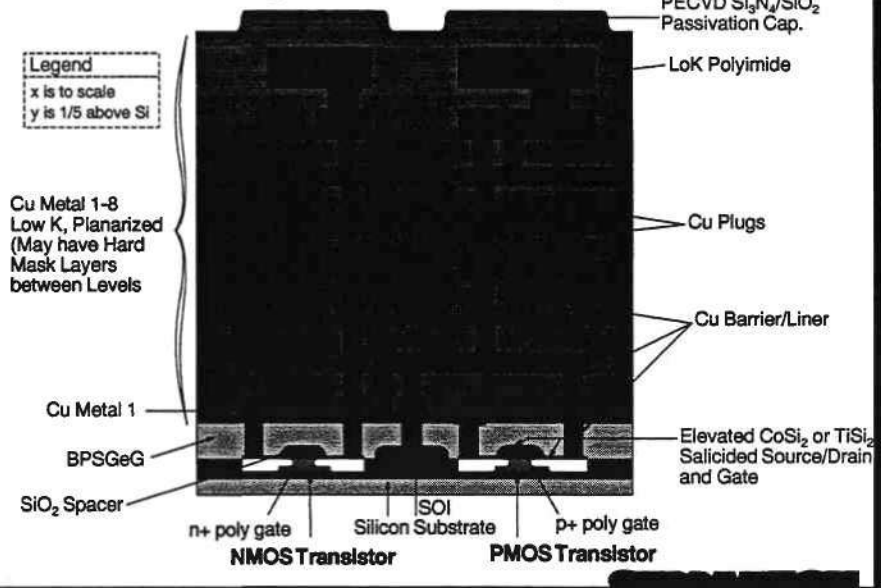
- Only ~8 years before specific product/process development begins
- Basic research needs to start now (e.g., Lithography, Interconnect, etc.)

* Based on the National Technology Roadmap for Semiconductors

Engineering

- Full of challenges
  - Device functionality
  - Lithography
  - Interconnect
  - Modeling
  - Design
  - Etc.

0.10µm CMOS Process Schematic "High Performance" Logic



Achieving 0.10µm Technology: What Will It Take?

Device Functionality

Toshiba fabricates MOS transistor with 0.04 µm gate length

– Feb. 1994

AT&T reports room temperature 0.1µm CMOS device

– Dec. 1993

IBM demonstrates 0.1µm CMOS device with 1.5V power supply

– Dec. 1993

Toshiba uses 0.1µm gate length in CMOS transistor model

– Oct. 1992

NTT develops prototype CMOS transistor with gate length of 0.1µm

– Dec. 1991

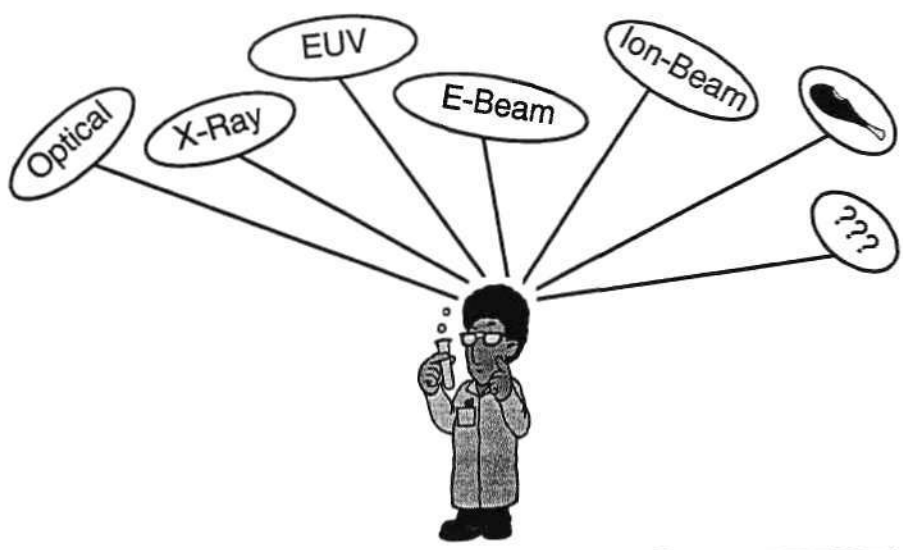
Mitsubishi makes prototype chip with 0.1µm linewidth

– Sept. 1989

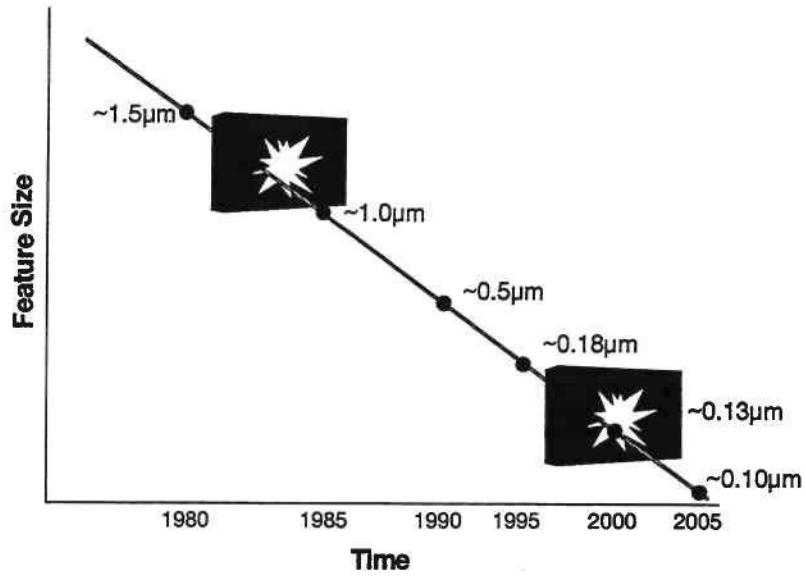
Hitatchi creates prototype FET transistor having a 0.1µm gate

– Sept. 1988

Lithography

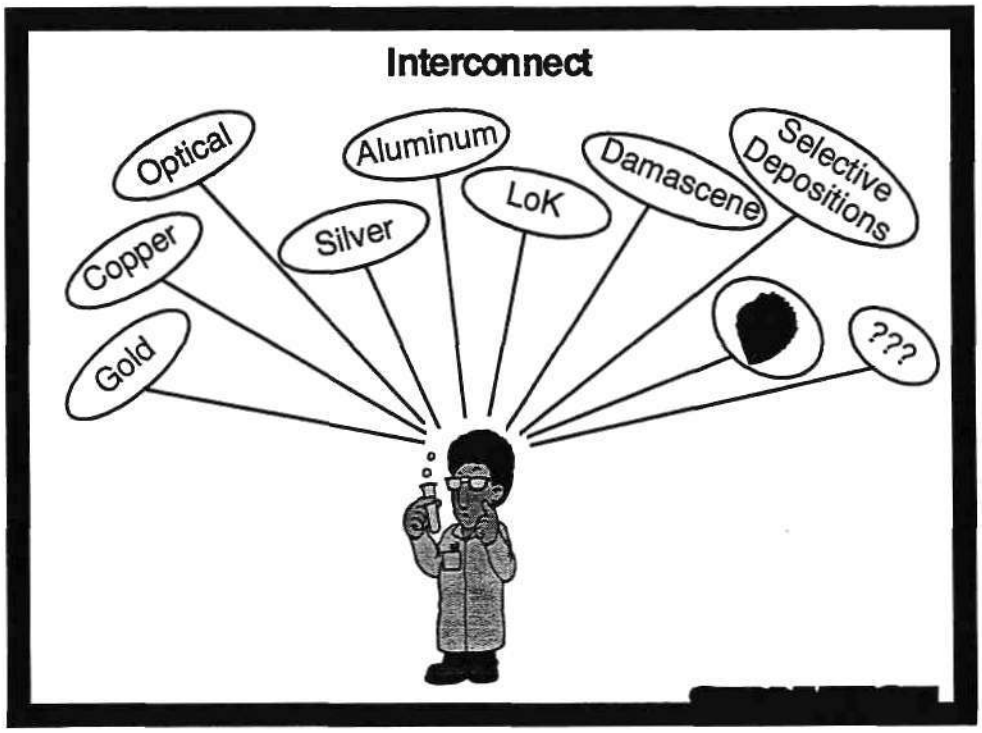


Limits on Optical Lithography



0.10µm Optical Lithography

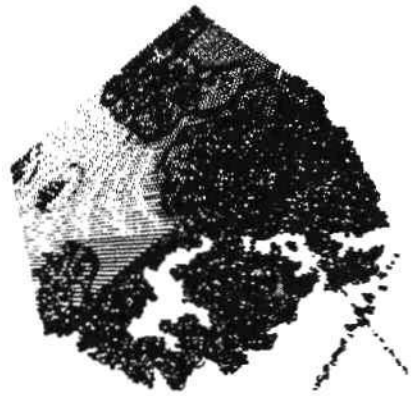
- Uses laser optical interference patterns
- Not a production process



Interconnect

- Technology can be a performance limiter
- National Technology Roadmap for Semiconductors is overly optimistic
  - Needs rationalization of simultaneous demands for
    1. Component density on chip (~50M logic transistors/cm²)
    2. Power management (~160 watts µP)
    3. Clock frequency (~1 GHz)
- Needs advanced modeling and simulation

Modeling



- Need understanding and models at the atomic level

- Ion implanter into silicon
  - 11 15keV Si atoms (random) onto Si crystal

Etc.

CD Control

Noise vs. Op. Voltage

Op. Voltage

Packaging

Etch

Depth of Focus

Reliability

Design

Resist

Power Dissipation

Etc.

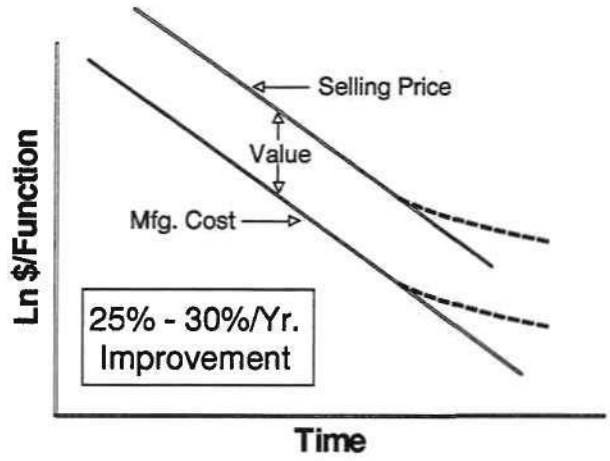
Engineering Summary

- Technically feasible
- Many engineering challenges

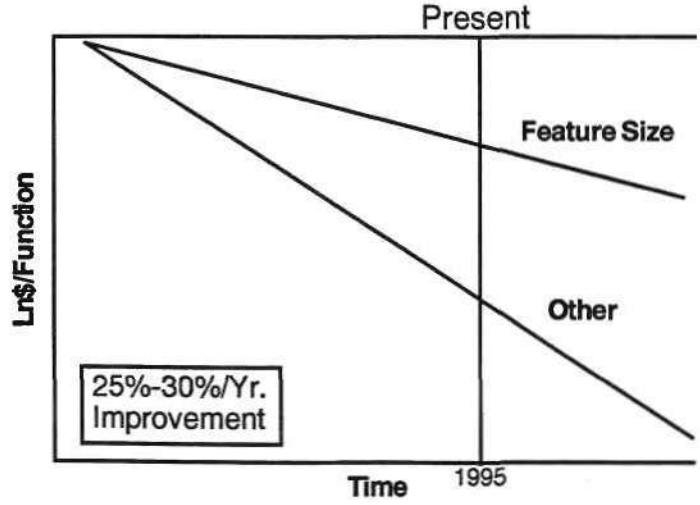
Money

Will it be there??

Keeping the Productivity Engine on Track

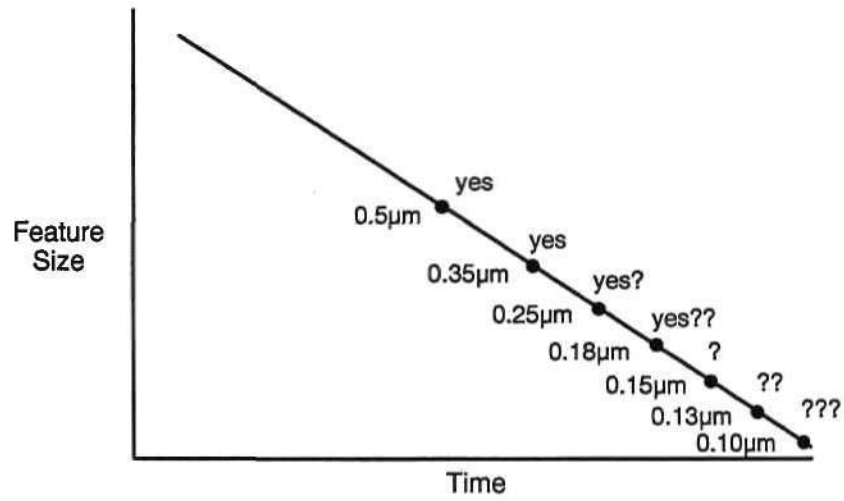


Historical Productivity Curve

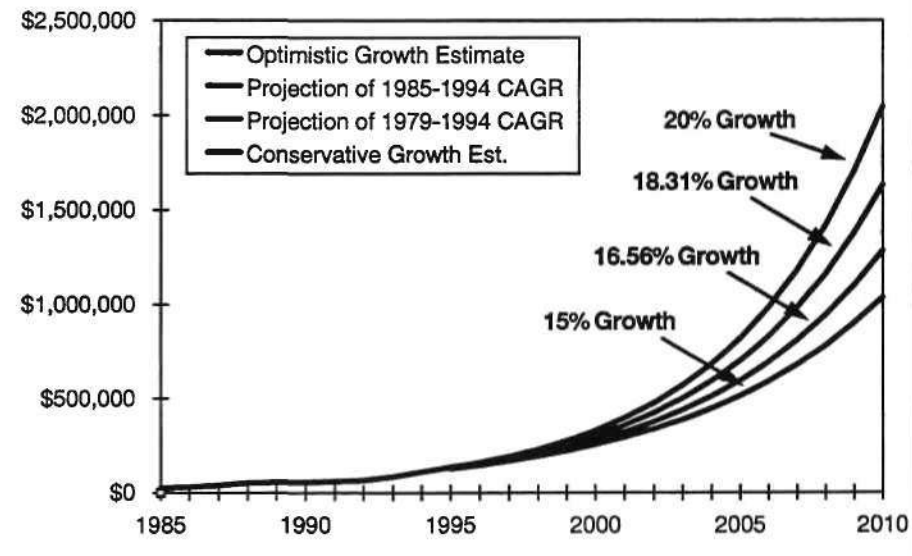


Feature size shrink is an economic necessity

Can We Afford the Factories?



Semiconductor Sales & Projections ($M)

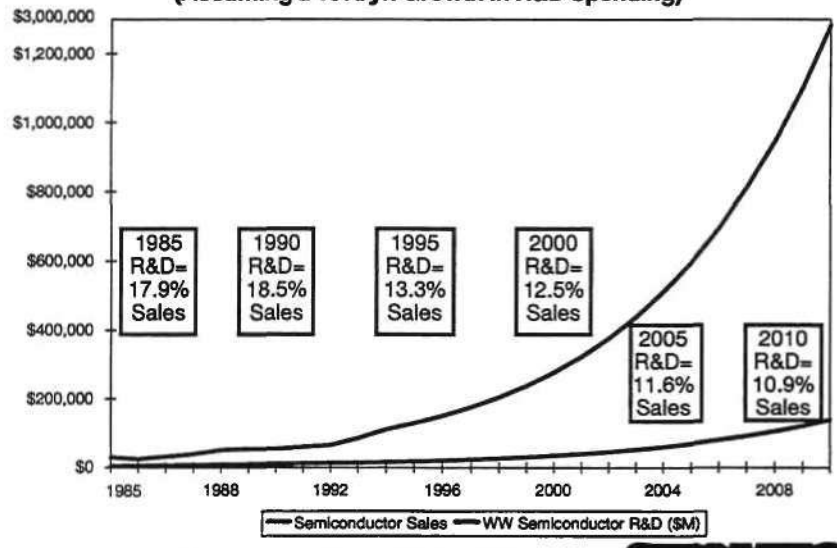


Source: Dataquest, SEMATECH projections

Money

Worldwide Semiconductor Sales vs. R&D

(Assuming a 15%/yr. Growth in R&D Spending)



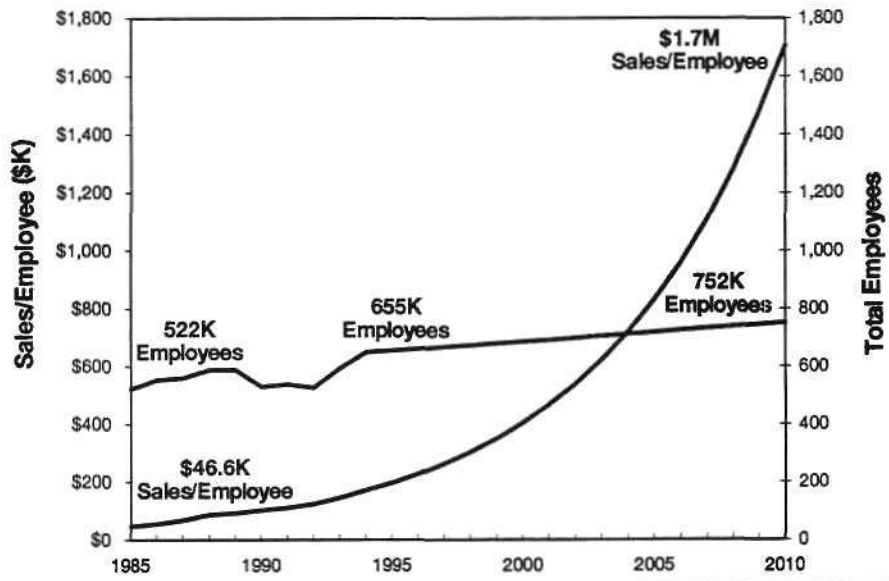
Money

- Need lots of it, but it will be there
- The precompetitive spending need is large– smart companies will work together through cooperative organizations (SEMATECH, SIRIJ, JESSI, SRC, etc.) to save money

People

- Will there be the quantity and quality of people needed?

Sales/Employee and Total Employees



Summary

- Time... need to get started soon

- Engineering... will happen

- Money... will be available

- People... will be there

Notes:

Deconstructing the Semiconductor Industry

William H. Davidow, Ph.D.
General Partner
Mohr, Davidow Ventures

Dr. Davidow has been a high-tech industry executive and venture investor for 20 years. Before joining Mohr, Davidow Ventures, he held a number of management positions at Intel Corporation, including Senior Vice President of Marketing and Sales, Vice President of the Microcomputer Division, and Vice President of the Microcomputer Systems Division.

Dr. Davidow holds a Ph.D. in electrical engineering from Stanford University (1961), and an A.B. degree from Dartmouth College (1957). He is the author of the best sellers *Marketing High Technology* (1986), *Total Customer Service* (1989), and *The Virtual Corporation* (1992).

Dr. Davidow is Chairman of the Board of Rambus Corporation and serves as Director of five other corporations. Dr. Davidow is also a Director of the Stanford Hospital and Smart Valley Inc. He is a member of the Board of Advisors to The Community Foundation of Santa Clara County and the Technology Museum of San Jose.

Deconstructing the Semiconductor Industry

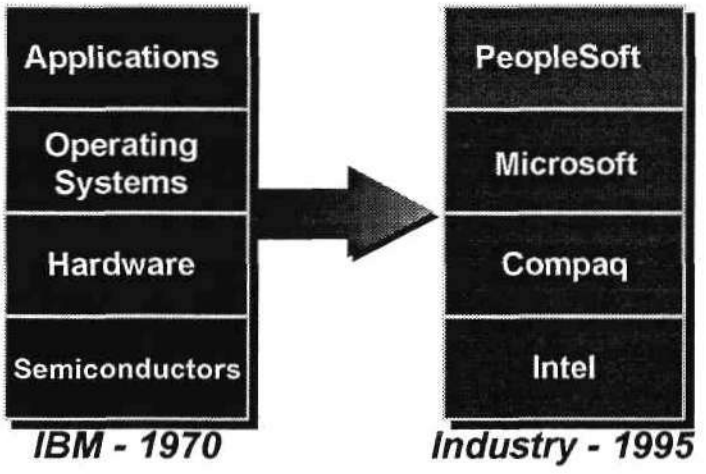
William H. Davidow

MOHR DAVIDOW VENTURES

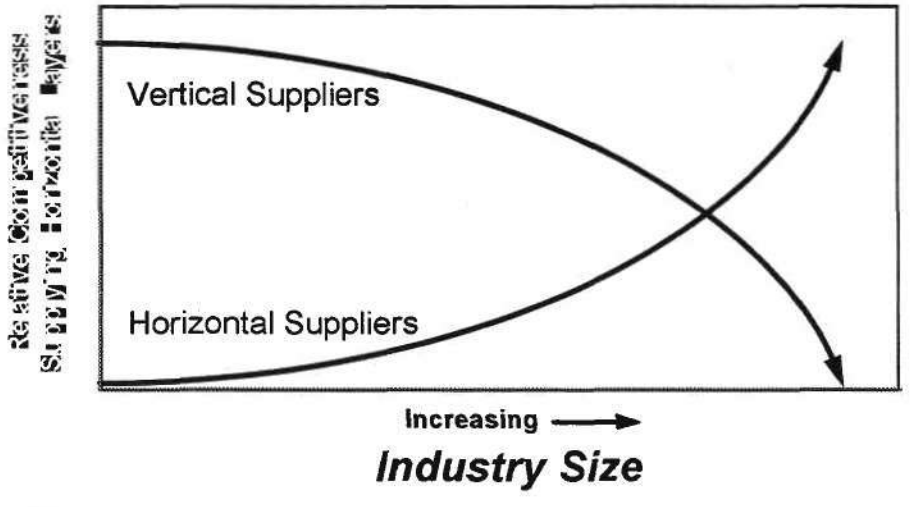
Real Men's Toys

- ✔ Play with Fabs
- ✔ Manipulate Foundries
- ✔ Dabble with Software
- ✔ Muse about Intellectual Property
- ✔ Rich and Chipless

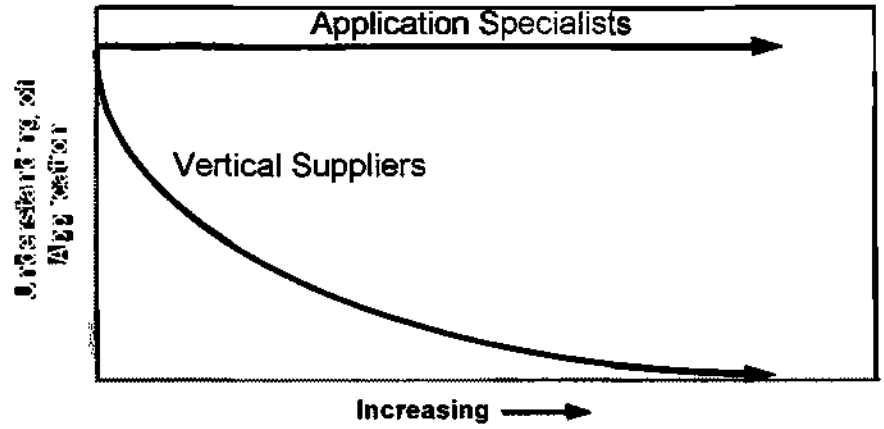
Deconstruction of Computer Business



Competitiveness Vs. Size



Understanding Vs. Complexity



Pattern of Deconstruction

- ✔ Companies Lose Key Competences
- ✔ Hold on too Long
- ✔ Under Invest in Core Competence
- ✔ Re-engineer Themselves

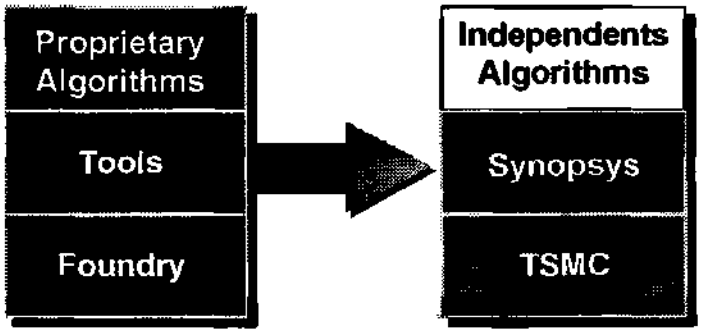
The Lesson

In periods of rapid change, companies that fail to leverage the competence of others are usually the losers

Semiconductor Core Competencies

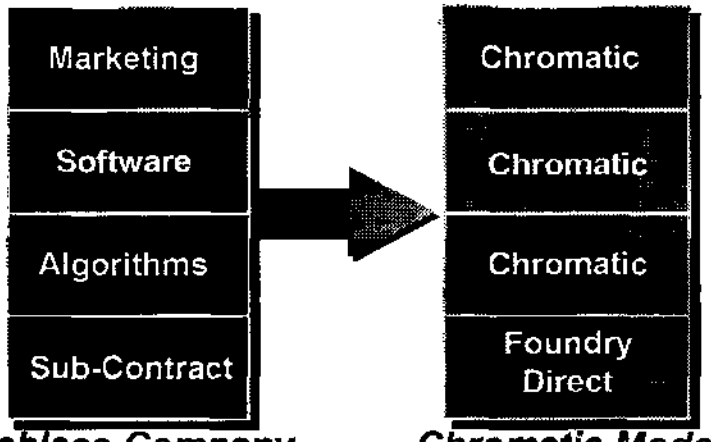
- ✔ Process and Foundry
- ✔ Packaging
- ✔ Circuit Design and Algorithms
- ✔ Component Related Software
- ✔ Multi-Chip Assemblies
- ✔ Marketing and Distribution
- ✔ Integration of Layers

Deconstruction of ASIC Business



ASIC Today *Possible Future*

Deconstruction of Fabless Business



Fabless Company *Chromatic Model*

Role of Assembly Houses

- ✔ Complex Systems--Few Chips on Substrate
- ✔ Capital and Skill Intensity of Assembly
- ✔ Chips from Multiple Sources
- ✔ Value Added Packaging Layer

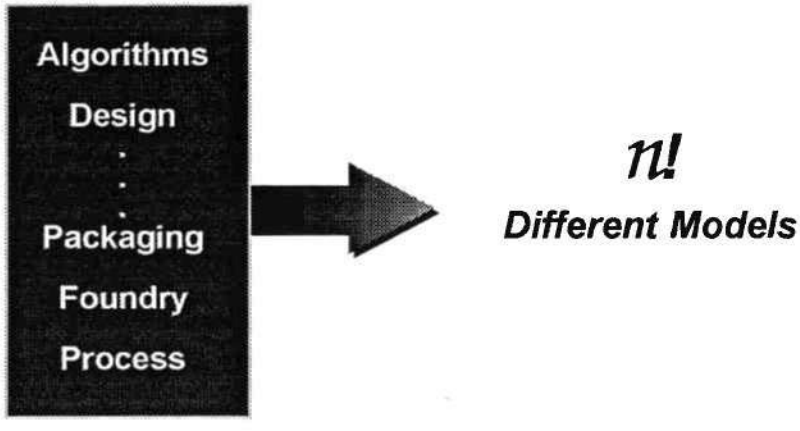
Role of Royalties

- ✔ Generally a Punishment or Toll
- ✔ Little Attempt to Deliver Value
- ✔ Horizontal Layers
  - Pooling R&D
  - Active Support for Partners
- ✔ Rambus Model

Vertical Suppliers

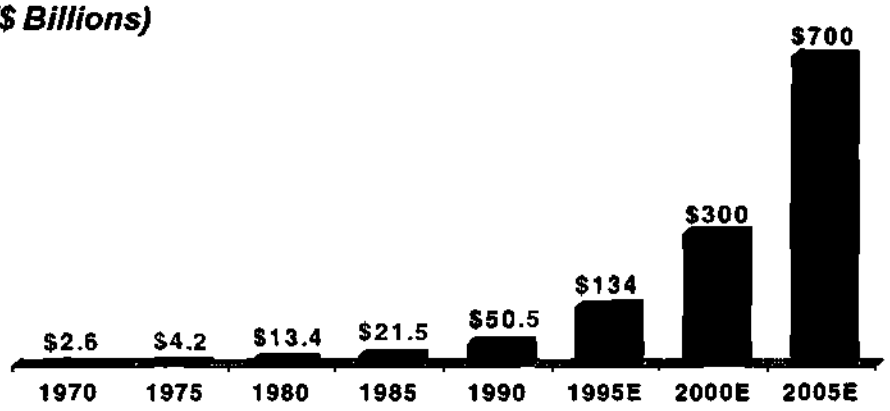
- ✔ **Continue to Dominate Industry**
  - **Purchase More Services**
- ✔ **Internal Capability Challenged**
- ✔ **Intel Example**
  - **Massive Volume, Time to Market, Optimized Processes**
- ✔ **Supplier Opportunities**

Deconstruction of Vertically Integrated Suppliers



Worldwide Semiconductor Consumption

($ Billions)



Source: World Semiconductor Trade Statistics, Robertson, Stephens & Co estimates

$1 Billion Is Nothing

- ✔ Intel Today About 2% of Year 2005 Market
- ✔ $1 Billion Company Will Have 0.1% Market Share
- ✔ 1% of Market Would Contain 100, $100 Million Companies
- ✔ Lots of Opportunities for New Business Models

Notes:

Multimedia 2000

Michael L. Hackworth
President and Chief Executive Officer
Cirrus Logic Inc.

Mr. Hackworth joined the Cirrus Logic founding team as President and Chief Executive Officer in January 1985. Under his leadership, the Silicon Valley company has grown from a start-up venture to a worldwide corporation with more than 2,800 employees. He has successfully overseen the acquisitions of eight companies and the expansion of Cirrus Logic's portfolio of products and technologies. Moreover, he has led his company into a joint venture with IBM to form MiCRUS, a wafer fabrication manufacturer based in East Fishkill, New York. Since completing its initial public offering (IPO) in June 1989, Cirrus Logic has experienced dramatic growth. Now posting annualized revenue of more than $1 billion, the company has been profitable quarter-to-quarter since before its IPO.

Before joining Cirrus Logic, Mr. Hackworth spent 14 years at Signetics Corporation (now Philips Semiconductor), most recently as Senior Vice President. There he was responsible for directing that company's successful entry into MOS semiconductor technology, with group executive responsibilities for three product divisions, which he built to more than $200 million in annual sales. Prior to his work at Signetics, he held a variety of marketing, sales, and general management positions at Motorola and Fairchild Semiconductor. Mr. Hackworth has more than 25 years of experience in the semiconductor industry.

Mr. Hackworth was named Semiconductor Entrepreneur of the Year in 1990 by *Ernst & Young* and *Inc. Magazine*. A native of Silicon Valley, Mr. Hackworth is active in supporting community programs. He serves on the Boards for The Tech Museum of Innovation (San Jose, California) and the San Jose Symphony.

Multimedia 2000:

Semiconductor Leadership In The Interactive Age

Michael L. Hackworth
President/CEO, Cirrus Logic, Inc.

Dataquest Semiconductor Conference
October 13, 1995

Growth Drivers In The Interactive Age

- **Humanistic Interfaces**
- **Internet & Broadband Communications**
- **Multimedia Applications & Content**
- **Unprecedented Affordability**

New Realities For Chip Makers

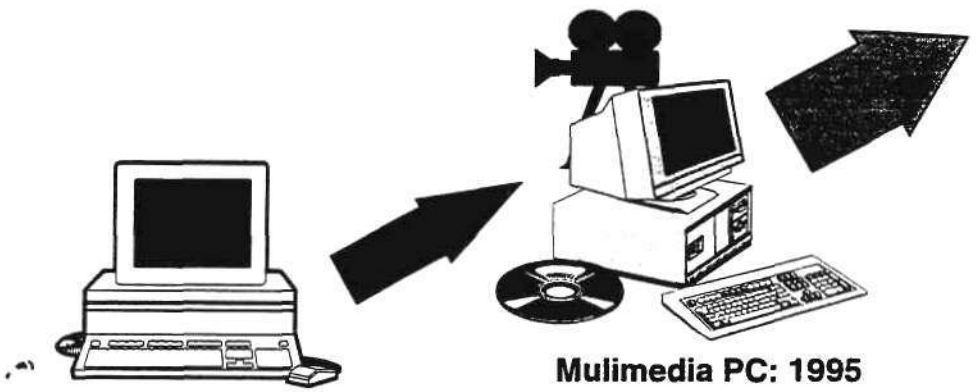
Breadth Of Market Influencers

New Realities
Our Silicon World Is Changing

- **Extensive Mix Of Technologies**
- **Breadth Of Market Influencers**
- **Higher Manufacturing Complexity**
- **Increasing Product Complexity With Shorter Life Cycles**

What Are The Implications?

Increasing Product Complexity



PC-XT: 1985
10.4 Million Transistors

Mulimedia PC: 1995
150.0 Million Transistors

Source: Dataquest

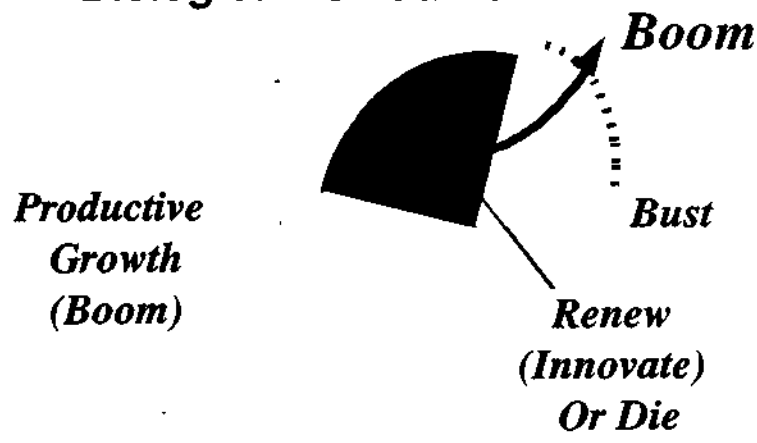
The Value-Added Chain

(Animated Sequence)

- **Today's Scenario**
- **Tomorrow's Status Quo**
- **Tomorrow's Opportunity**

Innovate...Or Die

Biological "S" Curve



Chip Makers Survival...

Innovation...
Not Just Integration!

- System Architectures
- Software Into Silicon
- Digital Convergence

More R&D Dollars and Skill Sets!!

Notes:

The Impact of Interactive Multimedia on Systems and Semiconductors

Moderator

Daniel L. Klesken, Ph.D.
Managing Director and Senior Semiconductor Analyst, Robertson, Stephens & Company

Panelists

James D. Hood, Ph.D.
Senior Consultant, Dataquest Incorporated

Allan Weiner
Principal Analyst, Dataquest Incorporated

Bruce Ryon
Director and Principal Analyst, Dataquest Incorporated

Rob Enderle
Senior Industry Analyst, Dataquest Incorporated

Moderator: The Impact of Interactive Multimedia on Systems and Semiconductors

Daniel L. Klesken, Ph.D.

Managing Director and Senior Semiconductor Analyst
Robertson, Stephens & Company

Dr. Klesken is a Managing Director and Senior Semiconductor Analyst with Robertson, Stephens & Company, a San Francisco-based investment banking firm. He has extensive research experience and knowledge of the semiconductor industry and is highly regarded as one of the top analysts in the technology field.

Prior to joining Robertson, Stephens & Company in March 1992, Dr. Klesken was Vice President and Senior Semiconductor Analyst with Prudential Securities Inc. for three years. Previous to that, he was a General Partner and Senior Semiconductor Analyst with Montgomery Securities for seven years.

As Vice President and General Manager of Dataquest's Semiconductor Group for seven years, Dr. Klesken was instrumental in establishing Dataquest's Semiconductor Industry Service. He also spent nine years at Texas Instruments where he was a member of the technical staff working on NASA and DOD-related programs. Dr. Klesken also supported TI's corporate staff with market research and long-range planning. While he was in graduate school, he worked at IBM and Bell Telephone Laboratories.

Dr. Klesken holds B.S. and M.S. degrees in electrical engineering from Lehigh University and a Ph.D. in electrical engineering from Carnegie-Mellon University.

Panelist: The Impact of Multimedia on Systems and Semiconductors

James D. Hood, Ph.D.

Senior Consultant
Consulting Group
Dataquest Incorporated

Dr. Hood is a Consulting Analyst with Dataquest. He is responsible for all custom consulting projects in support of strategic planning, business planning, and market analysis in the area of telecommunications.

Recent consulting assignments include an investigation of the communications business in the 21st century. This project was conducted for a major Asian manufacturer of communications equipment as a part of its long-term strategic planning process. The project identified the business and technological megatrends of the communications industry and projected the most attractive market segments for equipment manufacturers.

Another assignment focused on an ISDN end-user analysis program that addressed a wide range of ISDN users and potential users to determine why they were converting to ISDN services.

A third assignment was a business case analysis for the competitive access provider market that mathematically projected revenue and cost for CAP networks in selected tier II and tier III cities.

Dr. Hood has extensive knowledge of the technology associated with the telecommunications industry and broadly based management expertise. As President and CEO of broadcast and HDTV fiber technology pioneer for MERET Optical Communication Inc., he successfully directed the turnaround and sale of the company. Seeing the growing use of wide bandwidth fiber-optics systems for the transmission of video, audio, and data signals, he focused the company's development, manufacturing, and sales effort on market niches best suited to its capabilities. As President and CEO of cable industry pioneer CATEL Telecommunications Inc., he was instrumental in establishing the company as a leader in the transport of video signals on fiber-optics. He was responsible for analyzing the trends in the CATV industry and reorganizing the company to maximize the return on its technology investment in broadband transportation of video on fiber-optics.

Dr. Hood has held senior management positions in the telecommunications companies of DSC Communications Corp. and Granger Associates. As a Senior Vice President of DSC, he was responsible for the Microwave Radio Division and the Scancom Radio Division (a point to multipoint data radio). As a Vice President of Granger Associates, he was responsible for the Europe, Africa, and Middle East operations and was one of the founders of the Granger Telettra joint venture (a 50/50 joint venture between Granger Associates and Telettra, Milan, Italy) to develop, manufacture, and sell digital radio and fiber-optic systems into the private telecommunications marketplace.

Dr. Hood received his Ph.D. in engineering sciences from the University of Oklahoma. He also holds M.S. and B.S. degrees in engineering physics from the University of Oklahoma.

Panelist: The Impact of Multimedia on Systems and Semiconductors

Allen Weiner

Principal Analyst
Online Strategies Program Worldwide
Online, Multimedia, and Software Group
Dataquest Incorporated

Mr. Weiner is the Principal Analyst for Dataquest's Online Strategies service in the Worldwide Online, Multimedia, and Software group. The Online Strategies service includes online consumer and business services, with a focus on electronic commerce on the Internet and other emerging digital superhighways.

Mr. Weiner previously managed the Electronic Information Services Department for the *San Francisco Chronicle* and *Examiner* newspapers. He was involved in every aspect of new product development for *The Gate*, an online service that was introduced in May 1994. His responsibilities included developing the business plan, the capital/operational budget process, technological development, editorial coordination, and new product marketing. He also developed a World Wide Web home page for *The Gate* on the Internet and was responsible for its design and maintenance.

Mr. Weiner's career experience also includes past positions with Virgo Publishing Inc. as editor and publisher for the company's group of new technology magazines such as *Interactive World*, which covered the vast array of interactive services ranging from the pay-per-call audiotex market to early interactive television magazines; *Newspapers & Voice*, which provides a look at newspapers and their "new media" applications; and *International Telecom*, a publication that looked at interactive media from a global perspective.

Mr. Weiner was a media critic for seven years at *The Everett (WA) Herald*, covering the Seattle television scene as well as the emergence of the cable television and video industries. He also served as a reporter and columnist for *The Allentown (PA) Morning-Call*. A frequent television and radio guest, he hosted a weekly cable program, *On Video*, which appeared on the Tempo Network in 1989, and later was a regular on ABC-TV's *Home*, covering new video releases.

As a business entrepreneur, Mr. Weiner, along with his wife Kathleen, was founder of a chain of retail stores that sold informational videocassettes.

Mr. Weiner received a B.A. degree in American studies from Muhlenberg College and an M.A. degree in radio-TV-film from Temple University, School of Communications and Theater.

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Panelist: The Impact of Multimedia on Systems and Semiconductors

Bruce Ryon

Director and Principal Analyst
Multimedia Worldwide
Online, Multimedia, and Software Group
Dataquest Incorporated

Mr. Ryon is the Director and Principal Analyst in charge of multimedia research at Dataquest. He is responsible for examining and interpreting the dynamics that are shaping the markets impacted by multimedia technology, with emphasis on demand-side perspectives. In addition to providing strategic information to Dataquest's syndicated clients, he also develops tailored analyses and provides custom consulting on products, markets, and potential cross-industry partners.

Mr. Ryon is the most widely quoted multimedia analyst in the industry and one of the most widely quoted analysts at Dataquest. He is the Silicon Valley Business News anchor one week a month on KNTV, the San Jose, California, ABC-TV affiliate, where he provides Silicon Valley news and analysis on Good Morning San Jose, a morning news program that airs prior to ABC's Good Morning America. He is in great demand for industry conference speaking engagements.

Mr. Ryon joined Dataquest in April 1993 from Apple Computer Inc., where he was the Business Development Manager for Home Entertainment in the U.S. Consumer Division. He was responsible for the marketing of home multimedia and entertainment-related products, as well as channel strategy for CD-ROM hardware, diskette, and CD-ROM-based software. He has 18 years of experience in a combination of computer industry marketing (including 5 years in computer systems product management), film, graphics, and multimedia production. Prior to Apple, Mr. Ryon for four years owned a graphics and multimedia consulting firm that provided communications, print, and multimedia design and systems consulting services to advertising, public relations, and graphic design firms, as well as corporate communications departments for clients such as AT&T, Xerox, Pacific Bell, KPIX-TV (CBS), KRON-TV (NBC), and Apple.

Mr. Ryon also provided development and funding for, and management of, the first international online graphics service in 1987, the Design Access Network (covered in *Business Week* and *Inc. Magazine*). He started his career as an award-winning student intern at Warner Brothers Pictures but later moved into the nascent field of graphics and computers after two years at Warner Bros. in production management.

Mr. Ryon has a B.A. in film directing from the University of California at Berkeley where he received two national honors as an exceptional film student: the first was bestowed by Warner Bros. Pictures and the National Entertainment Council, and the second was awarded by the National Endowment for the Arts in 1974. He earned an M.B.A., summa cum laude, from San Jose State University in 1978. He also completed a full year of postgraduate work in computer science engineering from San Jose State University, also with honors.

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Panelist: The Impact of Multimedia on Systems and Semiconductors

Rob Enderle

Senior Industry Analyst
Client/Server Software Worldwide
Online, Multimedia, and Software Group
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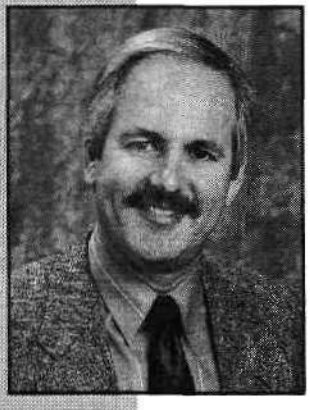

Mr. Enderle is a Senior Industry Analyst for the Client/Server Software program of the Online, Multimedia, and Software group. He specializes in research related to network and systems management software and operating systems.

Prior to joining Dataquest, Mr. Enderle was a Project Leader for both competitive analysis and software marketing for IBM's Storage Systems Division. At IBM he developed the branding strategy and the product comparison matrix and report form for IBM's distributed storage management product "ADSTAR Distributed Storage Manager." He was team leader for a companywide effort to redesign software marketing and sales for UNIX (AIX) and PC LAN products. His responsibilities included the identification of acquisition targets in areas such as video servers, fax servers, multimedia servers, and enterprise data access products. He received peer recognition for a program to consolidate and optimize IBM's internal competitive analysis organizations.

Prior to that, he was a competitive business and technical analyst for ROLM Systems Corporation, a private branch exchange telephone systems provider. He was placed in the IBM executive development program for projecting ROLM's decline in market share, analyzing its cause, and developing recommendations to reverse the decline. He also managed security and distributed computing assets for ROLM's corporate marketing function.

Mr. Enderle holds graduate and undergraduate degrees in business and marketing, the latest from California State University at Long Beach. He is a past member of the Board of Directors for the Southern California Marketing Directors Association and a current member of the Society of Competitive Intelligence Professionals.

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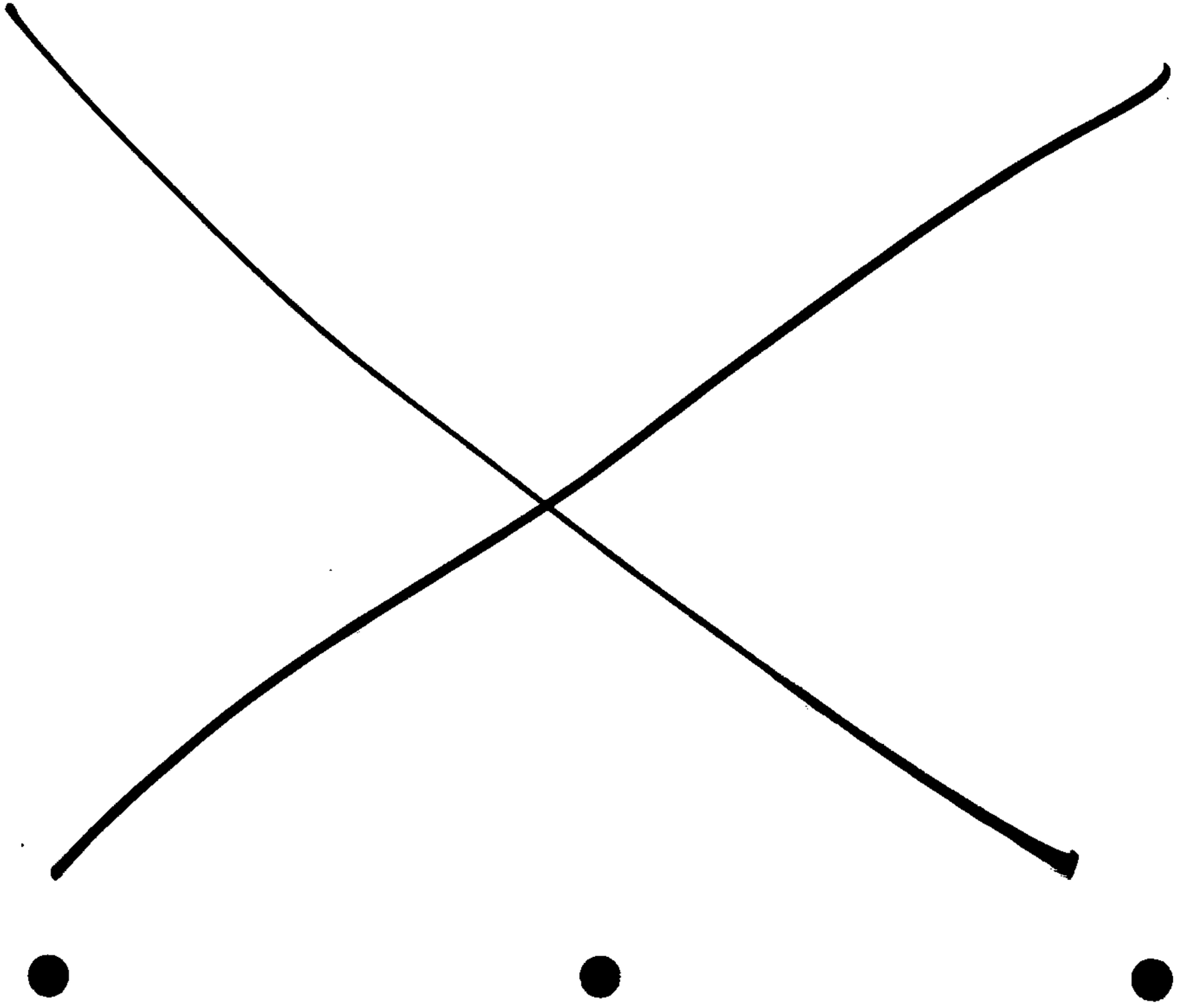

The Wireless Communications Odyssey: What Adventures Lie Ahead?

Moderator

Dale Ford
Senior Industry Analyst, Dataquest Incorporated

Panelists

Peter Karsten
Business Development Manager, Nokia Mobile Phones

Angelo V. Ugge
Vice President, SGS-Thomson Microelectronics

Sohail Khan
Vice President, AT&T Microelectronics IC Group

Ray Millington
Vice President and Director of Engineering, Motorola Inc.

Toshio Miki
Vice President and Executive Research Engineer, NTT Mobile Communications Network Inc.

Moderator: The Wireless Communication Odyssey—What Adventures Lie Ahead?

Dale L. Ford

Senior Industry Analyst
Semiconductor Application Markets Worldwide
Semiconductors Group
Dataquest Incorporated

Mr. Ford is responsible for conducting market research and analysis for the Semiconductor Application Markets Worldwide program at Dataquest. He is a specialist on the end use or application of semiconductors with the scope of analysis including both economic and technical trends regarding the semiconductor content of electronic equipment. His work also includes contributions on client-specific consulting projects.

Specific areas of expertise and responsibility include the following: personal computer and workstation semiconductor applications, mobile computing and communications semiconductor applications, and consumer semiconductor applications

Prior to his current role, Mr. Ford completed major consulting projects in the telecommunications, mobile computing, and multimedia industries for Dataquest. His work included the development of forecasting models to project the development of new technologies and the growth of emerging markets.

Before joining Dataquest, Mr. Ford was employed by Sun Microsystems in its product marketing organization where he created and implemented a marketing plan for introducing a major product redesign. He also formulated a plan to negotiate joint marketing agreements with third-party vendors. Earlier, he was a design engineer working with real-time image processing technologies and computer-aided-engineering systems for Evans & Sutherland, a producer of graphics workstations and high-performance flight simulators.

Mr. Ford has an M.B.A. in strategic management from The Wharton School, University of Pennsylvania, and a B.S.E.E. degree in electrical engineering from Brigham Young University.

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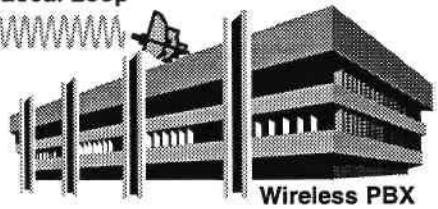
Emerging Wireless Communications Opportunities

Analog Cordless
25-Channel
Digital Cordless
900 MHz
DECT
PHS

Local Loop



Wireless PBX
DECT
Wireless LAN
RF
IR

Digital Cellular (GSM, TDMA, CDMA, PDC)
Broadband PCS (CDMA, TDMA, GSM/DCS...)
Pagers (traditional, narrowband PCS)
Satellite (Iridium, Global Star...)
Enhanced Specialized Mobile Radio

9505646

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NWWA: The New World of Wireless Acronyms

- TDMA: Time Division Multiple Access
  - Air interface access technology
  - Also used to refer to protocol standard (IS-43/IS-136)
- CDMA: Code Division Multiple Access
  - Air interface access technology
  - Also used to refer to protocol standard (IS-95)
- GSM: Global Standard for Mobile Communications
  - Protocol standard using TDMA interface
  - Adopted in European and countries in other regions
  - Basis for DCS-1800 standard in Europe and PCS-1900 standard in U.S.
- PACS: Personal Access Communications System
  - Protocol standard using TDMA interface and time/frequency modes
- Omnipoint
  - Protocol standard using hybrid of TDMA, CDMA, and frequency division technology (IS-661)

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NWWA: The New World of Wireless Acronyms

- DECT: Digital European Cordless Telephone
  - Forms basis for a proposed U.S. PCS standard—uses TDMA
- PDC: Pacific/Personal Digital Cellular
  - Digital cellular air interface standard adopted in Japan—uses TDMA
- PHS: Personal Handyphone System
  - Standard for PCS system adopted in Japan
- SMS: Short Message Service
  - Use of control channels in cellular/PCS transmissions to provide brief pagerlike messages and services
- CDPD: Cellular Digital Packet Data
  - Standard developed for sending packetized data by sharing idle time on voice cellular channels

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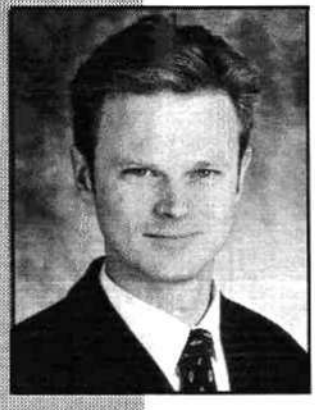
Dataquest

Notes:

Panelist: The Wireless Communication Odyssey—What Adventures Lie Ahead?

Peter Karsten

Business Development Manager
Nokia Mobile Phones



Mr. Karsten is the Business Development Manager of Nokia Mobile Phones, the second-largest cellular phone manufacturer in the world. He is in charge of marketing aspects and negotiations for new concepts, which included two new products from concept to market, one satellite-related patent, and one new group of ideas implemented in all major phone ranges. His responsibilities also include technology transfer to a new R&D center in the United Kingdom and organizing information flow from global sourcing to all R&D centers.

Prior to that he was New Technology Manager monitoring new developments relevant to cellular phones. Responsibilities also included identifying battery, smart car, user interface hardware, and satellite communications strategy and was awarded a patent related to battery technology. Before that, Mr. Karsten was Product Manager for new concept products. His responsibilities included the idea and implementation of a cellular modem on a PCMCIA card and getting it onto the market, which won the 1993 EMCOM award for the Most Innovative Product.

Mr. Karsten has presented various conference presentations on design, satellites, business development, cellular data, and cellular fax, among others.

Wireless Communications

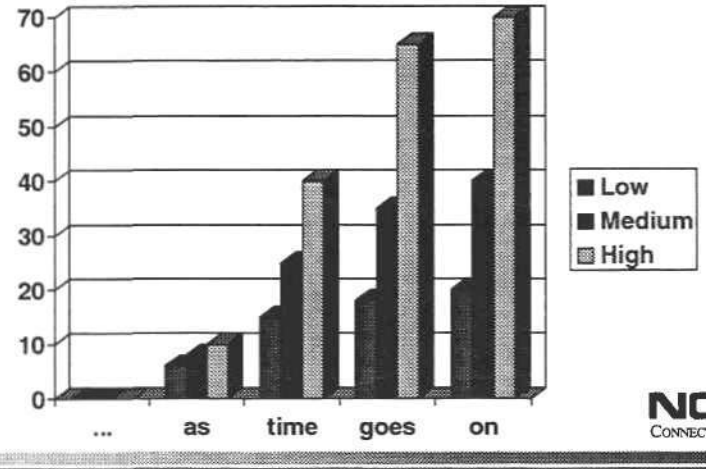
Nokia Mobile Phones

Peter Karsten
Business Development Manager

NOKIA
CONNECTING PEOPLE

Penetration implications

- Practically everyone here will have a cell phone within a few years



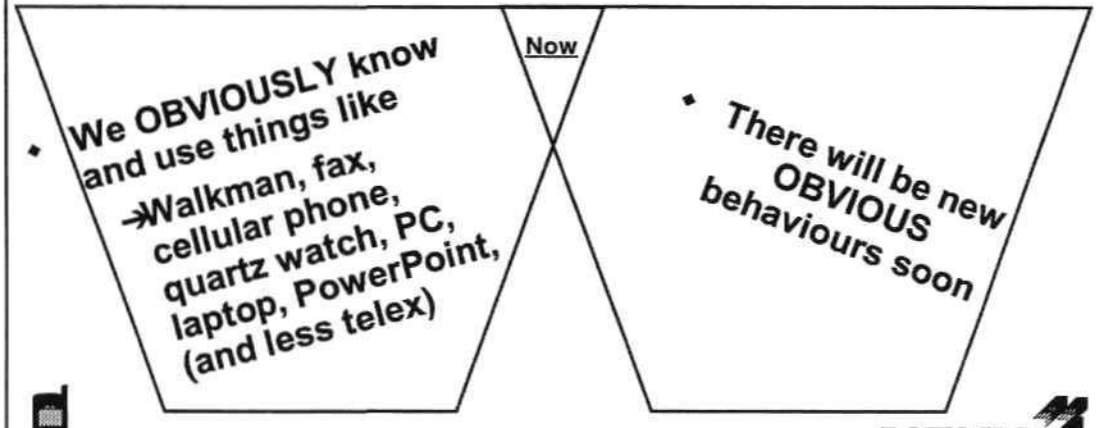
NOKIA
CONNECTING PEOPLE

Assuming current product line

- High volume moving targets require
  - →Flexibility at all stages
    - Upgrades and Customization
    - Modularity
  - →Reliability
    - Low margins do not allow field failures
  - →Tight vertical links
    - Demand > forecast causes immediate shortage
    - Open cards accepting reasonable profits

NOKIA
CONNECTING PEOPLE

Product line broadening



NOKIA
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GSM/CDMA95/PDC/PHS/TDMA136/DCS1800/PCS1900/DECT

- GSM based and PDC established
- US will have multiple digital standards
- High penetration
  - → allows room for multiple solutions
  - → means Basic models may dominate
- New concept explosions enabled by
  - →Miniaturization
  - →Convergence
    - Cellular - Intelligent Networks - etc.
    - Cross-standard in a broad sense

NOKIA
CONNECTING PEOPLE

Roll-out

- Over-estimating the short term impact of change and Under-estimating the long term impact of change are classic mistakes
- Getting a network rolled out is not a trivial task
- => Expect new networks, but later than expected

NOKIA
CONNECTING PEOPLE

Notes:

Notes:

Panelist: The Wireless Communication Odyssey—What Adventures Lie Ahead?

Angelo V. Ugge, Ph.D.

Vice President, North America (Tele)-Communications Business Unit (NACMBU)
SGS-Thomson Microelectronics

Dr. Ugge is employed with SGS-Thomson Microelectronics, holding the position of Vice President of the North America (Tele)-Communications Business Unit (NACMBU). This unit is the vertical integration of sales, marketing, and product development. The NACMBU focuses on a few key OEM customers nationwide in the telecommunications area and the broader market of telecom and datacom.

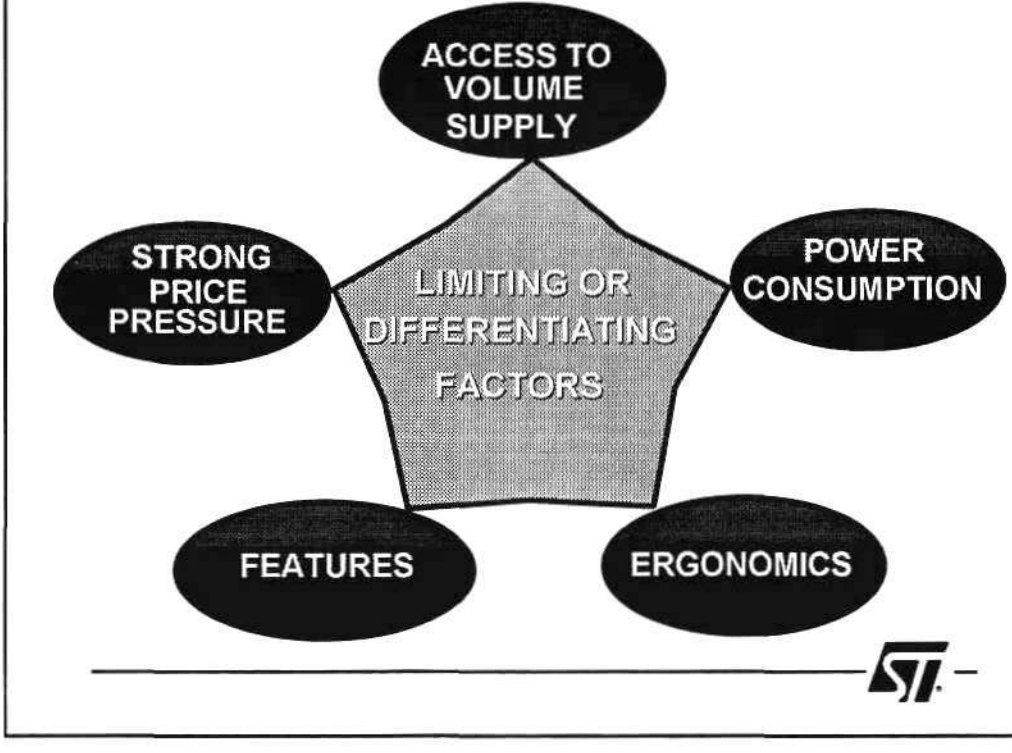
Dr. Ugge began his career in R&D and in 1977 initiated his career in technical marketing with SGS-Thomson at Agrate Brianza (Italy). He was the General Manager of the Dedicated Product Group, America Operations headquartered in Agrate Brianza and represents within SGS-Thomson the entity that develops, produces, and markets all custom or application-specific ICs for different application areas throughout the world. He moved to the the United States in 1983 and has held different managerial positions in marketing, sales, and business management.

Born in Milan, Italy, Dr. Ugge achieved a doctorate degree in physics from the University of Milan in 1973.

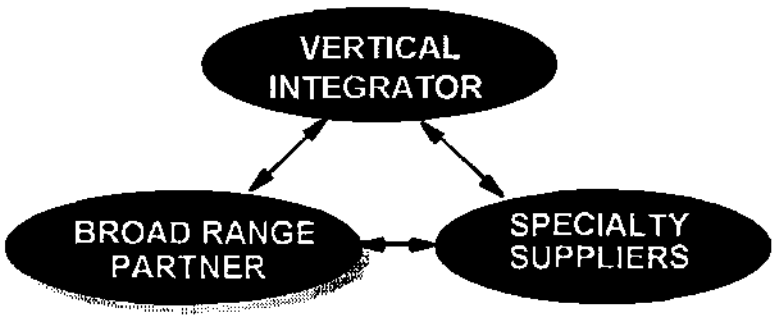
BY THE YEAR 2000 ...

...THERE WILL BE MORE THAN:

- > 250 M CELLULAR / PCS SUBSCRIBERS W.W.
- > 200 M PAGERS SUBSCRIBERS W.W.
- > 100 M NEW WIRELESS TERMINALS SOLD / YEAR
- > 50 M NEW PAGER SOLD / YEAR



ALTERNATIVE PROFILES OF SEMICONDUCTOR SUPPLIERS



- TECHNOLOGY ROAD MAP
- MANUFACTURING CAPACITY
- MARKET FOCUS ON FEW MKT LEADERS

- FABLESS OR LIMITED IN HOUSE MANUFACTURING
- APPLICATION FOCUS
- ADDRESS MOSTLY 2ND TIER

THE WINNING IC PARTNER

- SYSTEM KNOW HOW INFLUENCES SILICON PRODUCT & TECH. DEVELOPMENT
- CONTROLS THE EVOLUTION OF SPECIFIC & CONVERGING TECHNOLOGIES. (I.E. SUB MICRON, BICMOS + CMOS)
- HAS LARGE INSTALLED BASE OF SUB MICRON VOLUME MANUFACTURING
- WIRELESS IS A CORE CORPORATE STRATEGY
- CAN OFFER FAST TIME TO PRODUCTION

Notes:

Panelist: The Wireless Communications Odyssey—What Adventures Lie Ahead?

Sohail Khan

Vice President
Wireless and Multimedia Business Unit
AT&T Microelectronics IC Group

Mr. Khan is Vice President of the Wireless and Multimedia Business Unit within AT&T Microelectronics IC Group, where he is responsible for P&L, including development, marketing, and product engineering for digital signal processors (DSPs), conversion signal processors (CSPs), video processors, and RF devices. Since joining AT&T Microelectronics in January 1990, he has increased the business by over 15 times and increased AT&T's market share from 5 to 30 percent in the worldwide programmable DSP market.

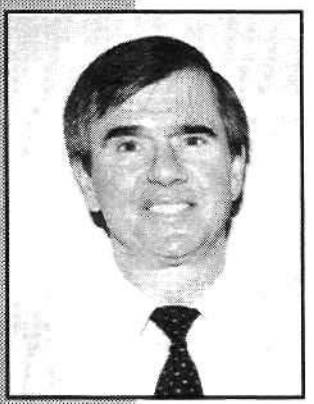
Prior to AT&T, Mr. Khan was employed by NEC Electronics and Intel as Product Line Manager/Product Marketing Engineer for programmable processors and nonvolatile memories.

Mr. Khan earned his B.S.E.E. degree from the University of Engineering, Lahore, Pakistan, in 1976, and an M.B.A. from the University of California, Berkeley, California in 1982.

Panelist: The Wireless Communications Odyssey—What Adventures Lie Ahead?

Ray Millington

Vice President and Director of Engineering
Advanced Products and Technology Division
Cellular Subscriber Group
Motorola Inc.



Mr. Millington is Vice President and Director of Engineering for the Advanced Products and Technology Division of the Cellular Subscriber Group at Motorola. He has been employed by Motorola since 1968, having been involved in radio telephone design since 1980, and he has played an integral role in the development of several key cellular products.

Mr. Millington's engineering teams were responsible for the NMT 450 Nordic mobile telephone, the original DynaTAC portable telephone, and the MicroTAC personal telephone.

Mr. Millington has a B.S. degree in electrical engineering from the Illinois Institute of Technology and an M.B.A. degree from Northwestern University. He also has two U.S. patents relating to the Pageboy II Program.

Digital Cellular Trends

U.S. Cellular Standards

800 MHz	1900 MHz
AMPS	GSM
NAMPS	CDMA
IS54 (TDMA)	TDMA
IS95 (CDMA)	•
	•
	•
	OmniPoint
	Wideband CDMA
	PACS
	DECT
	NAMPS

One Size Doesn't Fit All, But...!!

October 13, 1995

Digital Cellular Trends

Standards Needed

- Volume
- Quality
- Interoperability

October 13, 1995

Digital Cellular Trends

Cellular Systems

FDMA	TDMA	CDMA
AMPS	GSM	IS95
•	•	
•	•	
•	•	
NAMPS	NADC	

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Digital Cellular Trends

Cellular Handset Paradox

Lower Acquisition Cost

↓

Higher System Capacity

↓

Handset Complexity (More Flexibility & Functionality)

↓

Higher Acquisition Cost

October 13, 1995

Digital Cellular Trends

Digital Cellular Handset Complexity

- IC Equivalents 3-6X AMPS
- RF Complexity 1.5-3X AMPS
  - Linear RF
  - Speech Processing/Compression
  - Channel Error Mitigation
  - Greater Than 100X MIPS Increase

October 13, 1995

Notes:

Notes:

Panelist: The Wireless Communications Odyssey—What Adventures Lie Ahead?

Toshio Miki

Vice President and Executive Research Engineer
NTT Mobile Communications Network Inc.

Mr. Miki is a Vice President and an Executive Research Engineer of NTT Mobile Communications Network Inc. (NTT DoCoMo) research laboratories. His current research issues are on mobile multimedia signal processing techniques, including speech/audio/video coding and their implementation. He is taking the role of a chairman of the MPEG-4 committee and low-bit-rate videophone expert group in the Japanese national body. He was with AT&T Bell Laboratories as a residential visitor during the sabbatical year of 1988.

Since 1980, Mr. Miki has been with Nippon Telegraph and Telephone Corporation (NTT) Research Laboratories, Japan, where his major activities included digital modulation/demodulation and diversity reception for digital mobile communications.

Mr. Miki received the young engineers award of the Institute of Electronics, Information, and Communication Engineers (IEICE) of Japan in 1984. He also received the Paper of the Year Award from the IEEE Vehicular Technology Society in 1984. Recently, he received the Achievement Award of the IEICE in 1995 through the research and standardization of PDC half-rate speech coding named PSI-CELP.

Mr. Miki received B.S. and M.S. degrees in electronics engineering from Kyoto University, Kyoto, Japan, in 1978 and 1980, respectively.

Radio Interface for FPLMTS

- (Future Public Land Mobile Telecommunication Systems)

R1/R7	Cellular	car phone handy phone	Low Speed/High Speed
R2/R5	Cordless	indoor outdoor	Low Speed/High Speed
R3/R6 R4	Mobile Sattelite Paging		Low Speed/High Speed

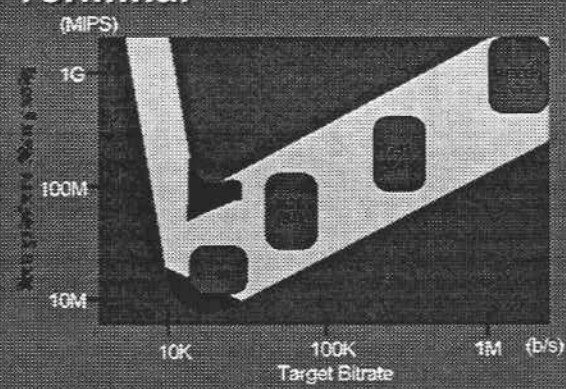
Low Speed (R1, R2, R3) : Voice, Low Bit Rate Data
High Speed (R5, R6, R7) : Phase I (Š 2Mb/s)
Phase II (2Mb/s)

Frequency Bands
2GHz Band, 230MHz: 1885-2025MHz, 2110-2200MHz

NTT Do Co Mo

Mobile Multimedia Terminal

- Audio-Visual CODEC
  - RISC-DSP
  - 100 ~ 1000 MIPS
  - Š100 mW
- Flat-Panel Display
- Long-Life Rechargeable Battery

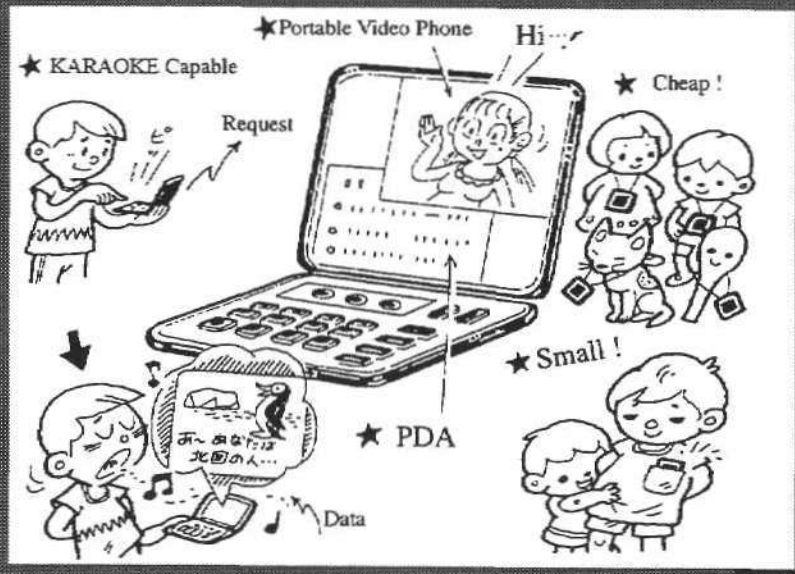


NTT Do Co Mo

Baseband Signal Processing for DS-CDMA

- High-speed A/D, D/A converter
  - quantization • 10-bits
  - Sampling Clock • 20 MHz
- Correlator for de-spreading
  - Chip-rate >> 20 MHz
  - Power Consumption Š 100 mW
- Demodulator LSI
- Interference Canceller
  - -4000 Mips for Multi-user, -120 Mips for Single-user
- Signal Processing for Adaptive Array Antenna

NTT Do Co Mo



NTT Do Co Mo

Notes:

How to Suceed in the Multimedia Consumer Systems Marketplace

Moderator

Greg Sheppard
Director and Principal Analyst, Dataquest Incorporated

Panelists

Kazuaki Mayumi
Director, Applications Laboratory, Matsushita Electronics Corporation

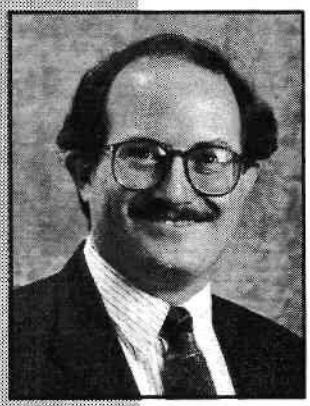
Kenji Hori
Chief Technology Officer, Sony Corporation of America

Paul Rioux
Executive Vice President, Sega of America Inc.

Klaus Volkholz, Ph.D.
Senior Director, Philips Electronics

Moderator: How to Succeed in the Multimedia Consumer Systems Marketplace

Gregory L. Sheppard
Director and Principal Analyst
Semiconductor Application Markets Worldwide
Semiconductors Group
Dataquest Incorporated



Mr. Sheppard is responsible for coordinating worldwide semiconductor applications research for Dataquest. Besides his own areas of research, he also oversees the research of the Semiconductor Application Markets (SAMM) Worldwide program and the Communications Semiconductor Applications Worldwide (CSAM) program. He has also participated in various customer-directed research projects concerning emerging semiconductor markets for application-specific products. Specific areas of expertise include: multimedia applications, personal computer and workstation applications, communications semiconductor market, and consumer and automotive applications

Mr. Sheppard is a specialist on the end use or application of semiconductors. His scope of analysis includes both economic and technical trends regarding the semiconductor opportunities in electronic equipment.

Prior to Dataquest, Mr. Sheppard was Worldwide Business Analysis Manager at Fairchild Semiconductor Corporation. In that position he coordinated the worldwide product and market plan that drove investment decisions. He has also been a participant in the World Semiconductor Trade Statistics (WSTS) organization and the American Electronics Association. Previously, he worked in engineering management at GTE Corporation specializing in communications systems design and decision aid systems.

Mr. Sheppard received a B.S.E.E./C.S. degree from the University of Colorado and an M.S. degree in system management from the University of Southern California.

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Panelist: How to Succeed in the Multimedia Consumer Systems Marketplace

Kazuaki Mayumi

Director, Application Laboratory
Matsushita Electronics Corporation

Mr. Mayumi is Director of the Application Laboratory at Matsushita Electronics Corporation and has been responsible for developing LSI architectures for advanced electronics systems and semiconductor applications technology and for managing intellectual property rights of the semiconductor group since 1990.

Mr. Mayumi graduated from Kyoto University and joined the Central Research Laboratories of Matsushita Electric Industrial Co. Ltd. in 1963. He was engaged in developing advanced digital systems, especially microcomputers, and their application systems, mainly for consumer electronics.

He is a member of IEICE of Japan and coauthored *One-chip Microcomputer* published by Maruzen.

Multimedia & Semiconductor

Mayumi K

Dataquest Conference 95

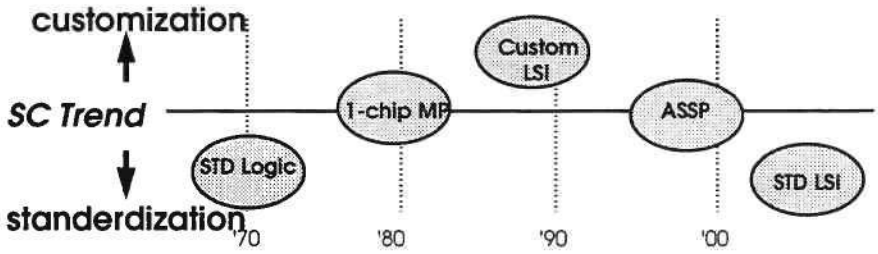
KM-DQConf-1

System Design and Semiconductors

design combination of STD parts → distinctive parts design → composition of STD functions

System Trend

KFS system architecture → customized parts → system software



KM-DQCon1-2

Multimedia Effect

— from individual system to unified system —

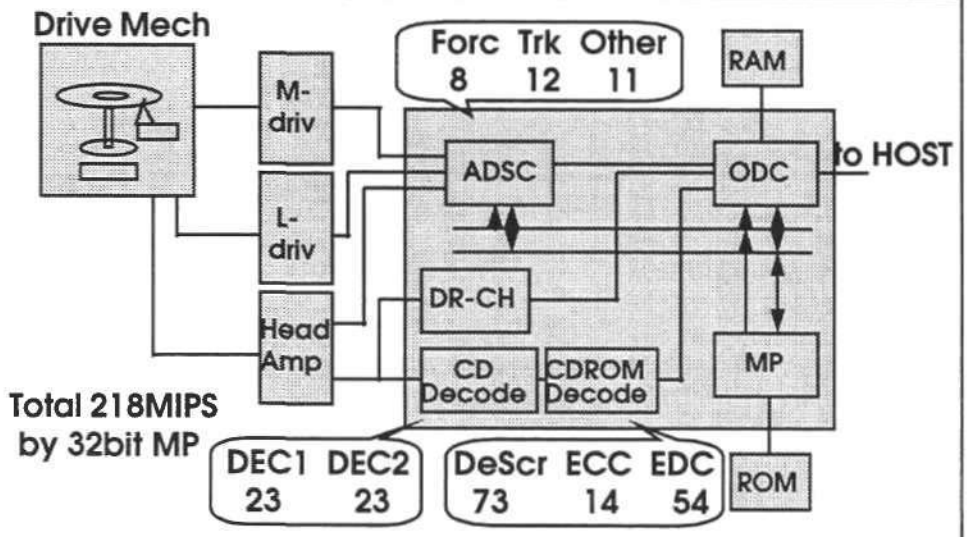
	TV	VCR	Radio	CATV
Comm	NTSC PAL	VHS 8-mm	AM FM	TCI TWC
Cont				
Proc				
I/O				

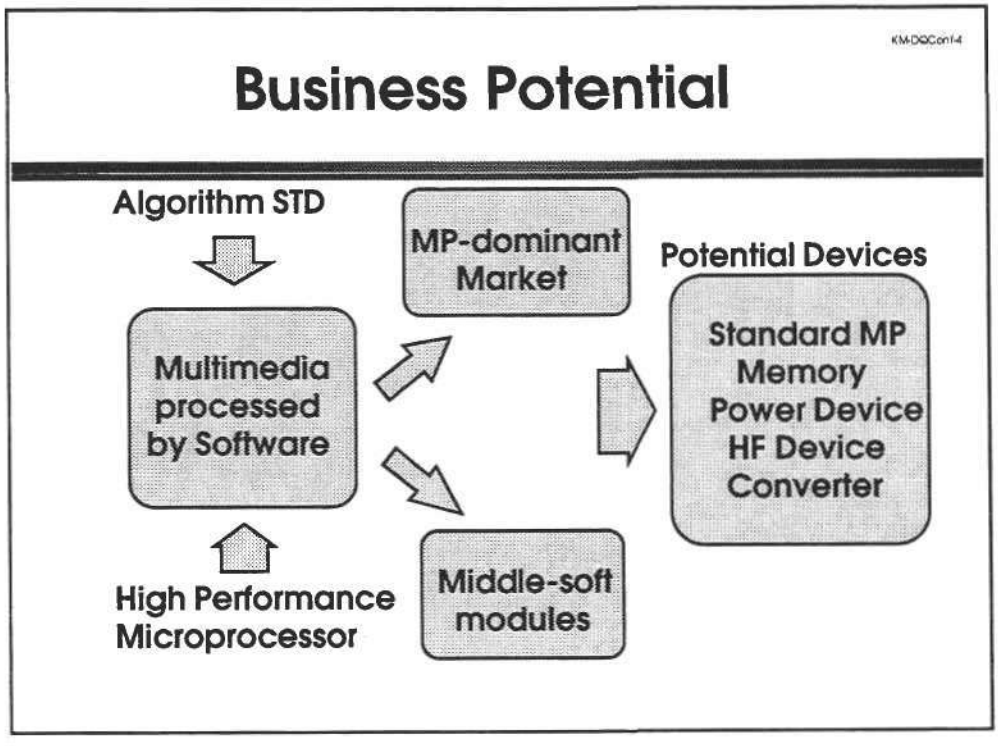
	TV	VCR	Tel	CATV
Comm	QAM QPSK VSB TCP/IP ATM			
Cont	Windows Telescript			
Proc	JPEG MPEG AC-3 ADPCM VCELP			
I/O	Keyboard Mouse Scanner CCD-camera			

KM-DQCon1-3

Multimedia System by Software

— Photo-disk Player as an example —




KM-DQConf-4
Business Potential
Algorithm STD
MP-dominant Market
Potential Devices
Multimedia processed by Software
Standard MP
Memory
Power Device
HF Device
Converter
High Performance Microprocessor
Middle-soft modules

Notes:

Notes:

Moderator: How to Succeed in the Multimedia Consumer Systems Marketplace

Kenji Hori

Member of Board of Directors
Sony Corporation
President and Chief Technology Officer
Research Laboratories
Sony Corporation of America

Mr. Hori has been the President and Chief Technology Officer of the Research Laboratories of Sony Corporation of America since April 1994. He is also a Director of Sony Corporation in Tokyo.

Mr. Hori joined Sony in 1961 and has held key positions in R&D planning, personal computer development, consumer video development, and advanced TV development. He coordinates Sony's U.S. R&D facilities in Montvale, New Jersey, and San Jose and San Diego in California.

Mr. Hori is a graduate of Tokyo University in 1961, with an M.S. degree in electrical engineering from Stanford Universtiy in 1965.

How to succeed in The Multimedia Consumer Systems Market Place

- **Broadcast/Network:** Satellite, Cable, Terrestrial, Telephone, ISDN
- **New Interactive Service** VOD, NVOD, Home Shopping
- **Computer:** Mulitimedia PC, Home Server
- **TV:** Digital STB, Large Screen, Wide Screen, Multiscan, HDTV, Flat Screen
- **Video:** Multimedia CD, Digital VCR, Digital Video Camera
- **Audio:** CD PLUS, MD, CD Changer
- **Home Network:** 1EEE 1394

PLASMATRON

High-Resolution, High-Contrast, Large-Screen, Active Matrix Flat Display, utilising Plasma Addressed Liquid Crystal Technology

Specifications:

- Address System: Plasma Address Type Active Matrix
- Liquid Crystal: 90-degree TN
- Color Filter: RGB Vertical Stripes
- Scanning Method: Non-interlace
- Display Range: Diagonal 25 inches (16 : 9)
- Pixel Number: 768 (trio) x 448 (line)
- Pixel Size: 0.72 (trio) x 0.69 (line) mm
- Brightness/Contrast: 250 cd/m^2 / 50:1
- Color Scale: 260,000 colors
- Panel Dimensions: 602 (W) x 380 (H) x 3.7 (D) mm
- Panel Weight: 1.7 Kg

Next-Generation High-Density Optional Disc Format

- Backward compatible with current CD media
- 0.6 mm substrate thickness, bonded disc (single - layer / dual layer) and 4.7GB data capacity per layer
- EFM Plus signal modulation
- RS-PC eror correction code

Consumer Digital VCR

- Cassette Size: 125(W)x78(H)x14.6(D) mm (DV Cassette)
  66(W)x 48(H)x 12.2(D) mm (Mini DVCassette)
- Tape Width: 6.35 mm (1/4 inch)
- Recording Time: 4 hour 30min (DV Cassette)
  1 hour (Mini DV Cassette)

Digital Compornent Recording (4:1:1)

Luminance:	13.5 MHZ, 8 bits
Chrominance:	R-Y 3.375 MHZ, 8 bits
	B-Y 3.375 MHZ, 8 bits
Video Rate:	24.948 Mbps
Recording Rate:	41.85 Mbps

- Tape Capacity (Unformatted): 85GB (DV Cassette)
  19GB (Mini DV Cassette)

Notes:

Panelist: How to Succeed in the Multimedia Consumer Systems Marketplace

Paul Rioux

Executive Vice President
Consumer Products Division
Sega of America Inc.

Mr. Rioux has set up and managed Sega of America's departments of finance, accounting, operations, and administration since November 1989. In addition, he is heading up Sega's corporate development in the United States.

Mr. Rioux brings more than 20 years of consumer electronics and toy business expertise to Sega. Prior to joining the company, he was chief operating officer and owner of Wonderline Inc., a toy company that owned the product franchises of "Wonder Horses," "Gym Dandy" gym sets, and "Extra Point" youth sports. He initiated the leveraged buyout of this company in 1986 and sold it to Roto-Molders Inc. in 1988. As COO, Mr. Rioux oversaw all aspects of the business, from finance to product planning and development, manufacturing, distribution, sales, and marketing.

As a partner at Denham, Rioux and Associates Consulting Services, Mr. Rioux supervised account services for CBS Inc., including product category analysis, advising the president of the Toy Group, and identifying and solving management, marketing, manufacturing, and financial problems. Prior to that, he served as senior vice president of finance and planning at Mattel, and was instrumental in organizing Mattel Electronics Inc., which grew from a $30 million product group of Mattel Toys in 1978 to a $500 million multinational, video game corporation by 1981.

Panelist: How to Succeed in the Multimedia Consumer Systems Marketplace

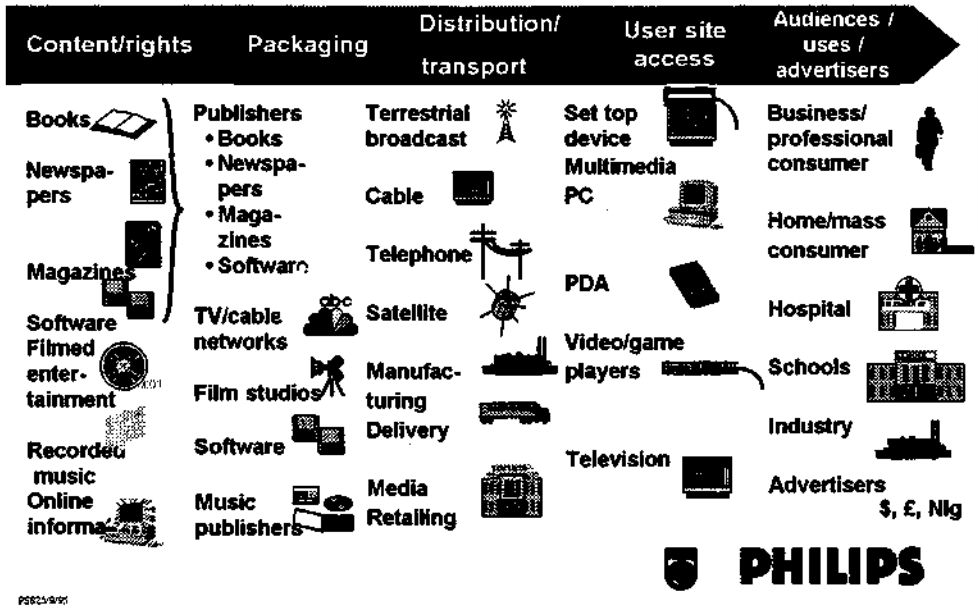
Klaus Volkholz, Ph.D.
Senior Director
Corporate Strategy
Philips Electronics

Since 1986, Dr. Volkholz has been the Senior Director for Corporate Strategy for Philips Electronics, headquartered in the Netherlands. He has been strongly involved in the process of redirection and change of the $35 billion multibusiness company.

During the last 10 years, Dr. Volkholz acted in a strategic planning and business development role for Philips Communications in Germany (1982-1986) and for Philips Semiconductors in California (1976-1982). In his earlier career, he held international product positions for Philips in the Netherlands and worked as a management consultant based in Switzerland.

Dr. Volkholz holds master's degrees in electrical engineering and economics, and a Ph.D. in electrical engineering, all from the University of Michigan.

THE WORLD OF MEDIA CAN BE SEGMENTED INTO A VALUE CHAIN



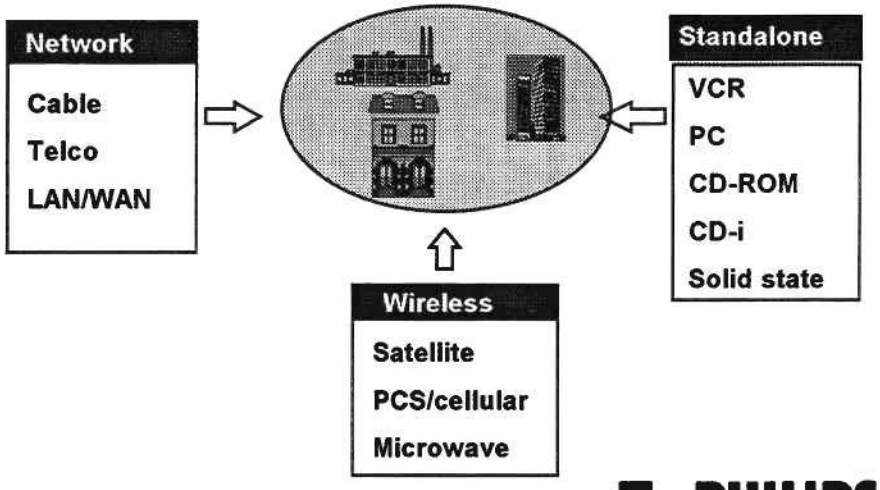
The media value chain

1993 market size (US$,B)

						Total
USA	50	70	265	30	Advertising pays 130	415
Europe	41	55	239	20	Advertising pays 67	355
China, Taiwan, Hong Kong Japan	24	28	131	27	Advertising pays 57	210

PHILIPS

More distribution paths to home and workplace



PHILIPS

PS825/9/95

Development of "Multimedia"

Challenges for the enabling technology:

- evolution of optical storage
- extension of compression capability
- evolution of broadband network and user access capability

Challenges for the Industry:

- "open" system architectures
- common formats
- Transparent, international rules on content-related Intellectual Property Rights

PHILIPS

PS825/9/95

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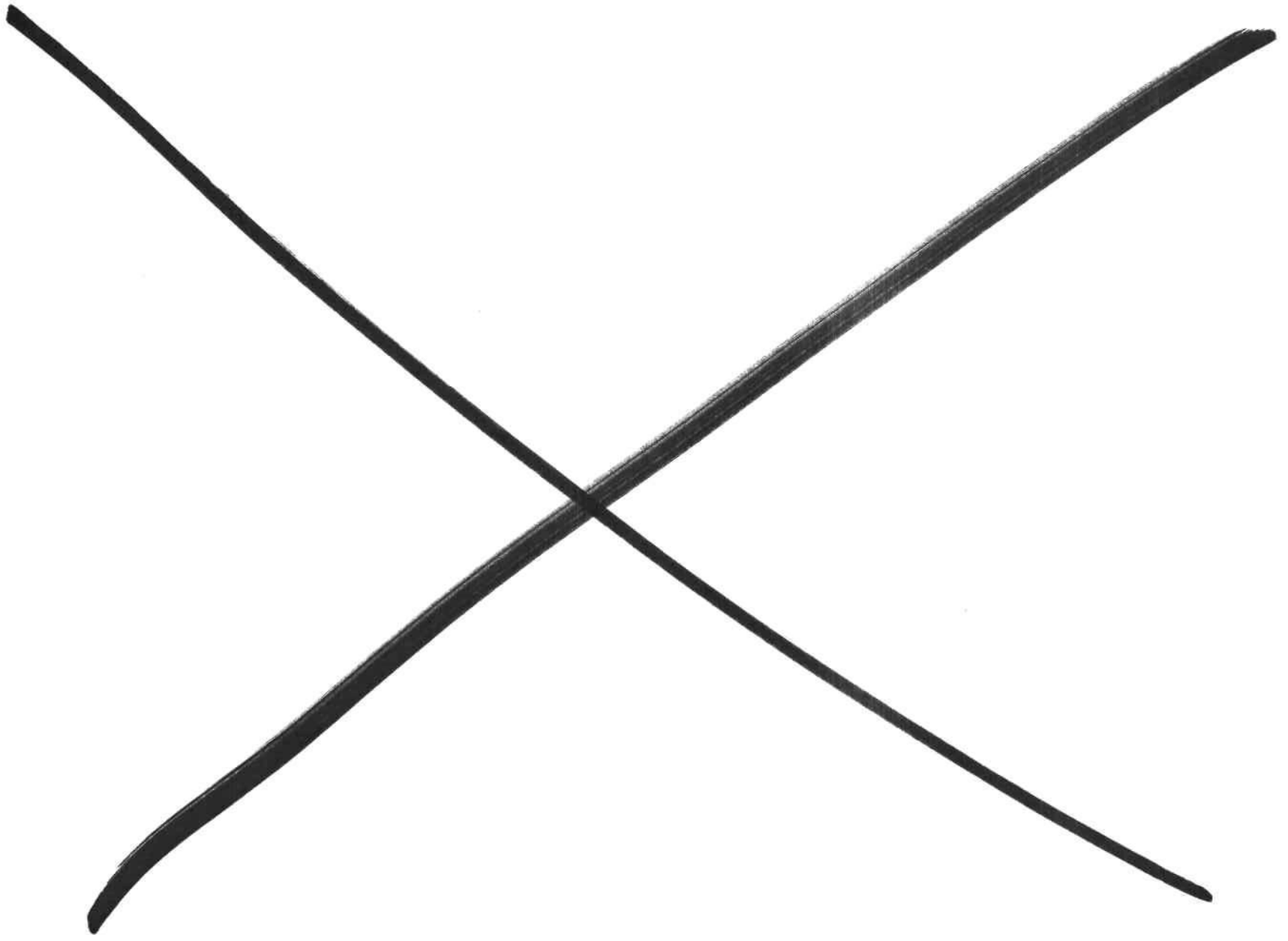

System-Level Integration: Profits on a Chip

Moderator

Bryan Lewis
Director and Principal Analyst, Dataquest Incorporated

Panelists

Brian Halla
Executive Vice President, LSI Logic Corporation

Donald Ciffone Jr.
Vice President and General Manager, VLSI Technology Inc.

Hiro Hashimoto
General Manager, NEC Corporation

Gary Smith
Director and Principal Analyst, Dataquest Incorporated

Moderator: System-Level Integration—Profits on a Chip

Bryan Lewis

Director and Principal Analyst
ASICs Worldwide Program
Semiconductors Group
Dataquest Incorporated

Mr. Lewis joined Dataquest in 1985 and is the Director and Principal Analyst of Dataquest's ASICs Worldwide program in the Semiconductors group. His focus is on analysis of gate arrays, cell-based ICs, and PLDs. He has responsibility for tracking and evaluating market movements, forecasting markets, and tracking technology trends. He has traveled extensively in Asia, Europe, and North America and worked with a wide variety of clients.

Prior to joining Dataquest, Mr. Lewis was a Research Manager for a semiconductor market research company. His responsibilities included establishing and managing a primary research group as well as performing research on GaAs ASICs.

Mr. Lewis received a B.S. degree in marketing from the University of Oregon.

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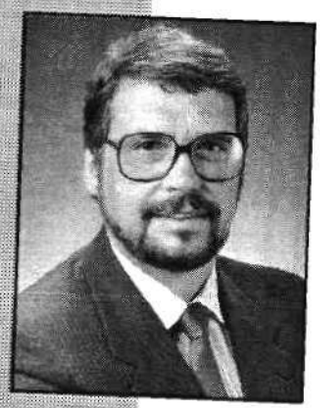
Panelist: System-Level Integration—Profits on a Chip

Brian L. Halla
Executive Vice President
LSI Logic Products
LSI Logic Corporation



Mr. Halla is Executive Vice President of LSI Logic Products, for LSI Logic Corporation.

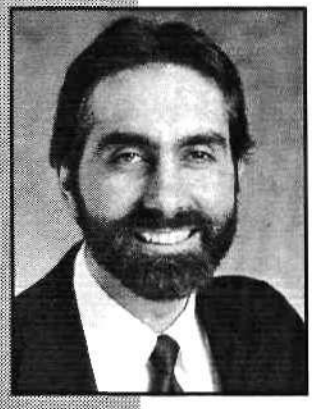
Mr. Halla, a 14-year Intel Corporation veteran, joined LSI Logic in 1988. He is responsible for the company's growing portfolio of products for selected vertical markets including networking/ telecommunications, digital video (cable and television, direct broadcast satellite, TV set-top boxes, and video games), and computer system logic (file servers, workstations, and personal computers).

Prior to joining LSI Logic, Mr. Halla was Director of Marketing for the Microcomputer Group at Intel Corporation. Earlier, he held a variety of management positions, including product marketing management for the Development Systems Group. Before Intel, Mr. Halla was a Manager of Field Application Engineering at Control Data Corporation in Sunnyvale, California.

Mr. Halla has a B.S.E.E. degree from the University of Nebraska.

Panelist: System-Level Integration—Profits on a Chip

Donald (Don) L. Ciffone, Jr.
Vice President and General Manager
VLSI Product Divisions
VLSI Technology Inc.



Mr. Ciffone joined VLSI Technology Inc. in November 1991 as Vice President of the Primary and Emerging Markets Division. In 1992, he was promoted to run the VLSI Product Divisions (VPD). In his current role as Vice President and General Manager of VPD, he is responsible for all marketing, product development, operations, strategic planning, and execution for the market-focused business units, including Consumer and Industrial Products, Computer and Government Products, Networking Products, Wireless Products, and Apple Products, as well as ASIC Core Technology and VPD Operations.

Mr. Ciffone began his professional career in January 1978, in operations at National Semiconductor Inc. in Santa Clara, California. Over the next 13 years, he held various program management and product marketing positions in the Semiconductor and ASIC divisions. From 1989 until 1991, he was Director of Marketing for the ASIC Division, with worldwide product marketing responsibility for a $160 million business unit comprising gate array, standard cell, COT, and software products in CMOS, ECL, and BiCMOS process technologies.

Mr. Ciffone received a B.A. degree from San Jose State University, San Jose, California, in 1977, and an M.B.A. degree from the University of Santa Clara, Santa Clara, California, in 1983.

Panelist: System-Level Integration—Profits on a Chip

Hiro Hashimoto
General Manager
ASIC Division
NEC Corporation

Mr. Hashimoto is General Manager of the ASIC Division in charge of worldwide ASIC operations at NEC Corporation. Previously he was Vice President of the Micro Computer and ASIC Divisions, and Associate Vice President and General Manager of the ASIC Division at NEC Electronics USA.

Mr. Hashimoto started his managerial career as manager of testing and product engineering and production at NEC Ireland Ltd. He later became Engineering Manager for ASIC Product Development at NEC Corporation, Japan. On returning to California, he held management positions in the ASIC Products Division and in the Marketing Department at NEC Electronics USA.

He has a B.S. degree in engineering from the National University of China.

Panelist: System-Level Integration—Profits on a Chip

Gary Smith

Director and Principal Analyst
Electronic Design Automation Program
Online, Multimedia, and Software Group
Dataquest Incorporated

Mr. Smith is the Principal Analyst and Director for Dataquest's Electronic Design Automation (EDA) program of the Online, Multimedia, and Software group. He is responsible for all research, publications, and client projects relating to the EDA marketplace. He is also involved in research and consulting projects in the emerging methodologies of RT-level design and electronic system design automation (ESDA).

Mr. Smith has more than 25 years of experience in the electronic design market. Starting in the semiconductor industry, he was involved in some of the first attempts at customer-designed ICs. During the 1980s, he specialized in the ASIC end of the semiconductor business. He was instrumental in the development of Plessey's "Megacell" design system, one of the first workstation-based IC design tools. While at IMI, he introduced "EasyGate," a PC-based design system capable of designing 10,000 gate arrays, some of the largest arrays offered at that time. While at LSI Logic, Mr. Smith became involved with true top-down design, later leaving the company to become a consultant in Design Methodology. Mr. Smith joined Dataquest in January 1994.

Mr. Smith received a B.S. degree in engineering from the United States Naval Academy, Annapolis, Maryland.

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New DRAM Architectures: Who Needs 'Em?

Moderator

Jim Handy
Director and Principal Analyst, Dataquest Incorporated

Panelists

Hans A.M. Wiggers
Senior Memory Systems Engineer, Hewlett-Packard Company

Paul Baker
Director of CPU Engineering, Apple Computer Inc.

Jodie Hughes
Vice President, Western Digital Corporation

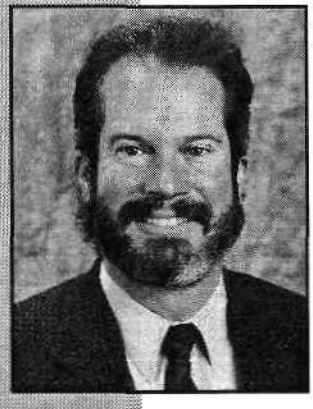
Max Bouknecht
Manager, IBM Corporation

Dipankar Bhattacharya
Principal Engineer, Opti Inc.

Moderator: New DRAM Architectures—Who Needs 'Em?

Jim Handy

Director and Principal Analyst
Semiconductor Memories Worldwide Program
Worldwide Semiconductor Group
Dataquest Incorporated



Mr. Handy is Director and Principal Analyst for Dataquest's Semiconductor Memories Worldwide program. He is responsible for the forecasting and analysis of memory products and markets.

Prior to joining Dataquest, Mr. Handy was Strategic Marketing Manager for static RAMs at Integrated Device Technology (IDT). Before IDT, he was Product Marketing Manager of memory and microcomputer-based products at Intel Corporation, National Semiconductor Corporation, and Siemens Corporation and has a rigorous design background. Mr. Handy is the author of *The Cache Memory Book* (Academic Press, 1993) and his other work has been widely published in the trade press including *Electronic Design, Computer Design, EDN,* and *Byte,* and he has spoken internationally at universities and numerous trade shows including Wescon, Electro, WinHEC, Northcon, Southcon, and the Personal Computer Design Conference. Mr. Handy is frequently quoted in the electronics trade press and is a patent holder in the field of static RAMs.

Mr. Handy earned his M.B.A. degree at the University of Phoenix and holds a B.S.E.E. degree from Georgia Tech.

jhandy@dataquest.com

The Problem: Bandwith!

- CPUs are getting faster
  - 1987: 16 MHz
  - 1995: 175 MHz
- Graphics are getting fancier
  - Was 800x600, 16 colors
  - Now 1024x768, 256 colors
  - Will be 1280x1024, 24-bit color
- Full-motion video is starting to gain acceptance
- Less DRAMs per system ≥ more bandwidth per DRAM

9505650

Dataquest

The Other Problem: 15 Varieties to Choose from!

Asynchronous	Synchronous	Specialty
Fast Page Mode	JEDEC	Video RAM
EDO	Rambus	Window RAM
Burst EDO	MoSys	Sync Graphics RAM
Enhanced DRAM	RamLink	3D-RAM
Cache DRAM	SyncLink	Sync Video RAM

9505651

Dataquest

Notes:

Notes:

Panelist: New DRAM Architecture—Who Needs 'Em?

Hans A. M. Wiggers
Senior Memory Systems Engineer
Memory Technology Center
Hewlett-Packard Company

Mr. Wiggers is a Senior Memory Systems Engineer in the Memory Technology Center at Hewlett-Packard. He moved to the United States from the Netherlands in 1966 and after spending several years with the Boeing Company and Fairchild Semiconductor, he joined the Hewlett-Packard Company in 1972. He held hardware design positions in the Test and Measurement divisions as well as the Computer System division. He later spent several years in Hewlett-Packard Research laboratories doing research in Memory Systems. He joined HP Procurement in 1992 as Senior Memory System Engineer in the Memory Technology Center. Here he concentrates on requirements for future memory components to HP systems. He is active in industry-standards efforts, particularly in IEEE (Chair P1596.4 "Ramlink") and in the JEDEC DRAM and interface standards committees JC42 and JC16. Mr. Wiggers is also a member of the JEDEC Engineering Council.

Mr. Wiggers graduated from Delft Technical University with an engineer's degree in electronics.

Memory Components at HP

- Significant user of DRAMS
- Large diversity of needs
  - Low cost printers (< 1 Mega Byte)
  - Personal computers
  - Unix work stations
  - Commercial systems solutions (> 4 Giga Bytes)
- Cost sensitivity
  - Extremely High -> Very High -> High
- Continuous pressure on our systems for better performance at lower cost.
- Assurance of supply (Commodity Components)
- Help drive industry directions.

Memory System Considerations

- Main memory represents large percentage of system cost
- Increased CPU speeds and new architectures require extremely high bandwith. (Super scalar, VLIW)
- Memory system must be expandable by users, with good performance for entry level. (Granularity, Standard Modules)
- Growth in number of bits per chip exceeds growth in required memory size. (Granularity, Bandwidth per component)
- High end systems have long life cycle. Must support three generations of DRAM density.(16M, 64M, 256M)
- Personal Computers have very short life cycle. Must be have latest technology available.

Technology Observations

- Current supply shortage does not encourage production of innovation. (e.g. SDRAM)
- Fewer number of components per system requires new solutions.
  - Wider parts (1Mx4, 1Mx16, 2Mx32, 4Mx64 ???)
  - Faster data rates (33 MHz EDO, 66 MHZ SDRAM, 132 MHz SDRAM , ...)
  - Multiple Banks inside SDRAM (2 banks, 4 banks)
- Revolutionary solutions are being sought.
  - Rambus (Proprietary)
  - Synclink (IEEE P1596.7)
- Graphics often early adopter of new technology.

Conclusion

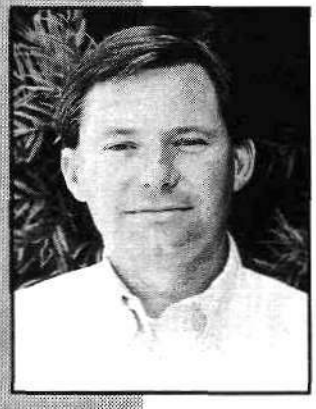
- Industry still seeking for solutions.
- Any solution must be high volume, standard.
- Price is overriding consideration.
- Impact of new systems (HDTV, Settop Box) is not yet well understood.
- There will continue to be a demand for small memory systems (Integrated in Controller ?)

Notes:

Panelist: New DRAM Architecture—Who Needs 'Em?

Paul Baker

Director, CPU Engineering
Macintosh Desktop Systems Group
Apple Computer Inc.



Mr. Baker is the Director of CPU Engineering in the Macintosh Desktop Systems group at Apple Computer. The CPU Engineering group is responsible for defining and designing new Macintosh desktop CPUs and transferring the final designs to production. Prior to his current assignment, he was responsible for the Entry Macintosh Products CPU engineering group, which performed a similar function for Apple's low-end CPUs only. He has held other management and engineering jobs during a 13-year Apple career.

Mr. Baker has held engineering and management positions at Hewlett-Packard, Kylex Inc., and Information Appliance Inc.

Mr. Baker holds a B.S.E. degree from Harvey Mudd College and an M.S.E.E. degree from Stanford University.

New DRAM Architectures

- The PC industry is very conservative in adopting new DRAM technology
- In general a new DRAM architecture will only be adopted if there is no cost penalty and no supply risk
- The 64 Mb DRAM may force an architecture change due to the minimum DRAM system that can be produced

DRAM Cost and Availability

- DRAM represents about 20% of total PC system cost
  - Paying a premium for interface to DRAM is a major cost issue
- New OS developments increase DRAM needs
  - Mac System 7.5 - 4 MB min
  - PowerMac systems - 8 MB min
  - Copland - 8 MB min
- The combination of DRAM cost and ever increasing demand mean that PC systems must use commodity DRAM
  - DRAM availability is a major supply issue for PC vendors

4 and 16 Mb organizations

- At the 4 Mb level, the 1Mx4 fast page DRAM is dominant
  - This is the case because the cost is lowest and supply is broad based
  - A 4 MB 32 bit wide system uses 8 parts
  - An 8 MB 64 bit wide system uses 16 parts
- At the 16Mb level, the 1Mx16 part will be very popular
  - 4 ea x16 yields an 8 MB, 64 bit wide memory
  - I believe 2 banks of x16 parts will be the preferred implementation for 16 MB
  - If EDO achieves cost parity with FPM, it will become dominant due to the higher performance provided at no extra cost
  - SDRAM will not be broadly used in main memory applications because of the cost premium

Implications of 64 Mb DRAM

- In the next few years, most PC systems will ship with 16 MB of DRAM and 64 bit processor busses
- Therefore, at the 64 Mbit level, 32 bit wide DRAM will be required to achieve a 16 MB system
- The alternative is to use a new interface that permits a smaller bus width to achieve the same performance
- The die area penalty for 32 bit wide busses may provide enough cost umbrella for a new interface standard to be developed

Notes:

Panelist: New DRAM Architectures—Who Needs 'Em?

Jodie Hughes
Vice President
New Business Development
Western Digital Corporation

Mr. Hughes is Vice President of New Business Development at Western Digital Corporation. This position includes responsibility for developing a corporate strategic plan across the complete information storage domain, evaluating investment/merger opportunities, evaluating new technologies, negotiating strategic alliances, and integrating multimedia strategies into the Western Digital corporate information processing strategies.

Prior to this position Mr. Hughes was the Vice President and General Manager for the Multimedia Products Division at Western Digital. He has also served as Vice President of Engineering for Sigma Designs Corp. and Unisys Corporation.

Mr. Hughes has a B.S.E.E. degree from the University of Santa Clara.

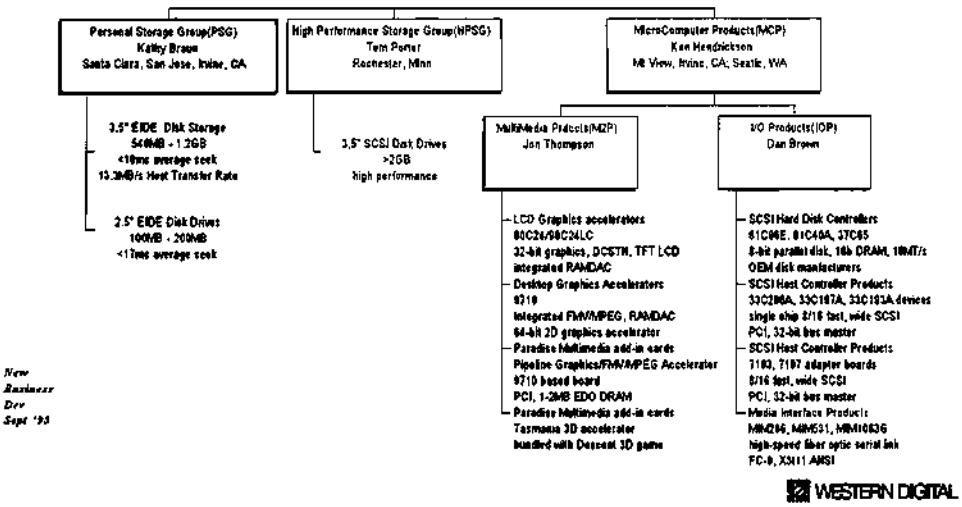
Unique DRAM Requirements

Jodie Hughes

New Business Dev Sept '95

WESTERN DIGITAL

Organizational Structure



New Business Dev Sept '95

WESTERN DIGITAL

DRAM Considerations

- Market is Driven by PC manufacturers
- above drives everything else
  - performance
  - price
  - capacity
  - availability
- Allocated Markets drive conservatism

New Business Dev Sept '95

WESTERN DIGITAL

DRAM Roadmap

PSG

- Cache, table store, overlay
- Thru CY '96
  - 1M, 70 ns
  - EDO Burst Mode
- PRICE!!!
  - 2M?, Embed?
    - vendors
    - cost(<$10)
    - defect density

HPSG

- Cache, tables, overlay, control
- Thru mid CY '96
  - 2M, 70-50 ns
  - EDO Burst Mode
- Fiber(2M?)
  - SDRAM CY '97
    - vendors
    - cost(<$10)
    - defect density

M2P

- Frame Buffer, texture, fonts
- Thru mid CY'96
  - 2M, 45ns
  - EDO Burst Mode
- Shared Frame Buffer
  - SGRAM CY'97
- PCB mixed
  - RAMBUS

New Business Dev Sept '95

WESTERN DIGITAL

Notes:

Panelist: New DRAM Architectures—Who Needs 'Em?

M.A. Bouknecht

Manager, Server Systems Development
IBM Corporation

Mr. Bouknecht joined IBM in 1969. He has held positions in product development for the IBM System/7, Series/1, RTPC, PS/2 Models 80 and 95, and the PC Server 320, 500, and 70.

Mr. Bouknecht is currently Manager of PC Server Systems Development, responsible for all hardware development and systems integration.

He holds a BS in Electrical Engineering from the University of Florida.

Panelist: New DRAM Architectures—Who Needs 'Em?

Dipankar Bhattacharya
Principal Engineer
Core Logic Business Unit
Opti Inc.

Mr. Bhattacharya has spent the last five years with Opti. He is Principal Engineer in its Core Logic Business Unit and is a consultant to all the 64-bit desktop core-logic design groups.

Mr. Bhattacharya has been the architect and design manager of Opti's immensely successful Viper family of chipsets. Prior to that he was the architect of Opti's EISA products.

DRAM Architecture for PC

- What does OPTi make?
  - PC Corelogic Chips
  - PC Audio Chips
  - PC Graphics Controllor
- OPTi & DRAM
  - Corelogic : System Memory
  - Graphics Controller: Display Memory

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DRAM Architecture for PC

- Why need Faster DRAM
  - Faster CPU: Pentium, P6, etc.
  - Faster Peripherals: Video, Audio, etc.
  - New architecture: Unified Memory
  - New Applications: Games, etc.

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DRAM Architecture for PC

- Density outpacing PC Memory Size
  - Increase data width
  - Increase DRAM size
  - Use lower density
  - Change architecture
- Improve What?
  - Performance : Latency & Bandwidth
  - Size & Fit : Granularity
  - Cost : $$$

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DRAM Architecture for PC

- Improve How?
  - Better Latency
  - Better Bandwidth
  - Fewer pins with faster clock
- Impediments
  - Too many choices !!
  - If you build it they will come: DRAM or Controller?
  - Volume & Cost: Chicken & Egg

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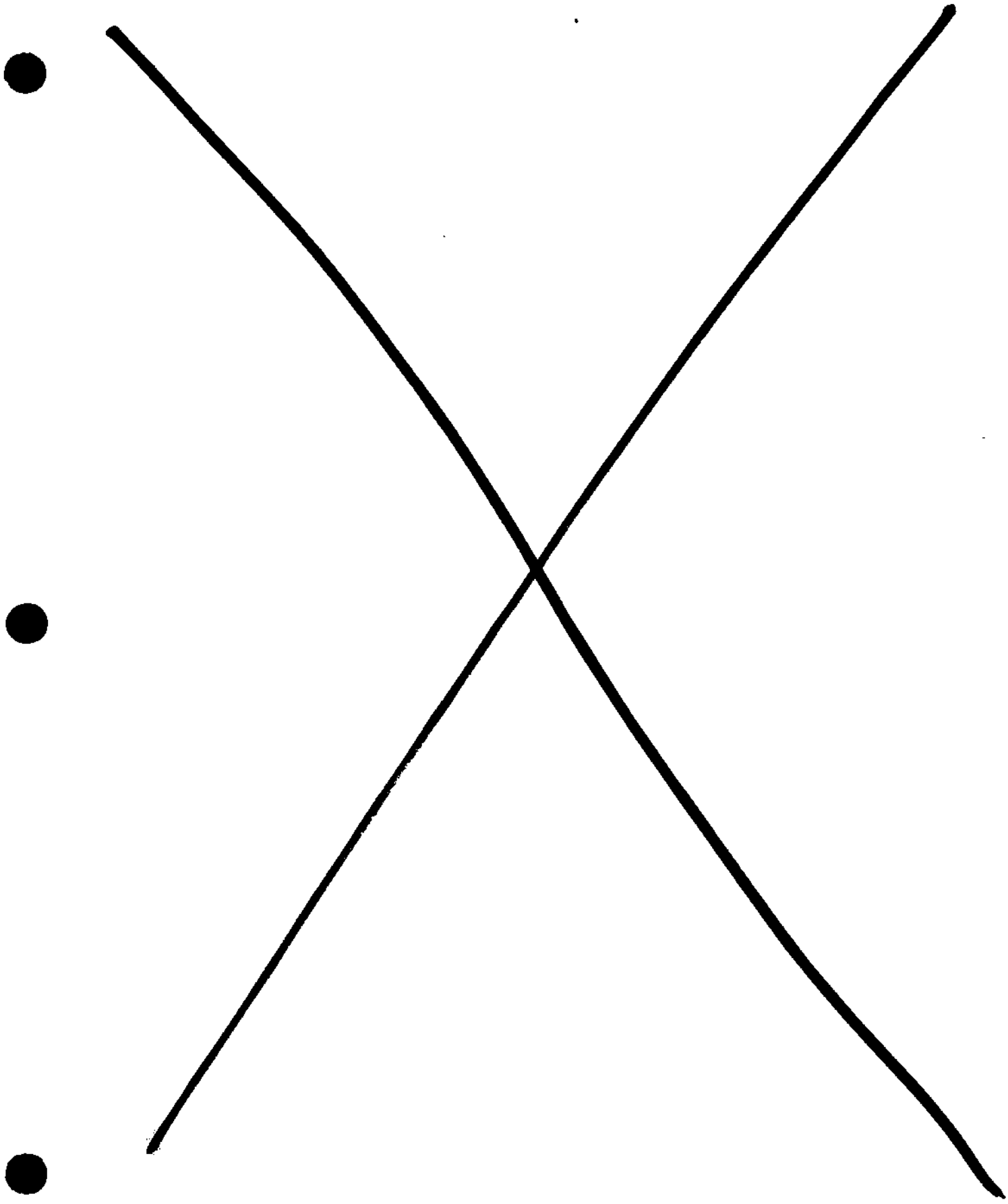
Notes:



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