

**AGENDA**  
**DATAQUEST-NATIONAL DAY**  
**NOVEMBER 11, 1991**

8:30-9:00	Sign-in, coffee	
9:00-9:30	Welcome & NSC Overview	Gil Amelio President & CEO
9:30-10:30	Networking	Jerry McDowell (DQ) Dir/Principal Analyst Krishna Shankar (DQ) Sr. Industry Analyst
10:30-10:45	Break	
10:45-11:15	Semiconductor Forecast	Gary Grandbois (DQ) Sr. Industry Analyst
11:15-12:15	Personal Computers	Andy Seebold (DQ) Dir/Principal Analyst
12:15-1:30	Lunch	BY INVITATION ONLY
1:30-2:15	Computer Storage	Phil Devin (DQ) Dir/Principal Analyst Nick Samaras (DQ) Dir/Principal Analyst
2:15-2:30	Break	
2:30-3:15	Wireless/Personal Communications	Steve Sazegeri (DQ) Dir/Principal Analyst Krishna Shankar (DQ) Sr. Industry Analyst
3:15-3:45	Office Automation	Dick Norton (DQ) Vice President/Dir.

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**2:30-3:15**

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## Dataquest

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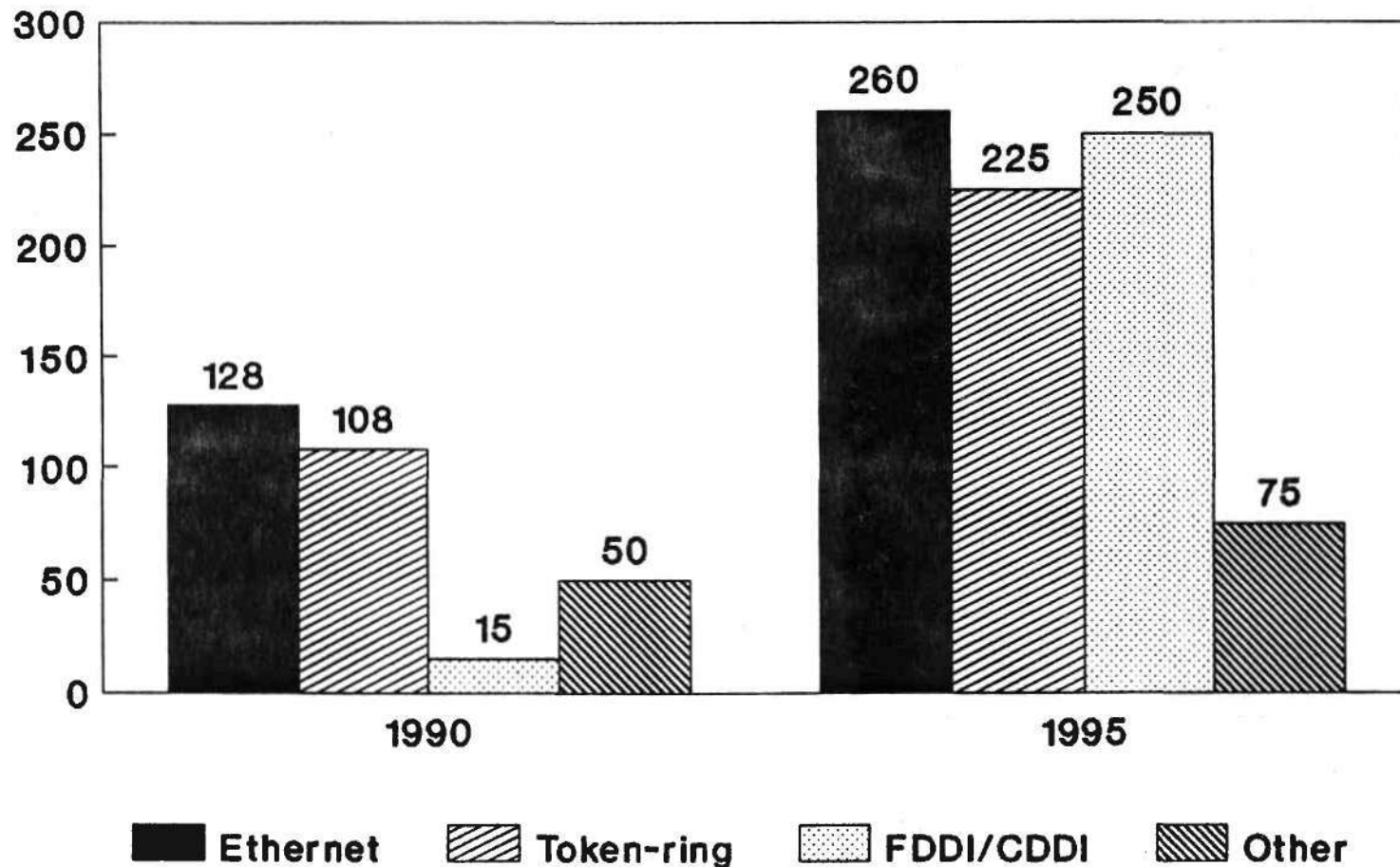
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# LAN CHIPSET MARKET

- **EMERGENCE OF LAN ASSP CHIPSET MARKET**
- **ETHERNET, TOKEN-RING, FDDI STANDARDS ESTABLISHED**
- **HIGHLY-INTEGRATED SOLUTIONS**
- **SHRINK-WRAPPED HARDWARE + SOFTWARE SOLUTIONS**
- **PC/WORKSTATION CONNECTIVITY DRIVES MARKET**
- **TARGET PC/WORKSTATION COMPANIES FOR DESIGN WINS**
- **STRATEGIC PARTNERSHIPS WILL BE CRUCIAL**

# WORLDWIDE LAN CHIPSET MARKET (MILLIONS OF DOLLARS)



Source: Dataquest/November 1991

**Dataquest**

## LAN CHIPSET APPLICATIONS DISTINCT MARKET SEGMENTS

### LOW-END

- DESKTOP PCS
- PORTABLE PCS
- ENTRY-LEVEL  
WORKSTATIONS

### MID-RANGE

- MID-RANGE  
WORKSTATIONS
- LOCAL HUBS
- DISKLESS  
WORKSTATIONS

### HIGH-END

- INTELLIGENT HUBS
- BRIDGES
- ROUTERS
- SERVERS
- HIGH-END  
WORKSTATIONS

# ETHERNET LAN CHIPSET TRENDS

- 10BASE-T (UTP) ETHERNET IS HIGH GROWTH MARKET
- HIGHLY INTEGRATED CHIPSET SOLUTIONS APPEARING
- MIGRATION TO MOTHERBOARD

# **LOW-END LAN CHIPSET MARKET HIGH-VOLUME ETHERNET LANS**

## **LAN CONTROLLER CHIP**

- CSMA/CD PROTOCOL CORE**
- 8-BIT/16-BIT DATA BUS**
- 10BASE-T INTERFACE**
- 16Mb/s to 20Mb/s serial rates**
- INTERNAL FIFO**
- AUTOMATIC RE-TRANSMISSION**

## **SERIAL TRANSCEIVER CHIP**

- DEDICATED AUI & 10BASE-T PORTS**
- LOW POWER MODES**
- DIAGNOSTIC LOOPBACK**
- ON-CHIP CLOCK RECOVERY**
- DIRECT CONTROLLER INTERFACE**
- LOW POWER 5V CMOS**



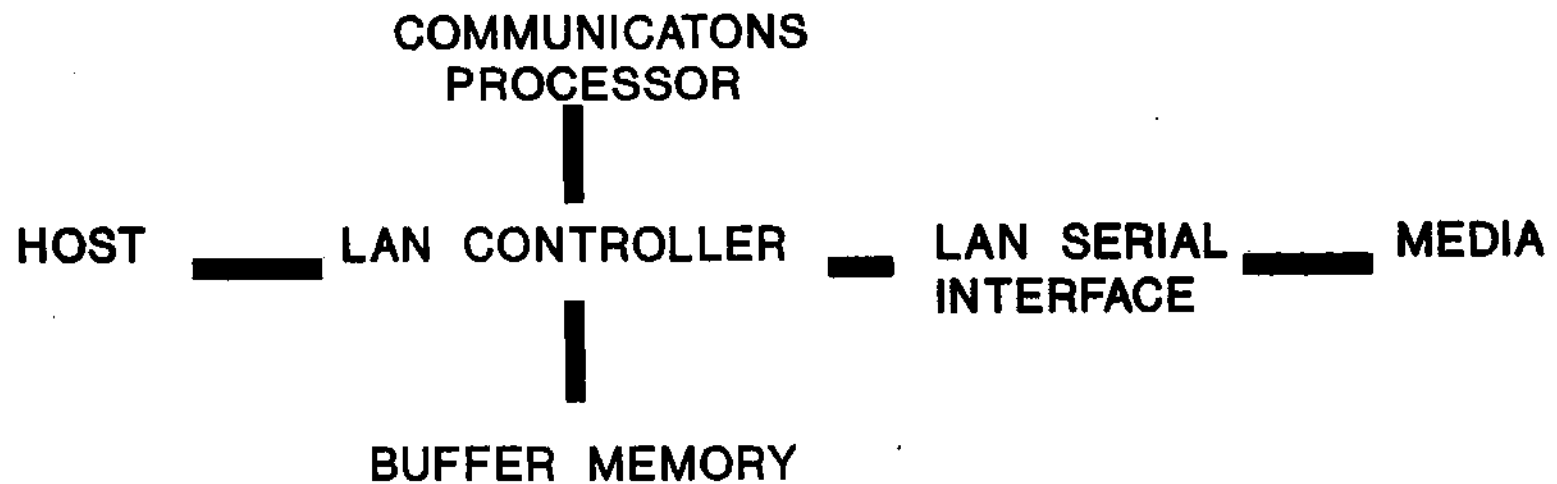
# **ETHERNET/TOKEN-RING MULTIPROTOCOL HIGH-END CHIPSET MARKET**

- **REALITY OF MIXED PLATFORM ENVIRONMENT**
- **INTERNETWORKING BETWEEN LANS**
- **MIGRATION TO MOTHERBOARDS**
- **FEATURE-RICH, HYBRID NETWORK MANAGEMENT**

# **HIGH-END LAN CHIPSET MARKET VALUE-ADDED CUSTOMIZATION**

- **NETWORK MANAGEMENT FEATURES**
- **SOFTWARE PROGRAMMABILITY**
  - PROTOCOL TYPE
  - SPEEDS
  - ADDRESS LOCATIONS
  - POWER DOWN MODE
  - REMOTE BOOTING
- **SHRINK-WRAPPED LAN SOLUTION**
  - CHIPSET
  - SOFTWARE DRIVERS
  - CUSTOMIZING SOFTWARE DEVELOPMENT KIT
  - SUPPORT FOR POPULAR NOS STANDARDS

# LAN CHIPSET IMPLEMENTATION



**Dataquest**

## **LAN CONTROLLER BLOCK TYPICAL FEATURES**

- **SUPPORT FOR FULL DUPLEX OPERATION**
- **BUFFER MEMORY MANAGEMENT**
- **NETWORK MANAGEMENT CONTROL**
- **REMOTE BOOT-UP SUPPORT**
- **DIRECT HOST BUS INTERFACE**
- **DIRECT HOST MEMORY ACCESS**
- **EXTERNAL ADDRESS FILTER CAPABILITY**
- **TRANSMIT BLAST MODE OPERATION**

## **LAN SERIAL INTERFACE BLOCK TYPICAL FEATURES**

- **BUILT-IN 10BASE-T TRANSCEIVER**
- **TTL/CMOS INTERFACE**
- **SINGLE 5V SUPPLY, LOW POWER CMOS**
- **POWER DOWN MODE**
- **PROGRAMMABLE PROTOCOL SELECTION**
- **ON-CHIP PLL FOR DATA/CLOCK RECOVERY**
- **LOOPBACK SELF-DIAGNOSTICS CAPABILITY**

# CONCLUSIONS

- EMERGENCE OF HIGH-VOLUME LAN ASSP CHIPSET MARKET
- ETHERNET, TOKEN-RING LANS BASED ON STP & UTP COMMON
- LOW, MID-RANGE, HIGH-END LAN CHIPSET MARKET
- FDDI/CDDI CHIPSET MARKET WILL GROW DRAMATICALLY
- TARGET PC, WORKSTATION, SERVER COMPANIES FOR HIGH-VOLUME DESIGN WINS
- STRATEGIC OEM PARTNERSHIPS ARE ESSENTIAL

*Gilbert F. Amelio*

President

&

Chief Executive Officer

# Summary: July 1991 Financial Analysts' Meeting

## ■ Macro industry issues

- Cost of capital
  - Need higher revenue per wafer start
- Component-to-subsystem transition
  - Changing the way we relate to customers

## ■ Company-specific issues

- Financial performance, including gross margin
  - Today: 24% *32% six years prior*
  - Goal: 40%
- Manufacturing capacity utilization
  - Today: 66% *→ same now*
  - Goal: > 85%
- R.O.I. on R&D
  - More revenue per dollar invested
  - Goal: approximately 15:1 *over life*

*\$3K rev/wafer start  
Industry revenues  
at half.*

*750-250 direct  
accounts  
focusing on  
linear -  
mixed signal  
comm.  
off. peripherals.*



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## *What Is National Doing to Address These Issues?*

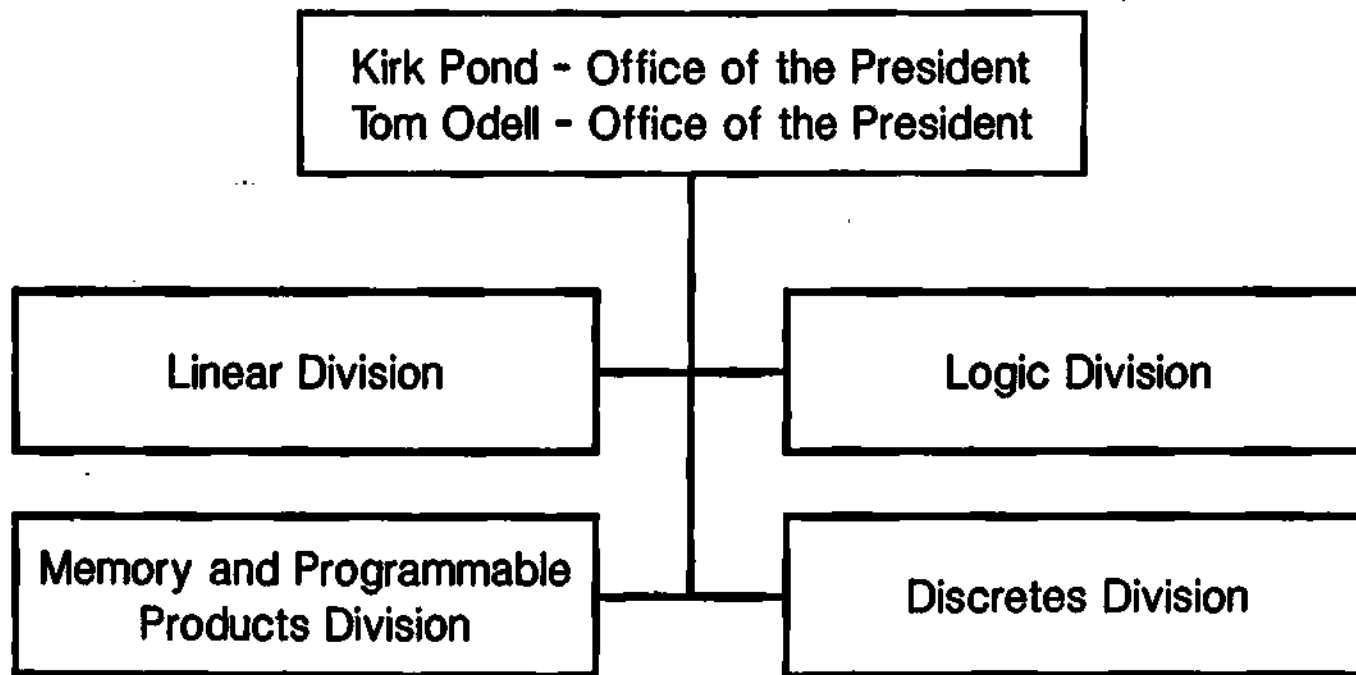
- Reorganization (June 1991)
- Restructuring (August 1991)
  - Capacity utilization
    - Focus future investments on fewer, better plants
  - Gross margin
    - Increase by **lowering** breakeven
- Task forces for continuous improvement
  - Establish teams of managers and employees to attack critical business issues
  - Progress monitored by an executive council of top 30 managers led by CEO

## *Reorganizing for Greater Market Focus*

- New corporate structure announced June 1991
- Decentralized → two major business groups
  - Communications & Computing Group (Ray Farnham)
  - Standard Products Group (Kirk Pond/Tom Odell)
- Decentralized manufacturing
- Market focus
  - Vertical
    - Products serving specific market segments
  - Horizontal
    - Products serving broad market segments

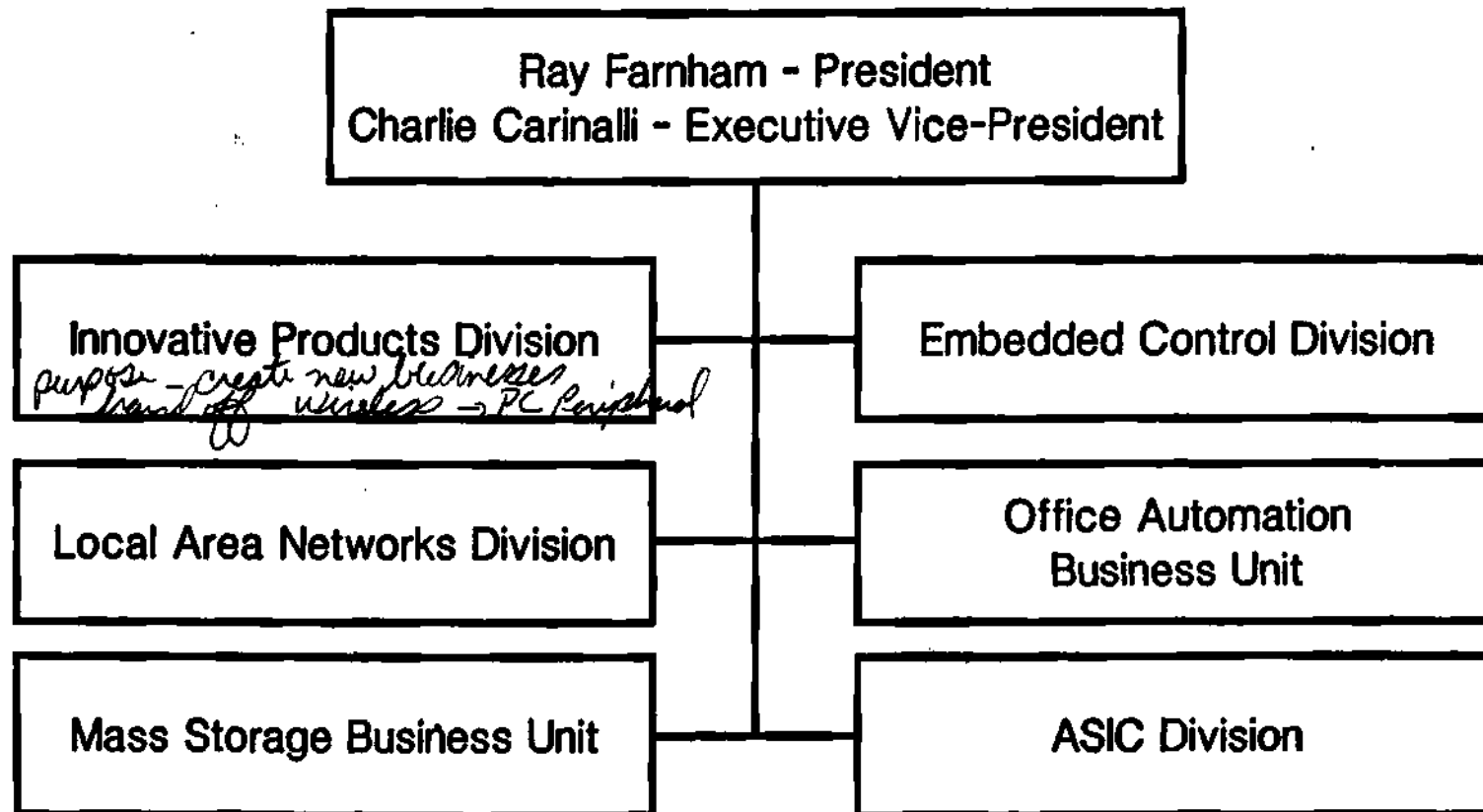
design  
key need for  
consumer  
eng.

## *Standard Products Group*



*Automotive here too*

# Communications and Computing Group



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## *Key Communications Markets*

- LAN
- FDDI
- Wireless
- OA: Fax/modem
- Telecom

## *Key Computing Markets*

- OA: Imaging
- Mass storage
- Embedded control
- PC products
- ASIC

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## *What Is National Doing to Address These Issues?*

- Reorganization (June 1991)
- Restructuring (August 1991)
  - Capacity utilization
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    - Increase by lowering breakeven
- Task forces for continuous improvement
  - Establish teams of managers and employees to attack critical business issues
  - Progress monitored by an executive council of top 30 managers led by CEO

\$150M  
charge

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## *Restructuring Action Plan Summary*

### What ?

- \$149.3 million restructuring charge
- NS will consolidate manufacturing
- Two to three year effort

### Why ?

- Breakeven point inconsistent with today's market realities
- Means to break downward cycle
  - Low capacity utilization → Losses →
  - Less investment → Loss of competitiveness

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## *Announced Restructuring Actions to Date*

<u>Action</u>	<u>Completion Date</u>
Closure of Hong Kong board plant	Q2 FY92
Reduction of C&C S.C. manufacturing headcount	Q2 FY92
Reduction of Migdal Haemek headcount	Q2 FY92
Consolidation of S.C. 4" Bipolar fab into S.C. 5" Bipolar fab	Q2 FY92
Closure of Campinas, Brazil, assembly plant	Q3 FY92
Closure of S.C. Discrete fab	Q3 FY92
Consolidation of S.C. 4" LFAST fab into existing UK facility	Q1 FY93
... More actions over next ten quarters	



## *Benefits of Restructuring*

- Manufacturing cost reductions, higher utilization
- Higher gross margin, lower breakeven revenue
- Higher revenue per employee and per square foot



**Increased competitiveness and performance**



**Increase in shareholder value**

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## *What Is National Doing to Address These Issues?*

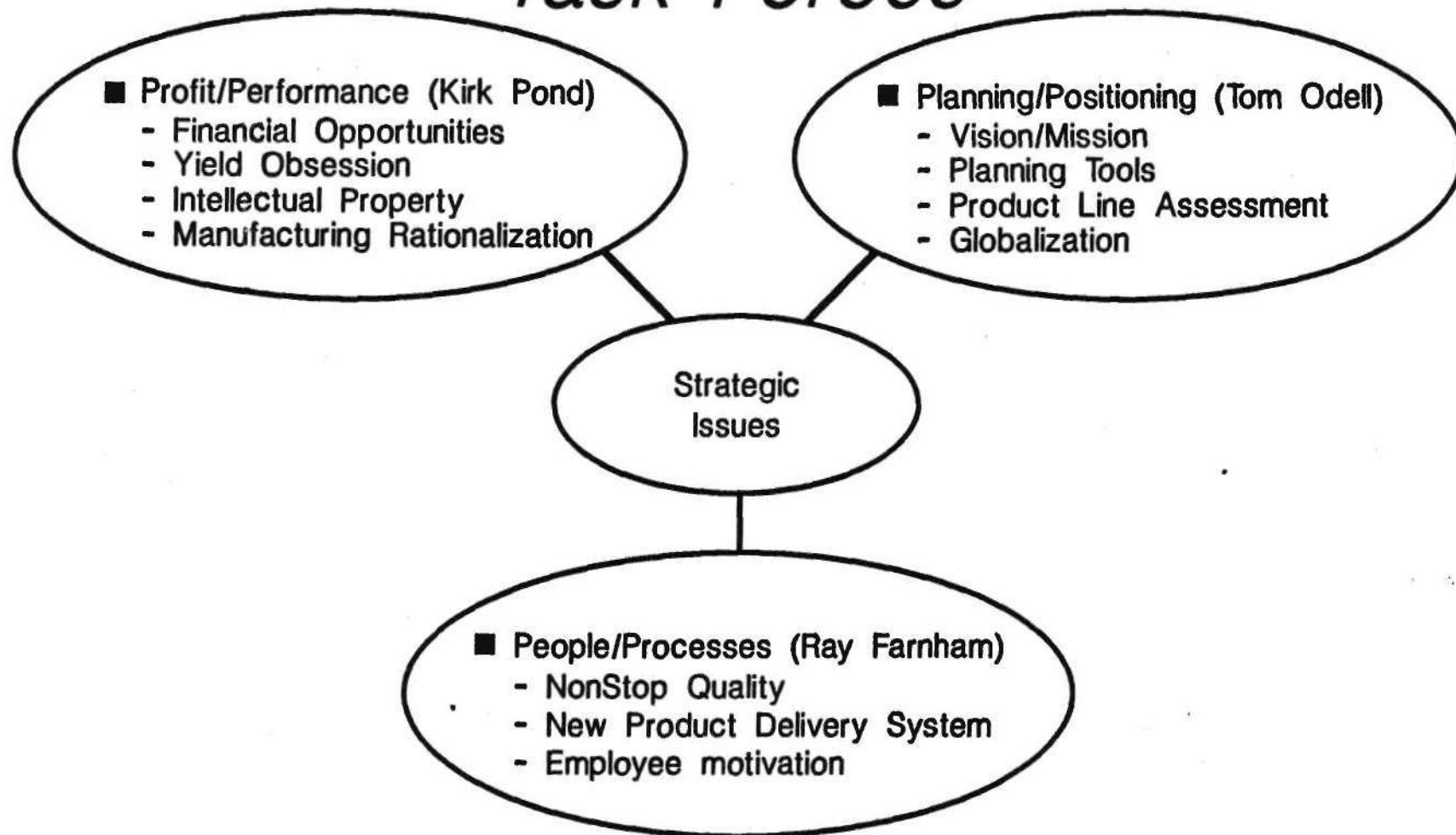
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    - Increase by lowering breakeven
- **Task forces for continuous improvement**
  - Establish teams of managers and employees to attack critical business issues
  - Progress monitored by an executive council of top 30 managers led by CEO

## *Purpose of Executive Workshops*

A forum where Executive Management can:

- Formulate our long-term strategies
- Develop plans for managing the change process
- Build an effective team
- Develop a short list of critical strategic issues, and address those issues NOW

## *Task Forces*



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# *The Future of NSC*

## *A Path to Performance and Profits*

- Focusing management on shareholder value
- Reorganized for today's marketplace
- Restructuring manufacturing capacity
- Change... an on-going process

Dataquest's  
Corporate Technology Program  
Presents:

# Dataquest Day

A Strategic  
Review of  
H i g h  
Technology  
M a r k e t s

*A Special Presentation for National Semiconductor*

*Dataquest  
November 11, 1991*

*Published by Dataquest Incorporated*

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**A Strategic Review of High Technology Markets**

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## Agenda

### DATAQUEST DAY

*A Strategic Review of High Technology Markets*

*A Special Presentation for National Semiconductor Corporation*

*Monday, November 11, 1991*

*National Semiconductor Corporation*

*Santa Clara, California*

- 8:30 a.m.      **Sign-In and Coffee**
- 9:00 a.m.      **Welcome and NSC Review**  
Gil Amelio  
*President and CEO*  
*National Semiconductor Corporation*
- 9:30 a.m.      **Networking**  
Jerry McDowell      Krishna Shankar  
*Principal Analyst/Director*      *Senior Industry Analyst*  
*Dataquest Incorporated*      *Dataquest Incorporated*
- 10:30 a.m.      **Break**
- 10:45 a.m.      **Dataquest's Semiconductor Industry Forecast**  
Gary Grandbois  
*Senior Industry Analyst*  
*Dataquest Incorporated*
- 11:15 a.m.      **Personal Computers**  
Andrew M. Seybold  
*Principal Analyst/Director*  
*Dataquest Incorporated*
- 12:15 p.m.      **Lunch**
- 1:30 p.m.      **Personal and Wireless Communications**  
Steve Sazegari      Krishna Shankar  
*Principal Analyst/Director*      *Senior Industry Analyst*  
*Dataquest Incorporated*      *Dataquest Incorporated*
- 2:15 p.m.      **Break**
- 2:30 p.m.      **Computer Storage**  
Phil Devin      Nick Samaras  
*Principal Analyst/Director*      *Principal Analyst/Director*  
*Dataquest Incorporated*      *Dataquest Incorporated*
- 3:15 p.m.      **Office Automation Markets**  
Richard C. Norton  
*Vice President/Director*  
*Dataquest Incorporated*

*Welcome and  
NSC Review*

**Gil Amelio  
President and CEO  
National Semiconductor  
Corporation**

## **Welcome and NSC Review**

**Notes:**

## Speakers' Biographies

### **Phil Devin**

Mr. Devin is Principal Analyst/Director of Dataquest's Computer Storage industry service. His primary responsibility is analysis of small-diameter rigid disk drives in the computer storage industry. He also handles company analyses, consulting reports, and client projects. Mr. Devin has 27 years of experience in the computer industry, in positions ranging from early process control system design to marketing management in the computer storage industry. He has been an active member of ANSI subcommittees. Mr. Devin received a bachelor's degree in Engineering from Iowa State University.

### **Gary Grandbois**

Mr. Grandbois is a Senior Industry Analyst for Dataquest's Semiconductor Group. His responsibilities include market research and product, market, and industry analysis for analog and mixed-signal products. Mr. Grandbois has extensive experience in the semiconductor industry in both the application engineering and marketing areas. He has held positions as Applications Manager at Siliconix Inc., Product Marketing Manager at Precision Monolithics Inc., and Vice President of Marketing/Sales at Teledyne Semiconductor. Mr. Grandbois received B.S.E.E. and M.S.E.E. degrees from San Jose State University.

### **Jerry McDowell**

Mr. McDowell is a Principal Analyst/Director for Dataquest's Telecommunications industry service. He specializes in the research and management of information systems, their products, and services. Prior to joining Dataquest, Mr. McDowell was Vice President of Communications Consulting and Director of META Education at the META Group. He has consulted for such companies as Gould, IBM, Paradyne, and Wang in computer and voice network technologies and management. He has also consulted and worked with other communication industry experts to evaluate and set new standards for both local and wide area networks. Mr. McDowell holds degrees in Business Management and Electrical Engineering.

### **Richard C. Norton**

Mr. Norton is Vice President of Dataquest's Document Management Group and Director of the Copying and Duplicating industry service. He directs the development of market information and forecasts on photocopiers, printers, facsimile, duplicators, and office consumables. These consumables include paper, toner, developer, and photoreceptors used in copiers and electronic printers. Prior to joining Dataquest, Mr. Norton held a variety of marketing management positions at Savin Corporation including market analysis for the entire copier product line and product management of the supplies business. He also was Manager of Market Planning at Pitney Bowes Incorporated. Mr. Norton received a B.A. degree in Economics from Iona College in New York and an M.B.A. degree from the University of Connecticut.

## Speakers' Biographies

### Nicolas C. Samaras

Mr. Samaras is a Principal Analyst/Director in Dataquest's Semiconductor Group. He is responsible for both analyzing semiconductor consumption in data processing applications and tracking trends in nonvolatile memory products and markets. Previously, Mr. Samaras founded Telamon, a marketing and research firm specializing in the emerging smart card/memory card technology. Prior to that, he was Director of the Microcomputer Division of Catalyst Semiconductor Inc. During his tenure at Catalyst, he was the principal developer of a new serial EEPROM architecture (CAT35C704), which was named best of both 1988 and 1989 by *Electronic Design* magazine. Mr. Samaras received a B.S.E.E. degree from McGill University in Montreal, Canada. Currently, he is pursuing an M.B.A. at the University of Phoenix.

### Steve Sazegari, Ph.D.

Dr. Sazegari is a Principal Analyst/Director in Dataquest's Telecommunications Group. His major areas of responsibility include coverage of ISDN, Signaling System 7, intelligent networks, fiber optics, local loop carriers, public networks, video teleconferencing, wireless communications, enhanced services, packet data switching networks, RBOCs, independent telcos, and long distance carriers. In his more than 20 years of industry experience, Dr. Sazegari has worked for AT&T, Bank of America, Fujitsu America, Pacific Bell, US Sprint Communications Company, and U S WEST. He also headed his own telecommunications consulting business for several years. Dr. Sazegari received a B.S.E.E. degree in Telecommunications and Computers from London University in England, an M.B.A. degree from Golden Gate University in San Francisco, and M.S.E.E. and Ph.D. degrees in Telecommunications and Computers from the Naval Post Graduate School in California.

### Andrew M. Seybold

Mr. Seybold is a Principal Analyst/Director of Computer Technologies for Dataquest. His responsibilities include in-depth analysis, evaluation, forecasting, and research of personal computer hardware and software products. He is also responsible for customized consulting focused on the microcomputer industry. With more than 21 years of experience in the computer and communications industries, he has authored many articles on microcomputers and a number of books about computers and communication. His particular areas of expertise include systems planning, implementation and applications, and software development and evaluation. He is considered an authority on laptop productivity and the portable personal computer market and was the cofounder of The Computer School in Los Angeles. Mr. Seybold received a B.S. degree in Electrical Engineering from Northwestern University.

### Krishna Shankar

Mr. Shankar is a Senior Industry Analyst in Dataquest's Semiconductor Manufacturing and Applications Group. His responsibilities include market research and consulting in the areas of semiconductor manufacturing equipment, process technology trends, and semiconductor device applications in end-use electronic systems. Prior to joining Dataquest, Mr. Shankar was a Senior Process Engineer at Cirrus Logic, where he was responsible for foundry program management and evaluation of advanced CMOS foundry processes. Previously, he worked at Advanced Micro Devices in the areas of CMOS process development, device characterization, multilevel interconnect processes, and technology transfer of new processes from development fabs to production fabs.

Mr. Shankar holds a B.S. degree in Chemical Engineering from the Indian Institute of Technology, an M.S. degree in Chemical Engineering from the University of Southern California, and an M.S. degree in Management from Stanford University.

**Welcome and  
NSC Review**

**Notes:**

*Networking*

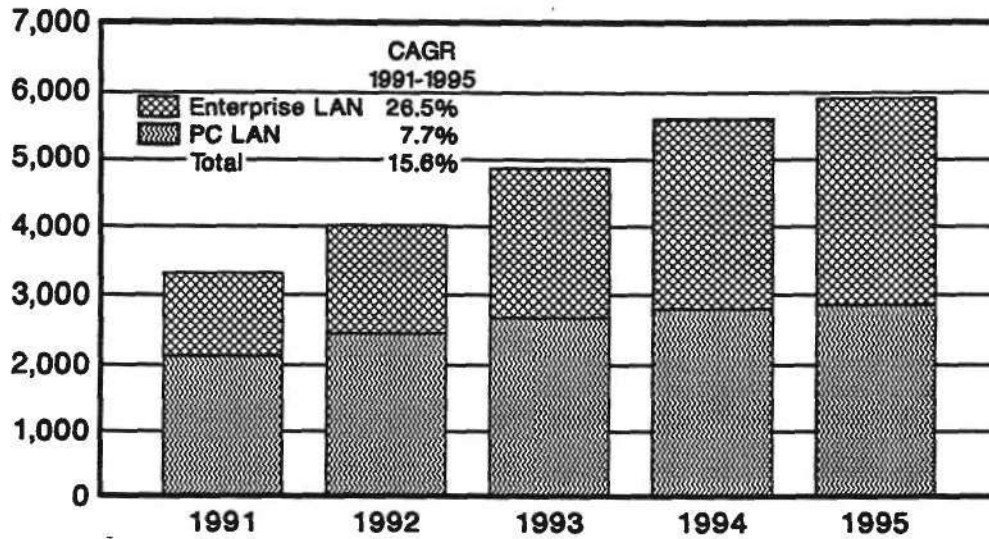
**Jerry McDowell**  
**Principal Analyst/Director**  
**Dataquest Incorporated**

**Krishna Shankar**  
**Senior Industry Analyst**  
**Dataquest Incorporated**

## Networking

### TOTAL LAN REVENUE MARKET GROWTH

Millions of Dollars

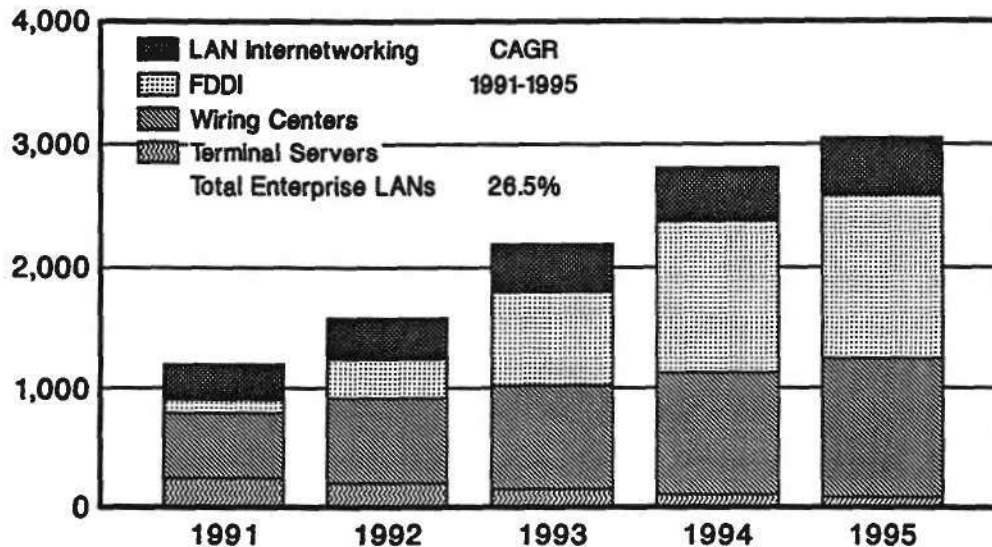


Source: Dataquest

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### ENTERPRISE LAN REVENUE FORECAST

Millions of Dollars



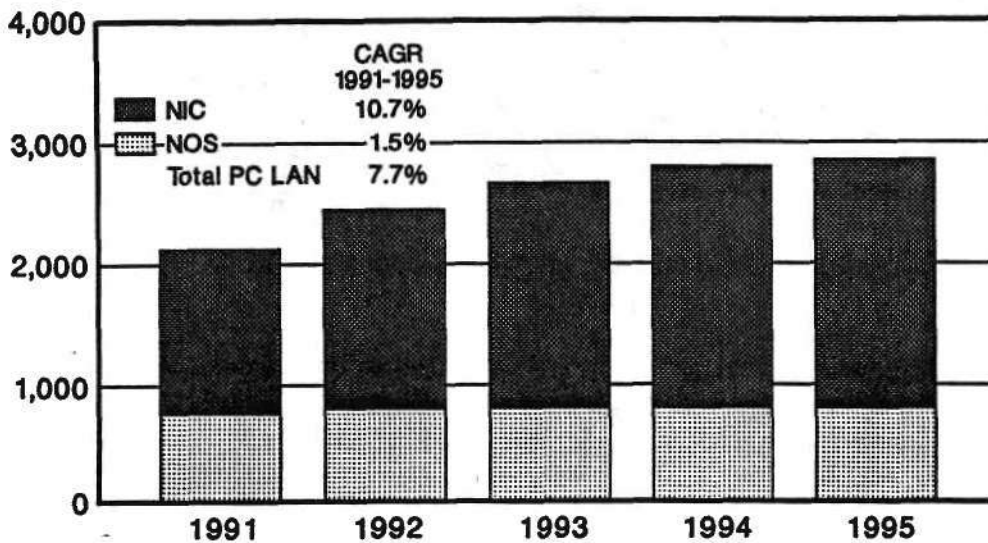
Source: Dataquest

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## PC LAN REVENUE FORECAST

Millions of Dollars



Source: Dataquest

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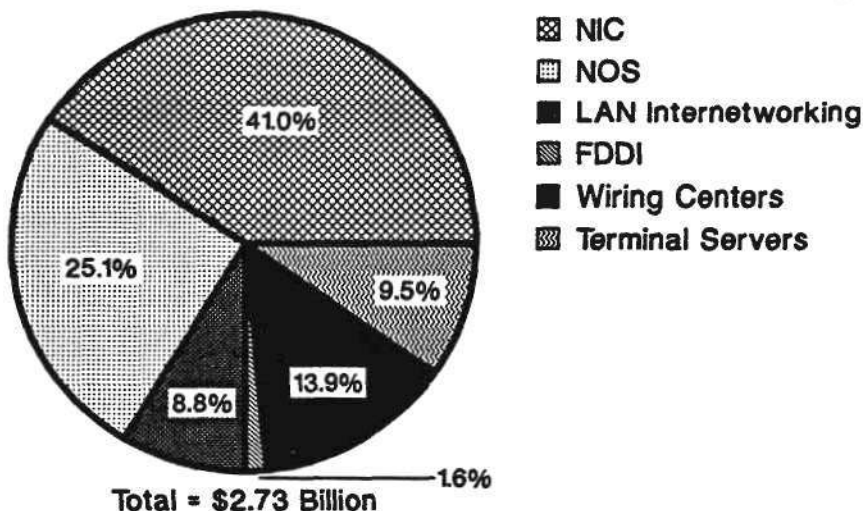
Notes:

\$150 / node

FDDI → coming

15m / Symposium TR - UTP

## ESTIMATED 1990 U.S. LAN MARKET



Note: Percentages may not add to 100 percent because of rounding.

Source: Dataquest

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## ESTIMATED U.S. 1990 ETHERNET MARKET

### Network Interface Cards

Company	Market Share (%)
1. 3Com	29.2
2. Western Digital	19.2
3. Anthem Electronics	11.4
4. Racal-Interlan	5.7
5. Digital Equipment Corporation	4.3
6. Gateway Communications	3.3
7. Tiara	3.0
8. Ungermann-Bass	2.6
9. AT&T	2.6
10. Cabletron	2.4
Others	16.3
Total Shipments =	1.8 Million Units

Source: Dataquest

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**ESTIMATED U.S. 1990 TOKEN-RING MARKET**

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**Network Interface Cards**

<u>Company</u>	<u>Market Share (%)</u>
1. IBM	76.8
2. Proteon	7.7
3. 3Com	2.9
4. NCR	2.8
5. Racore Computer	2.5
6. Western Digital	2.2
7. Madge	0.8
8. Ungermann-Bass	0.2
9. Tiara	0.1
Others	4.0
<b>Total Shipments =</b>	<b>831,926 Units</b>

Source: Dataquest

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Notes:

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## NETWORK INTERFACE CARDS

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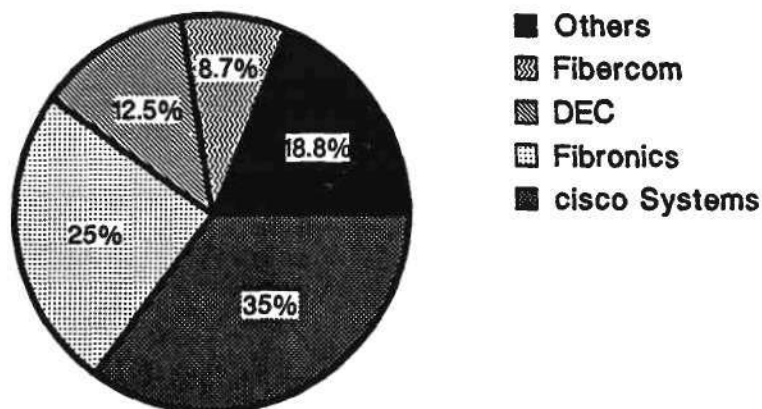
### Items of Interest

- Average sales prices were down 25 percent for Ethernet boards
- In Ethernet, coax boards dominate shipments (67.8 percent); twisted pair is second (29.2 percent); fiber optic is last (2.1%)
- In token-ring, shielded twisted pair dominates (80.7 percent); unshielded twisted pair is next (17.4 percent); followed by fiber (1.5 percent) and coax (0.4 percent)
- Token-ring shipments did not meet expectations, due to jitter problems with Texas Instruments FALCON chip

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## ESTIMATED U.S. 1990 FDDI MARKET

### Internetworking Units



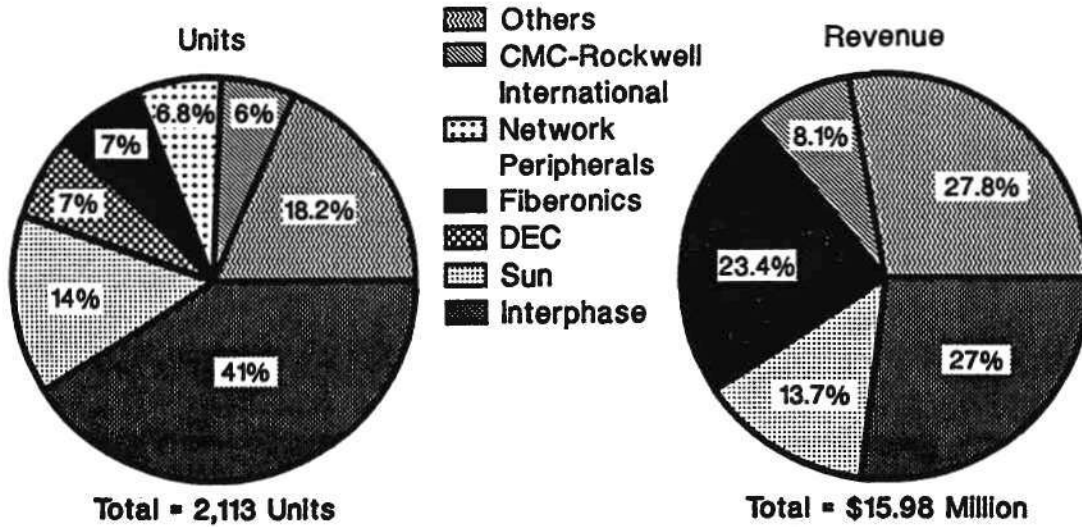
Total = 1.197 Units

Note: The "Others" category includes sales by AT&T, Fibermux, Network Systems Corporation, Proteon, Raycom, Timeplex, Ungermann-Bass, and Wellfleet (excluding units sold by the OEM, Cisco Systems).

Source: Dataquest

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## ESTIMATED U.S. 1990 FDDI NIC MARKET

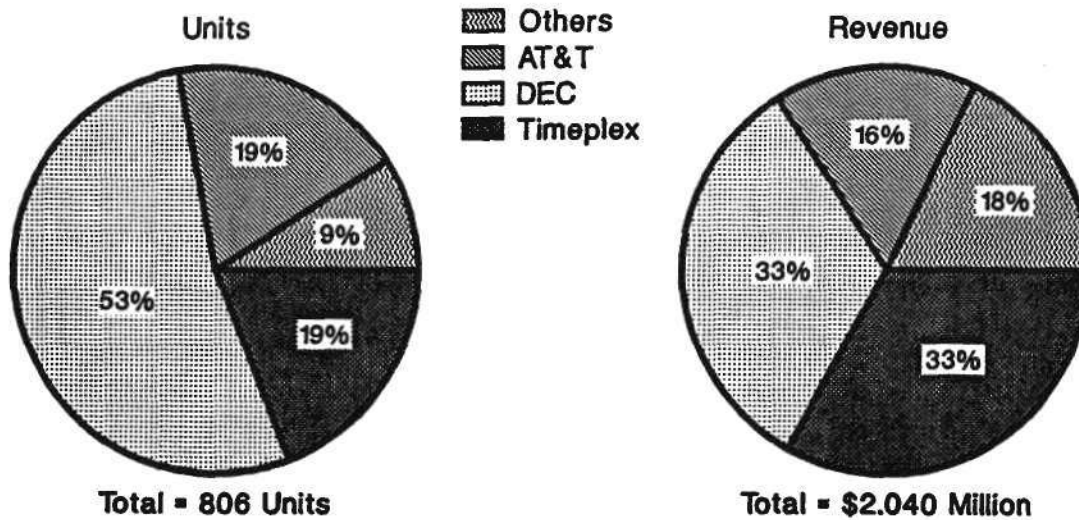


Source: Dataquest

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Notes:

## ESTIMATED U.S. 1990 FDDI CONCENTRATOR PORTS



Source: Dataquest

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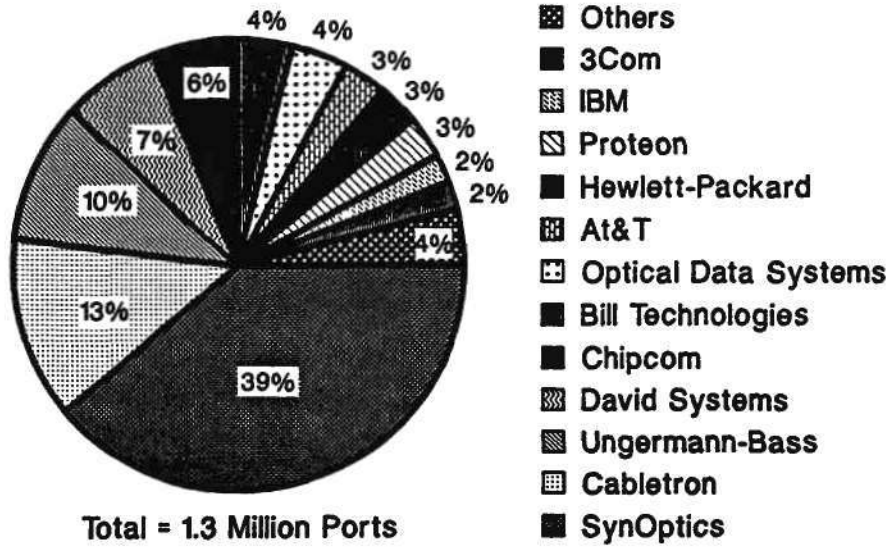
## FDDI TRENDS

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- Connectivity for workstations will dominate FDDI network interface card market
- By 1995, 50 percent of all workstations will ship with a FDDI connection

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## ESTIMATED U.S. 1990 WIRING CENTER MARKET



Source: Dataquest

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Notes:

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## **WIRING CENTER TRENDS**

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- UTP will be used not only for Ethernet, but also increasingly for token-ring and FDDI
- Per-port costs will fall due to more efficient manufacturing and price wars in the low-end market
- Vendors will compete in one of two market areas
  - Price
  - Overall value (service, quality, features)
- Chips will gain in importance
  - More features/functions
  - Allow hub to be less bulky

10929.07 A

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## **WIRING CENTER TRENDS (continued)**

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- Wiring centers provide platforms for network management
- Vendors can put more features on a chip and on a module, including network management and bridging
- High-end vendors will increase the speed and bandwidth of the concentrator backplane
- High-end vendors will move toward more wide area and metropolitan area networking capabilities

10929.08 A



## UNSHIELDED TWISTED PAIR (UTP)

- Existing products
- 10 base T standard
- Product directions
  - Token ring
  - Multimedia
  - Network management
  - Multiprotocol support

Notes:

## LAN INTERCONNECTION TRENDS

- 1

2

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## Deck and network

- Market driven by high-performance applications

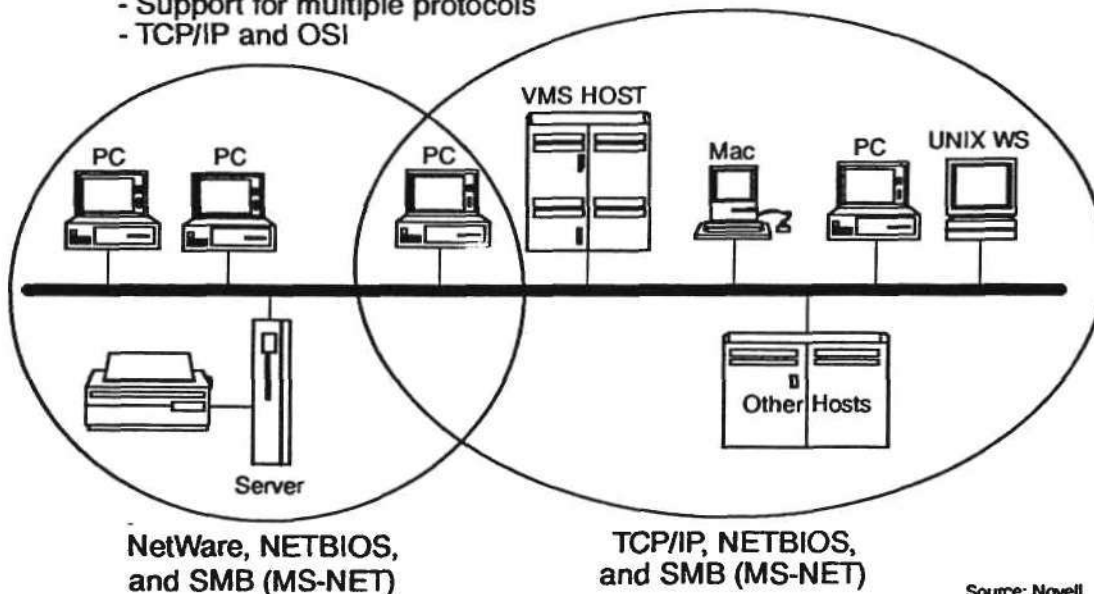
## WAN TECHNOLOGY

- Boundary between LAN and WAN blurring
  - LAN interconnect
  - Wiring closet evolution
- Transport technology evolution
  - Many choices in backbone network equipment (T-1 mux, packet switch, modem, VSAT)
  - Transmission alternatives = savings and confusion (T-1, DDS, FT-1, T-3, FT-3)
  - Battle of the latest buzzwords

Notes:

## TECHNICAL ISSUES AND TRENDS

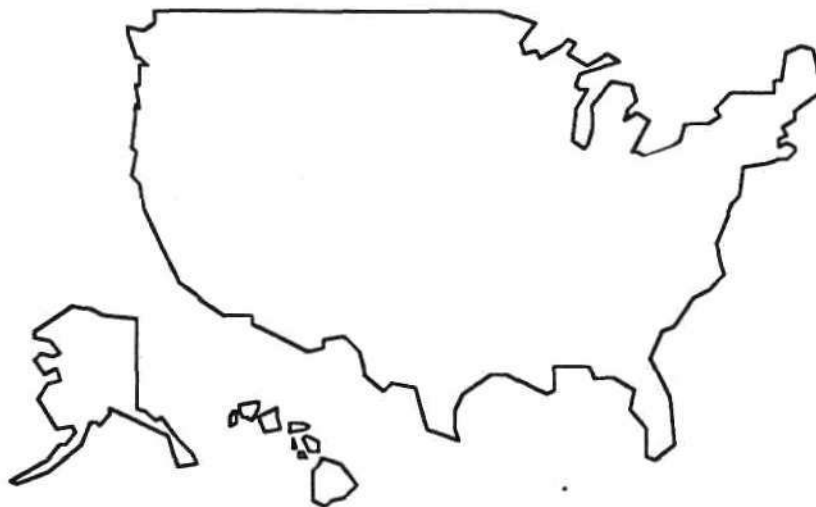
- Heterogeneous networking
- Support for multiple protocols
  - TCP/IP and OSI



Source: Novell

## ISDN IN THE UNITED STATES

### Current Status



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## HAS ISDN LIVED UP TO ITS BILLING?

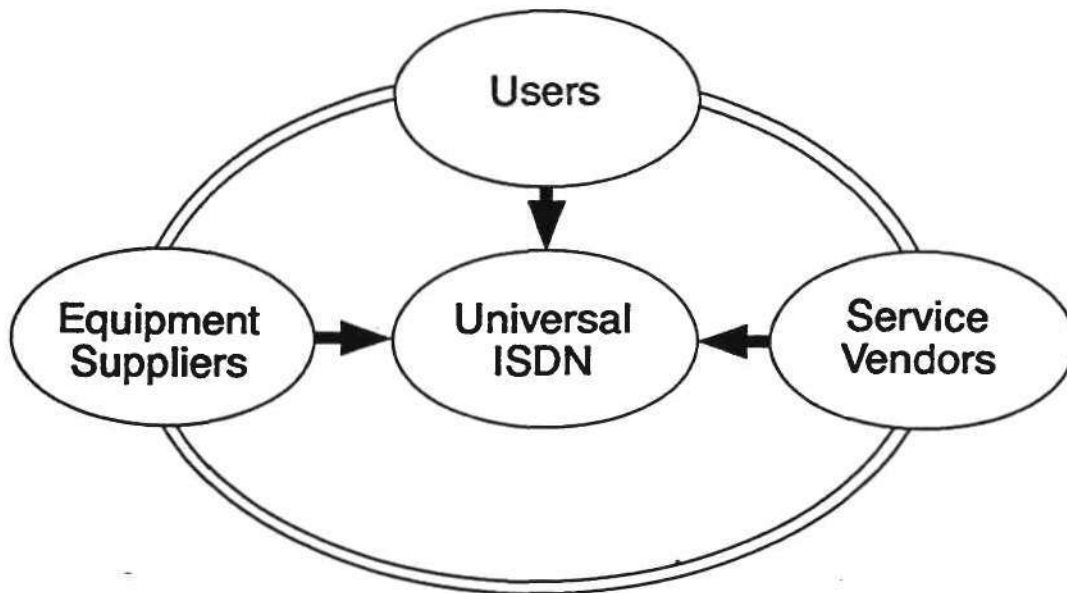
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The perception of ISDN has been tarnished by excessive hype; expectations are not being met

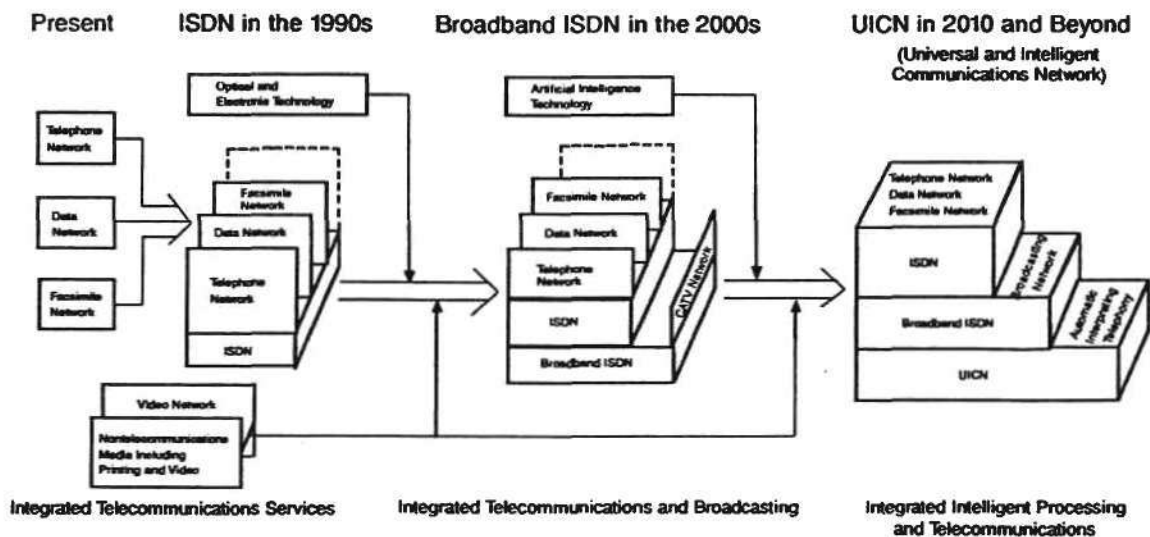
- Availability of service
- Service capabilities
- Time frame of introduction

Notes:

## ISDN DILEMMA



## THE DEVELOPMENT OF TELECOMMUNICATIONS TECHNOLOGY



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## NATIONAL ISDN-1 PLAN

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- Will provide a national ubiquitous system
- Driven by Corporation for Open Systems (COS)
- Four participating groups
- Implementation from 1989 to 1992

Notes:

\_\_\_\_\_

- \_\_\_\_\_

\_\_\_\_\_



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**1990 ESTIMATED NUMBER OF LINES VS. MARKET  
SHARE OF ISDN BRI LINES IN SERVICE**

---

<u>Telephone Companies</u>	<u>Number of Lines (K)</u>	<u>Market Share (%)</u>
Ameritech	20.2	26.4
Southwestern Bell	14.5	19.0
Bell Atlantic	10.1	13.2
NYNEX	5.3	6.9
BellSouth	2.1	2.8
U S WEST	2.0	2.6
Pacific Bell	1.7	2.2
Other Telephone Companies	0.6	0.8
Private Networks	19.9	26.1
Total	76.4	100.0

Source: Dataquest

Notes:

---

## **ISDN -- THE CATALYST**

---

- Network digitization
- SS7 implementation
- Intelligent network
- Extended super frame
- Frame relay
- U interface/DAML
- HDSL based on 2B1Q
- Switched data service – DS0, H0, H11

## Networking

Notes:

*Networking*

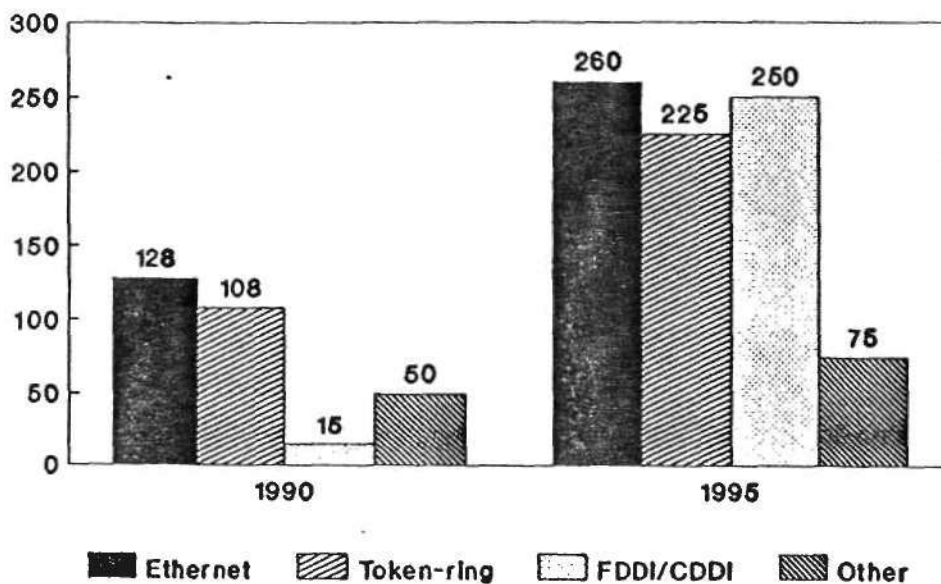
**Jerry McDowell**  
**Principal Analyst/Director**  
**Dataquest Incorporated**

**Krishna Shankar**  
**Senior Industry Analyst**  
**Dataquest Incorporated**

## LAN CHIPSET MARKET

- EMERGENCE OF LAN ASSP CHIPSET MARKET
- ETHERNET, TOKEN-RING, FDDI STANDARDS ESTABLISHED
- HIGHLY-INTEGRATED SOLUTIONS
- SHRINK-WRAPPED HARDWARE + SOFTWARE SOLUTIONS
- PC/WORKSTATION CONNECTIVITY DRIVES MARKET
- TARGET PC/WORKSTATION COMPANIES FOR DESIGN WINS
- STRATEGIC PARTNERSHIPS WILL BE CRUCIAL

### WORLDWIDE LAN CHIPSET MARKET (MILLIONS OF DOLLARS)



Source: Dataquest/November 1991

## LAN CHIPSET APPLICATIONS DISTINCT MARKET SEGMENTS

### LOW-END

- DESKTOP PCS
- PORTABLE PCS
- ENTRY-LEVEL  
WORKSTATIONS

### MID-RANGE

- MID-RANGE  
WORKSTATIONS
- LOCAL HUBS
- DISKLESS  
WORKSTATIONS

### HIGH-END

- INTELLIGENT HUBS
- BRIDGES
- ROUTERS
- SERVERS
- HIGH-END  
WORKSTATIONS

Notes:

## **LOW-END LAN CHIPSET MARKET HIGH-VOLUME ETHERNET LANS**

### **LAN CONTROLLER CHIP**

- CSMA/CD PROTOCOL CORE**
- 8-BIT/16-BIT DATA BUS**
- 10BASE-T INTERFACE**
- 16Mb/s to 20Mb/s serial rates**
- INTERNAL FIFO**
- AUTOMATIC RE-TRANSMISSION**

### **SERIAL TRANSCEIVER CHIP**

- DEDICATED AUI & 10BASE-T PORTS**
- LOW POWER MODES**
- DIAGNOSTIC LOOPBACK**
- ON-CHIP CLOCK RECOVERY**
- DIRECT CONTROLLER INTERFACE**
- LOW POWER 5V CMOS**

## **ETHERNET LAN CHIPSET TRENDS**

- 10BASE-T (UTP) ETHERNET IS HIGH GROWTH MARKET**
- HIGHLY INTEGRATED CHIPSET SOLUTIONS APPEARING**
- MIGRATION TO MOTHERBOARD**

- 

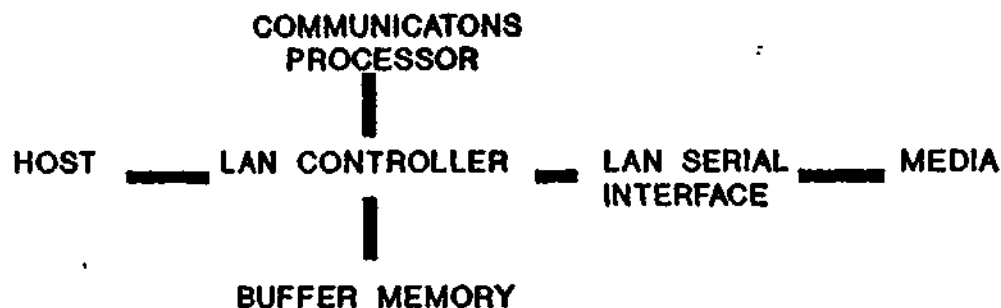
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## **HIGH-END LAN CHIPSET MARKET VALUE-ADDED CUSTOMIZATION**

- **NETWORK MANAGEMENT FEATURES**
- **SOFTWARE PROGRAMMABILITY**
  - PROTOCOL TYPE
  - SPEEDS
  - ADDRESS LOCATIONS
  - POWER DOWN MODE
  - REMOTE BOOTING
- **SHRINK-WRAPPED LAN SOLUTION**
  - CHIPSET
  - SOFTWARE DRIVERS
  - CUSTOMIZING SOFTWARE DEVELOPMENT KIT
  - SUPPORT FOR POPULAR NOS STANDARDS

## **LAN CHIPSET IMPLEMENTATION**



## **LAN CONTROLLER BLOCK TYPICAL FEATURES**

- **SUPPORT FOR FULL DUPLEX OPERATION**
- **BUFFER MEMORY MANAGEMENT**
- **NETWORK MANAGEMENT CONTROL**
- **REMOTE BOOT-UP SUPPORT**
- **DIRECT HOST BUS INTERFACE**
- **DIRECT HOST MEMORY ACCESS**
- **EXTERNAL ADDRESS FILTER CAPABILITY**
- **TRANSMIT BLAST MODE OPERATION**

**Notes:**

## **LAN SERIAL INTERFACE BLOCK TYPICAL FEATURES**

- **BUILT-IN 10BASE-T TRANSCEIVER**
- **TTL/CMOS INTERFACE**
- **SINGLE 5V SUPPLY, LOW POWER CMOS**
- **POWER DOWN MODE**
- **PROGRAMMABLE PROTOCOL SELECTION**
- **ON-CHIP PLL FOR DATA/CLOCK RECOVERY**
- **LOOPBACK SELF-DIAGNOSTICS CAPABILITY**

## **CONCLUSIONS**

- **EMERGENCE OF HIGH-VOLUME LAN ASSP CHIPSET MARKET**
- **ETHERNET, TOKEN-RING LANS BASED ON STP & UTP COMMON**
- **LOW, MID-RANGE, HIGH-END LAN CHIPSET MARKET**
- **FDDI/CDDI CHIPSET MARKET WILL GROW DRAMATICALLY**
- **TARGET PC, WORKSTATION, SERVER COMPANIES  
FOR HIGH-VOLUME DESIGN WINS**
- **STRATEGIC OEM PARTNERSHIPS ARE ESSENTIAL**

## Networking

Notes:

*Dataquest's Semiconductor  
Industry Forecast*

**Gary Grandbois  
Senior Industry Analyst  
Dataquest Incorporated**

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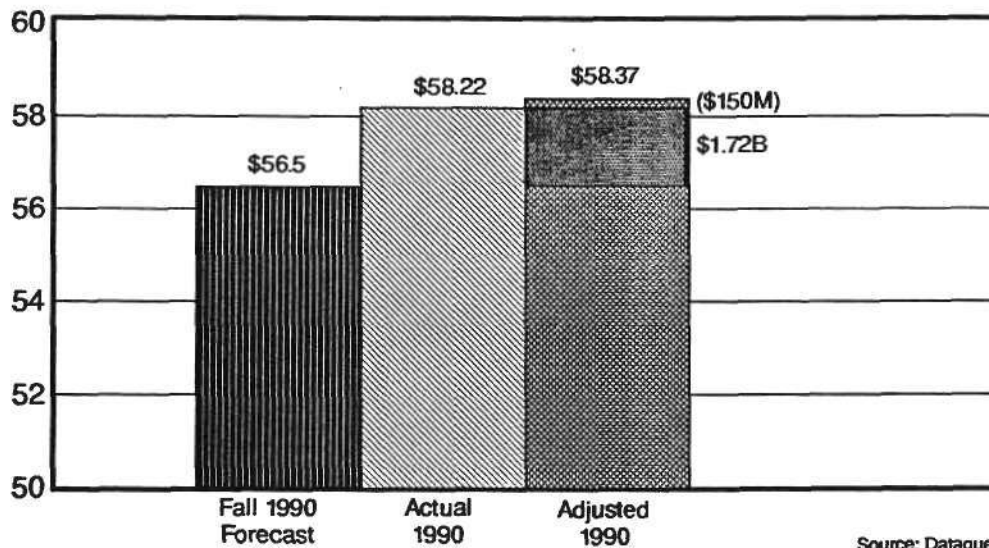
## AGENDA

---

- The semiconductor forecast
- Review of recent booking/billing trends
- Product overview
- End use and applications
- Summary

## 1990 SCORECARD

Billions of Dollars



# Dataquest's Semiconductor Industry Forecast

0074005.DAQ 002001.BAN

## 1991 FORECAST SCORECARD

1991

Spring 1991	13.7%
Fall 1991	9.3%

$\Delta$  = Exchange Rates

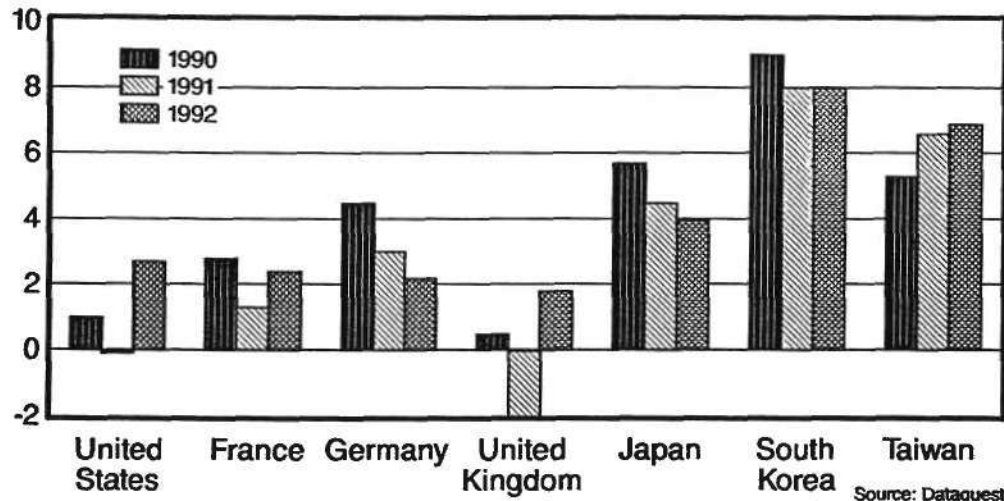
Source: Dataquest

Notes:

## ECONOMIC OUTLOOK

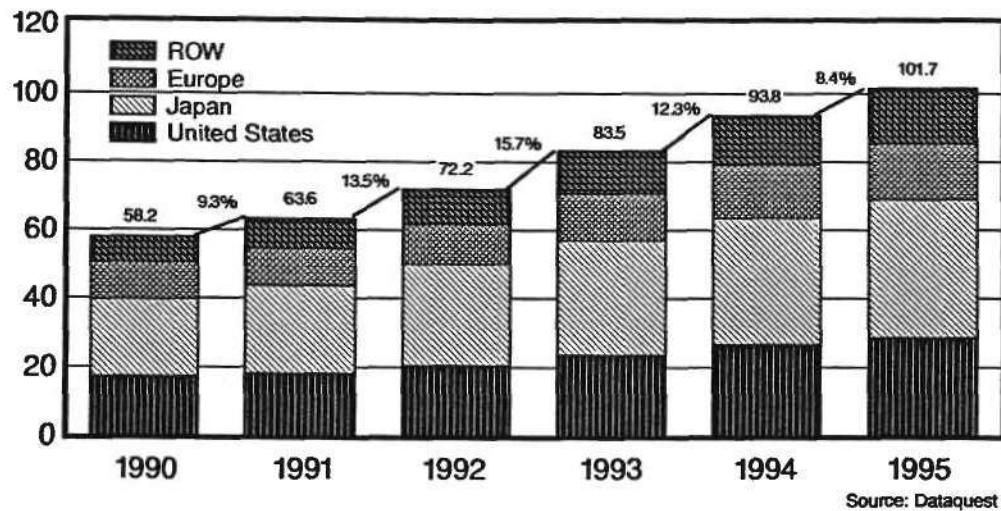
Real GNP/GDP Growth, Local Currencies

Annual Growth (%)



## WORLDWIDE SEMICONDUCTOR CONSUMPTION FORECAST

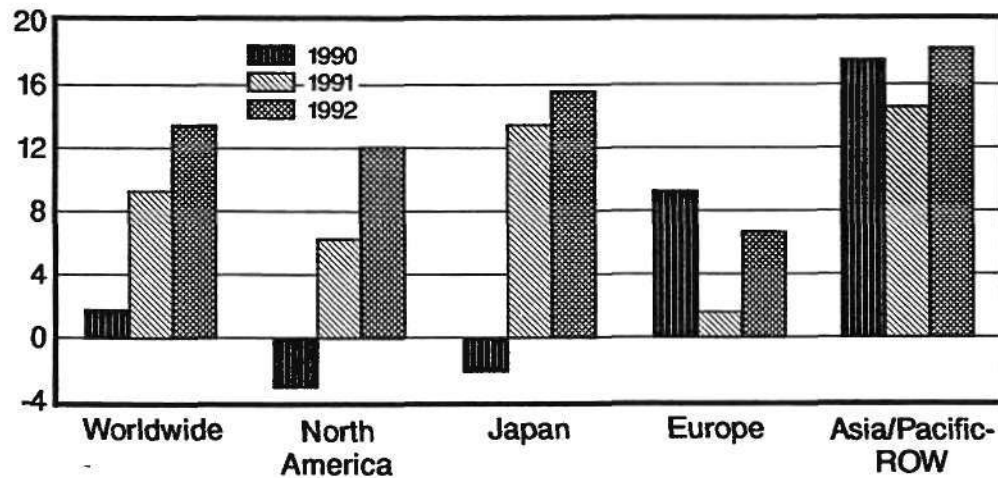
Billions of Dollars





## **WORLDWIDE SEMICONDUCTOR REVENUE GROWTH FORECAST BY REGION**

Dollar Growth



Source: Dataquest

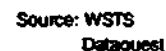
Notes:

### Monthly Growth Comparison

Source: WSTS  
Dataquest

**RESEARCHER: DR. GUYAN CHA**

### Percentage Billings Growth

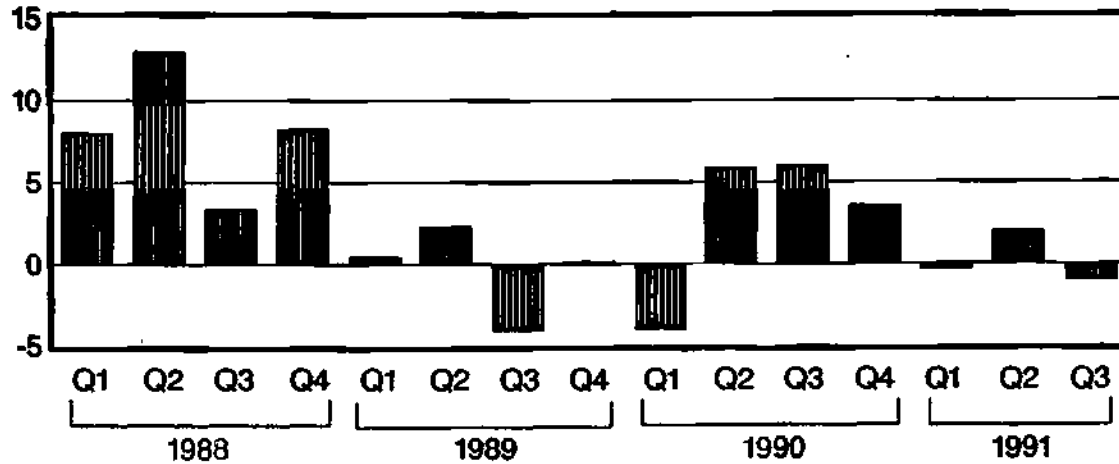


8-20000-000 10/24/91-GFA

## IC BILLINGS

Growth by Quarter

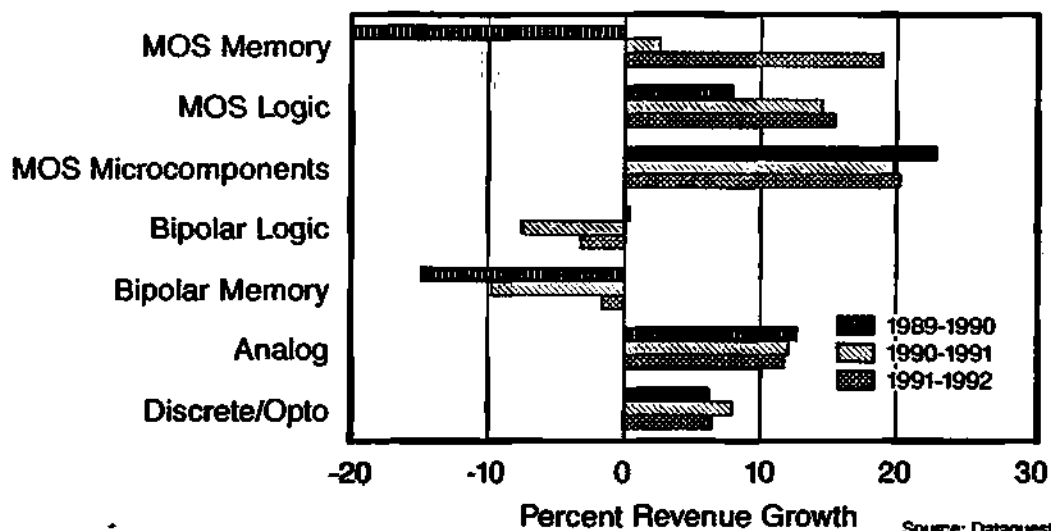
Percentage Growth



Source: WSTS  
Dataquest

Notes:

## SEMICONDUCTOR PRODUCT GROWTH FORECAST



### MOS MEMORY

- Price erosion continues
- Lackluster DRAM bit growth
- Fast SRAM becoming a commodity

---

## LOGIC

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- Growth drivers
  - DP (workstations and notebooks)
  - Telecom
- ASIC densities increasing dramatically
- CMOS/BiCMOS replacing bipolar
- CPLD rapid growth continuing

Notes:

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## **MICROCOMPONENTS**

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- Microcontroller growth very strong
  - Driven by consumer and telecom in Europe and Japan
- Microprocessor and microperipheral markets weak
  - Attributable to soft PC demand

---

## **ANALOG**

---

- Strong consumer market
  - Application-specific linear ICs
- Mixed signal growth = 20%
  - Driven by communications and EDP
- Functional block growth declining  
(Amplifiers, comparators, etc.)

Source: Dataquest

---

## IC GROWTH COMPARISON

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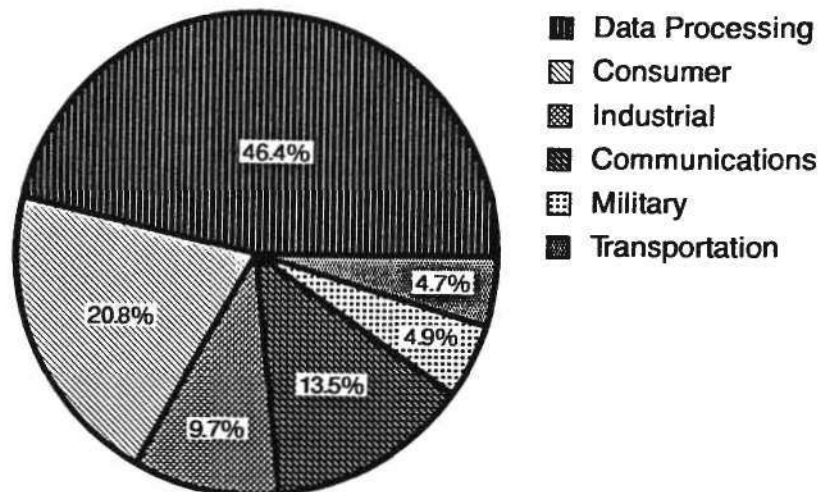
1985-1990 CAGR

	<u>Revenue</u>	<u>Unit</u>
Digital ICs	17.6%	12.0%
Linear ICs	9.2%	12.6%
Mixed-Signal	22.6%	21.3%

Source: Dataquest

Notes:

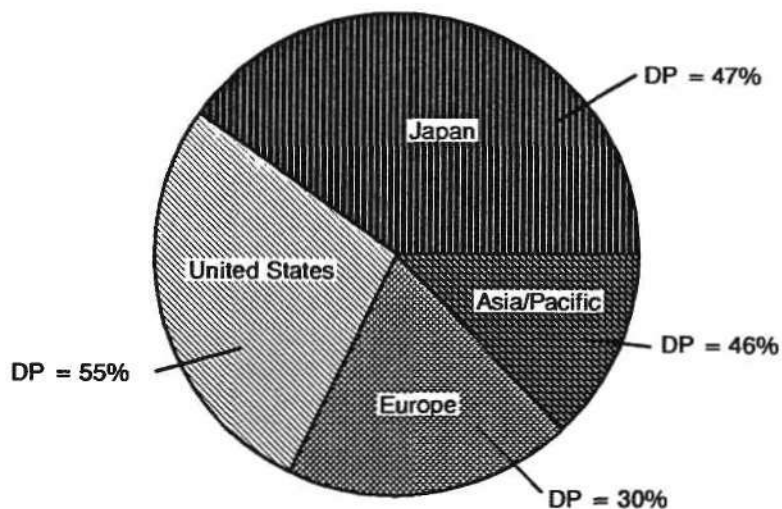
## WORLDWIDE SEMICONDUCTOR CONSUMPTION BY APPLICATION



1991 = \$63.6 Billion

Source: Dataquest

## WORLDWIDE SEMICONDUCTOR CONSUMPTION BY REGION



Total = \$63.6 Billion

Source: Dataquest



**Notes:**

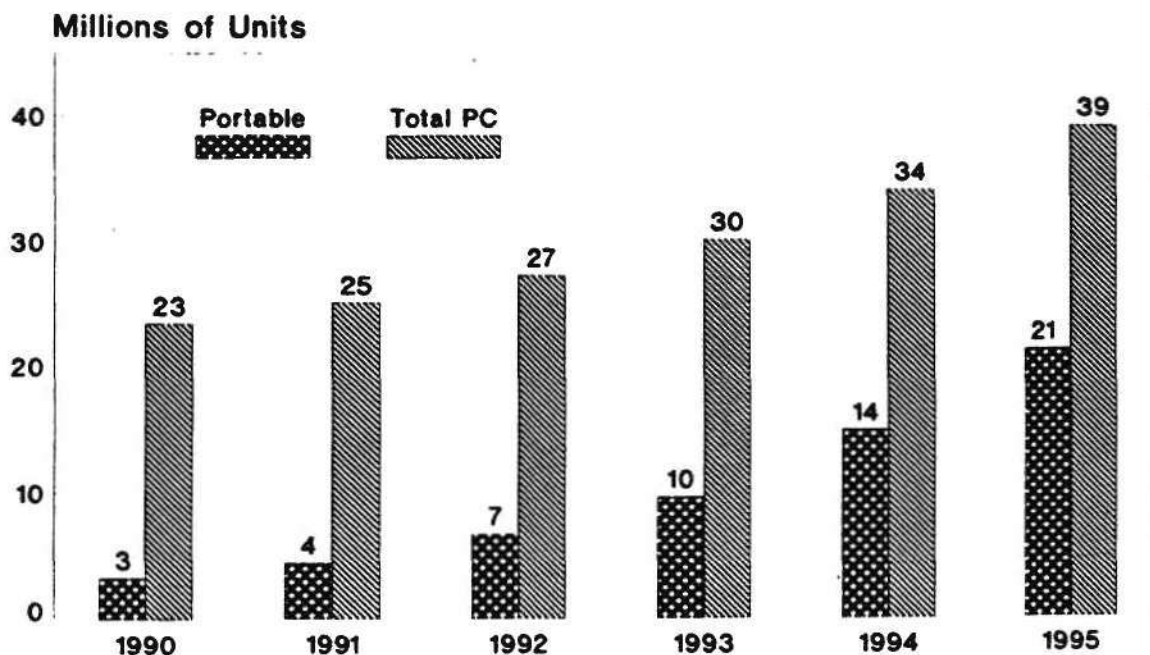
*Personal Computers*

**Andrew M. Seybold  
Principal Analyst/Director  
Dataquest Incorporated**

## AGENDA

- Portable issues for the 1990s
- Worldwide market projections
- Notebook PC issues
- A look ahead to 1996

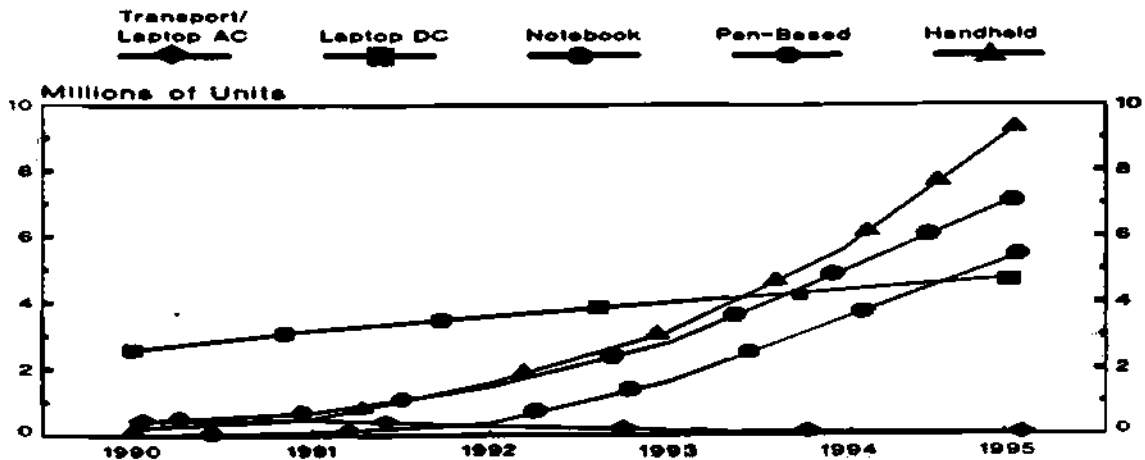
### PROJECTED PORTABLE PC GROWTH AS A FUNCTION OF TOTAL WORLDWIDE PCs



Source: Dataquest

## PORTABLE SYSTEMS MARKET PROJECTIONS WORLDWIDE MARKET

- No compromise in:
  - Size, weight, transportability
  - Memory and storage capacity
  - battery life and ruggedness
- End-user requirements
  - Demand increase performance
  - MS-DOS and Windows compatibility
  - Expandable with communications



Source: Dataquest

Notes:

*Phoenix - board design on tape*

---

## **WHAT'S HOT**

---

- **Portable computing**
  - Notebooks
  - Hand-held systems
  - Pen-based systems
  - Communications
- **High-end computing**
  - Local area networks and servers
  - High-performance systems
  - PC crossover into workstations area

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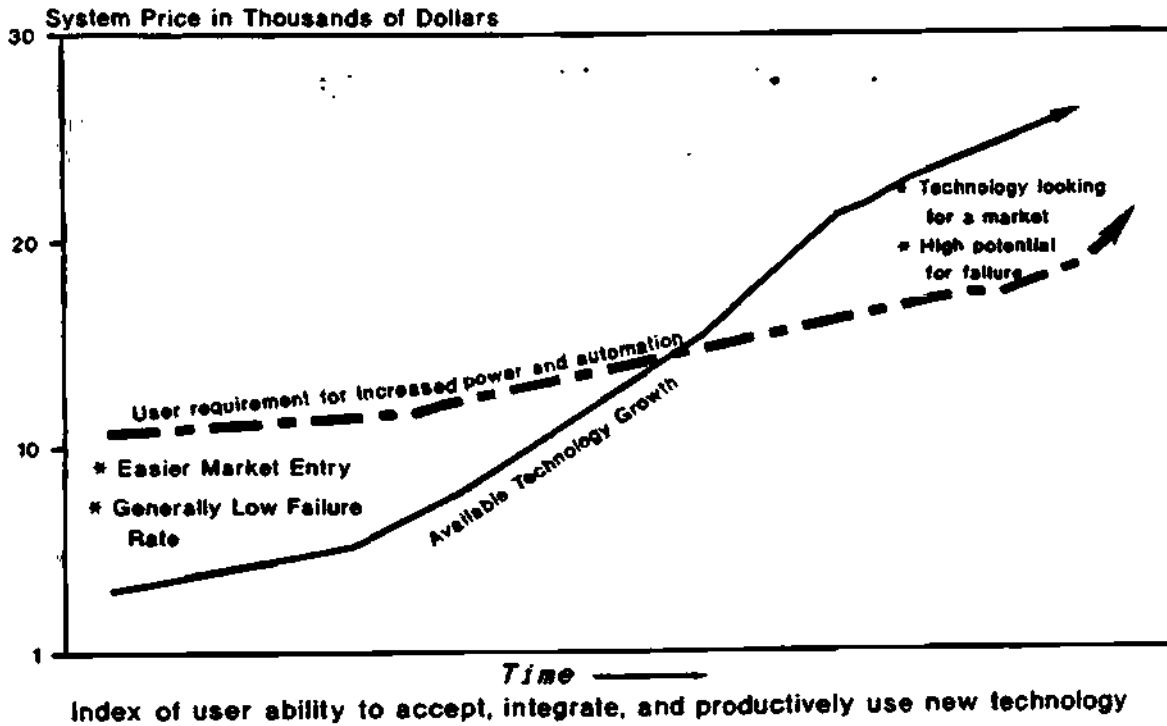
## **WHAT'S HOT**

---

- **High-end computing**
  - Add-in and add-on devices
  - Home computing
  - Multimedia
- **Communications**
  - Marriage of computing to transmission methods
  - Cellular phones, wireless LANs, worldwide access

## TECHNOLOGY VS. APPLICATION

When is enough too much?



Source: Dataquest

Notes:

---

## **NOTEBOOK ISSUES**

---

- A look ahead to 1996
  - Storage
    - CD technologies
    - Chip based
    - Card based
    - Hard disk based

---

## **NOTEBOOK ISSUES**

---

- A look ahead to 1996
  - Applications
    - Fully interactive with desktops
    - Optimized for portables
    - Notebooks become the companion PC
  - Storage requirements
    - Increased due to graphics, but decreased due to datacomm

---

## NOTEBOOK ISSUES

---

- Communications
  - Wireless
    - Licensed vs. unlicensed
    - Frequency coordination
    - 902 to 928 MHz spectrum issues
  - Cellular
    - Systems today
    - Future satellite use
    - Specialized wireless service providers

Notes:



---

## NOTEBOOK ISSUES

---

- A look ahead to 1996
  - Costs
    - Average selling price: \$2,500 includes:
      - Fully integrated PC and communications
      - Battery life: about 12 hours
      - Weight: 2 to 3 lbs
      - Pen or key entry
      - Full color
      - Fulltime use

---

---

***Portable Design Trends  
More Power & Less Weight***

---

---

August 20

# PC Week

1990

**PC Buyers want  
more power, and better screens**

" As the market moves to Windows<sup>TM</sup> software, 386... (architecture) will be very important - but not at the expense of size. The machines should not get any heavier than they are now."

Notes:

## MAJOR CUSTOMER BUYING CONCERNS

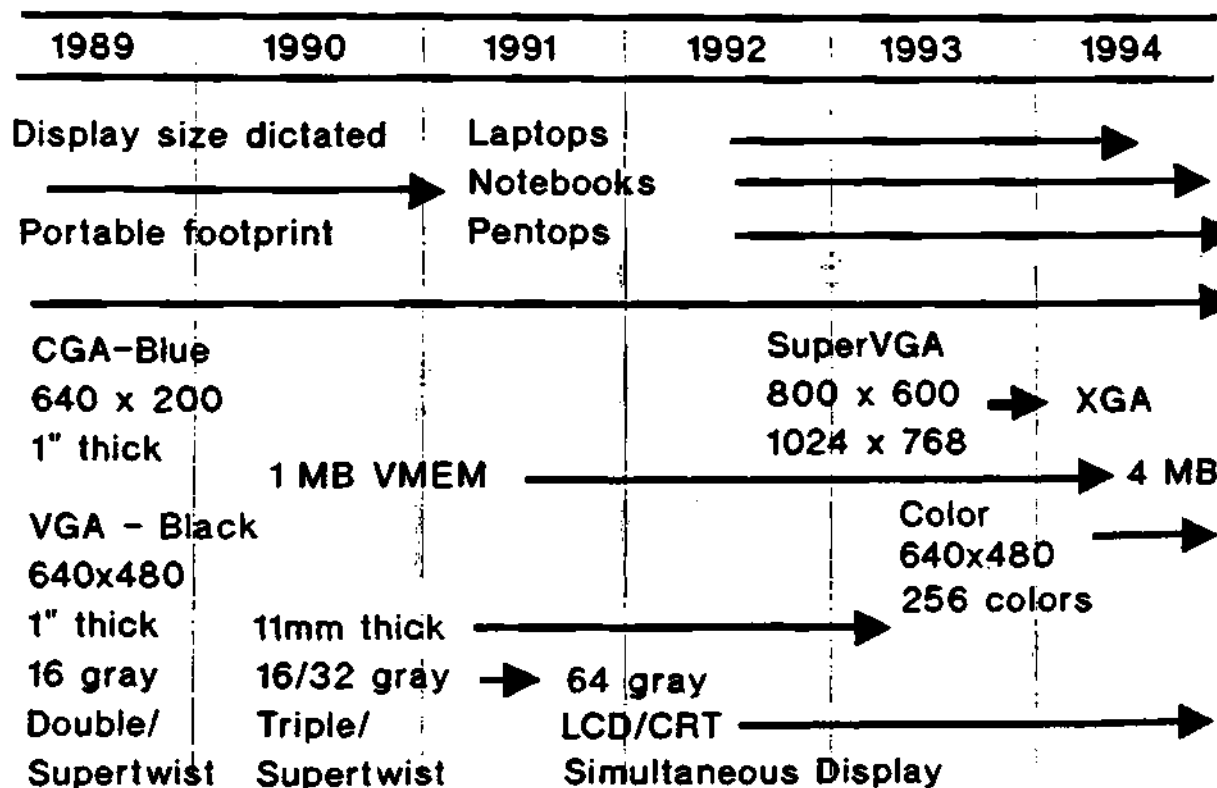
Extracted from PCWEEK Survey of Low-Cost,  
lightweight 386SX notebook users

April 1, 1991

### Priority Buying Concern

- 1 Quality and readability of display
- 2 Size, weight, transportability
- 3 Quality of construction, ruggedness
- 4 Quality of keyboard
- 5 System performance
- 6 Battery life and recharge time
- 7 Disk performance
- 8 Convenience of accessories
- 9 Expandability
- 10 Quality of documentation

### DISPLAY TRENDS



---

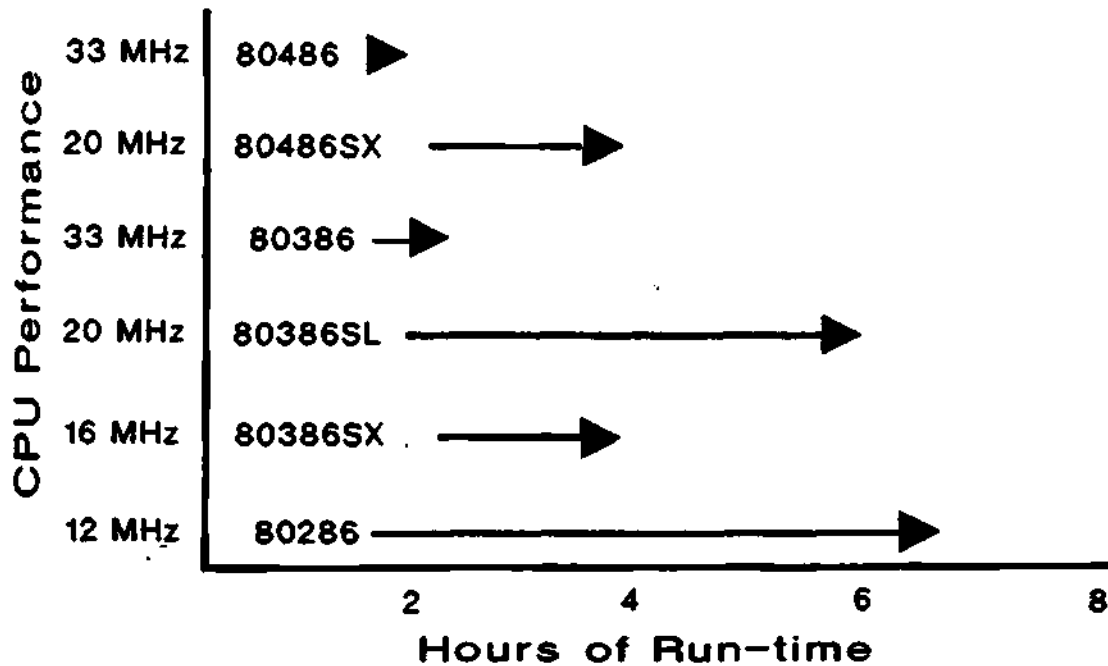
## DISPLAY TRENDS

---

- Color technology will follow B/W trends for portables
- CGA was common in 1989/1990
- VGA was common in late 1990 and 1991
- High quality VGA is appearing on larger footprint laptops
- Lower quality (duty cycle) color panels will be the initial offerings for Notebooks and Pentops

Notes:

## NOTEBOOK TRENDS BATTERY LIFE 1991



## DESIGN EVOLUTION

### Portable Products

Features	Portables	Laptops	Notebooks
Size	Big and heavy 28 - 32 Pounds	Cumbersome 12 - 18 Pounds	Sleek and light 4 - 7 Pounds
Processor	→ 80286-80486	→ 80386SX	→ 80386SL
Memory	→ 8MB	→ 16MB	→ 16MB
Storage	→ 120MB	→ 120MB+	→ 60 - 180MB
Display	Mono and Color	Mono and Color	Mono and Color
Power	AC	Battery / AC	Battery / AC

## NOTEBOOK TRENDS

	1991	1993	1995
Weight	4 - 7 Pounds	3 - 6 Pounds	2 - 4 Pounds
Processor	386 (SX,SL)	486	386,486, and more
Memory	2 - 16 MB	8 - 20 MB	16 - 32 MB
Drive	60 MB	80 - 120 MB	120 - 210 MB 500 MB - 1 GB
Display	VGA 640X480 B/W	Super VGA 800X600 B/W	XGA 1024x768 B/W, Color
Communications	Modem/FAX 2400 bps / LAN	Modem/FAX 2400 bps / LAN	Modem/FAX/Cellular V.32 bis/ISDN - LAN

Notes:

## KEY DESIGN CONCERNS

### Group I

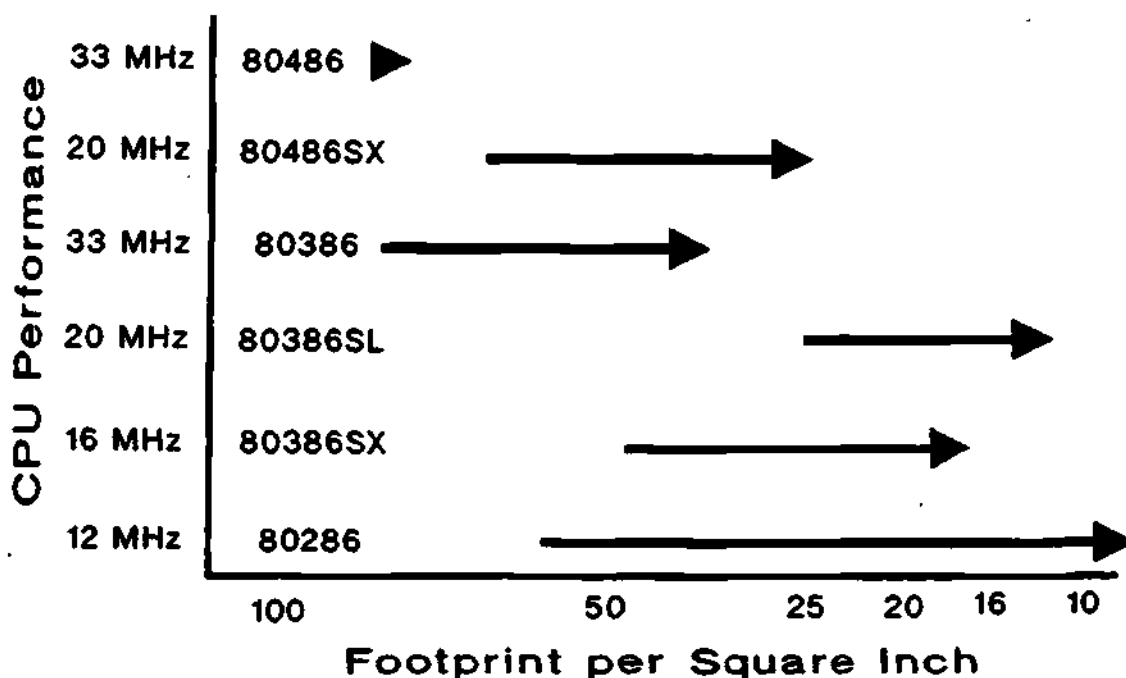
- **DISPLAY QUALITY**
  - Screen size, gray shades, video memory, resolution
- **SIZE AND WEIGHT**
  - Footprint, height, traveling weight
- **RUGGEDNESS**
  - Environmental, physical, robust

### Group II

- **SYSTEM PERFORMANCE**
  - Type CPU, CPU speed, memory size / speed
- **DISK PERFORMANCE**
  - Access time, disk size, shock / vibration (operation)
- **BATTERY LIFE**
  - Run-time vs. weight, charge time, ease of exchange

TRADEOFF AREAS

## NOTEBOOK TRENDS PRINTED CIRCUIT per SQUARE INCH



# Headline 1996

May 22

## PC Week

1996

**PC Buyers want more information  
better video, and better sound**

" As the market moves to Multi-Media software, high definition (architecture) will be very important – but not at the expense of size. The machines should not get any heavier than they are now."

Notes:



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## **DATAQUEST OUTLOOK**

---

- Entry into markets is very costly
- Most major players will remain as major players
- Intense battle for market share
  - Top 10 players account for 42% of the market
  - There are over 100 vendors competing for the balance of the available market
- Mergers, partnerships, and alliances will be key to survival

**Source: Dataquest**

---

## **DATAQUEST OUTLOOK**

---

- Marketing and distribution expertise is as important, if not more important than the product
- U.S. PC reseller margins will continue to decrease
- U.S. PC channel will continue to consolidate
- Major channel shifts to mass merchants, superstores, and direct response marketing will continue

## DATAQUEST OUTLOOK

- The industry shakeout will be felt in the bottom 60% of the market
- Major players will have to work smarter AND harder
- Smaller vendors will have to align themselves with strategic partners
- Niche markets will provide a higher probability of success

**Source: Dataquest**

[illegible]

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## THE LAST SIX MONTHS

---

*Mergers, consortiums, and acquisitions portend the future:*

- IBM buys Metaphor
- Borland buys Ashton-Tate
- Novell buys Digital Research
- Symantec buys Zortech and Dynamic Microprocessor Associates
- Microsoft, MIPS, Compaq, Acer, SCO, Digital, (and others) form ACE
- IBM and Apple agree to form software company

---

## THE RESELLER SHAKEOUT MERGERS AND ACQUISITIONS 1990 through 1991

---

Driving reasons for channel consolidation

- IE buys Connecting Point
- JWP buys Neeco
- JWP buys Businessland
- ComputerLand buys Nynex
- Inacomp and ValCom merge
- CompuCom buys Computer Factory

# ***CAN PC MAKERS STILL MAKE IT?***

Notes:

*Personal and Wireless  
Communications*

**Steve Sazegari**  
**Principal Analyst/Director**  
**Dataquest Incorporated**

**Gary Grandbois**  
**Senior Industry Analyst**  
**Dataquest Incorporated**

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## **AGENDA**

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### **Personal Communications**

- Cellular telephone
- Paging
- Personal Communications Network (PCN)
- Conclusion

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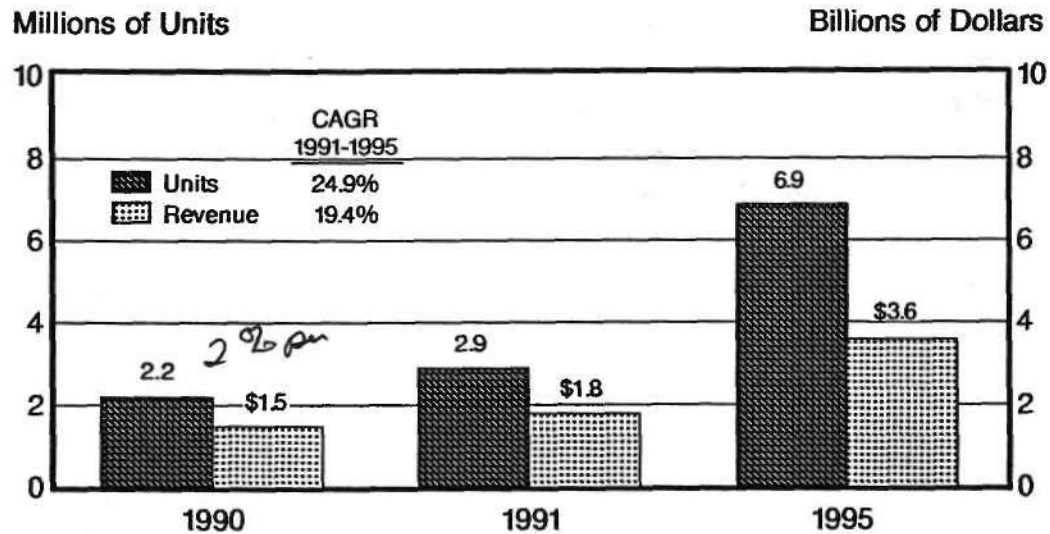
## **CELLULAR TELEPHONE**

---

- Service inaugurated in 1983
- More than 300 urban areas on-line
- Rural Service Area franchises being awarded by FCC
- More than 5 million telephones in service
- Broadening market penetration
  - Softening service prices
  - Declining telephone prices
- Growing popularity of portable telephones

B3480000, RM, 03/25/91, SAJ

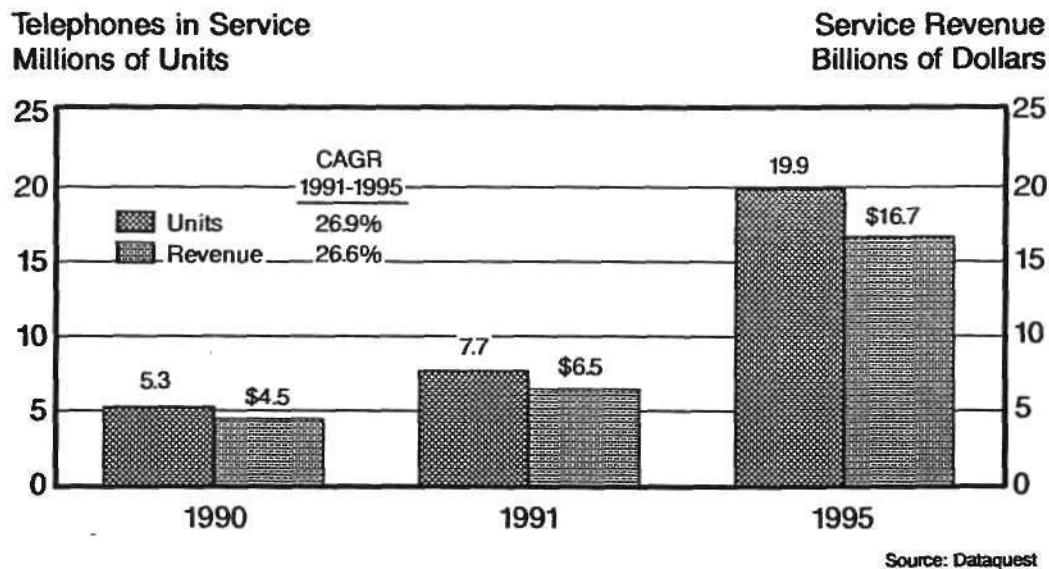
## ESTIMATED U.S. MARKET FOR CELLULAR TELEPHONES



Source: Dataquest

Notes:

## **ESTIMATED GROWTH OF THE U.S. CELLULAR SERVICES MARKET**



## **DIGITAL CELLULAR RADIO**

- Cellular radio will evolve
  - Analog → dual mode → digital
- Significant increase in system capacity
- TDMA is now standard; CDMA a future contender
- Comparable or better voice quality
- New ISDN-like service possible
- Security



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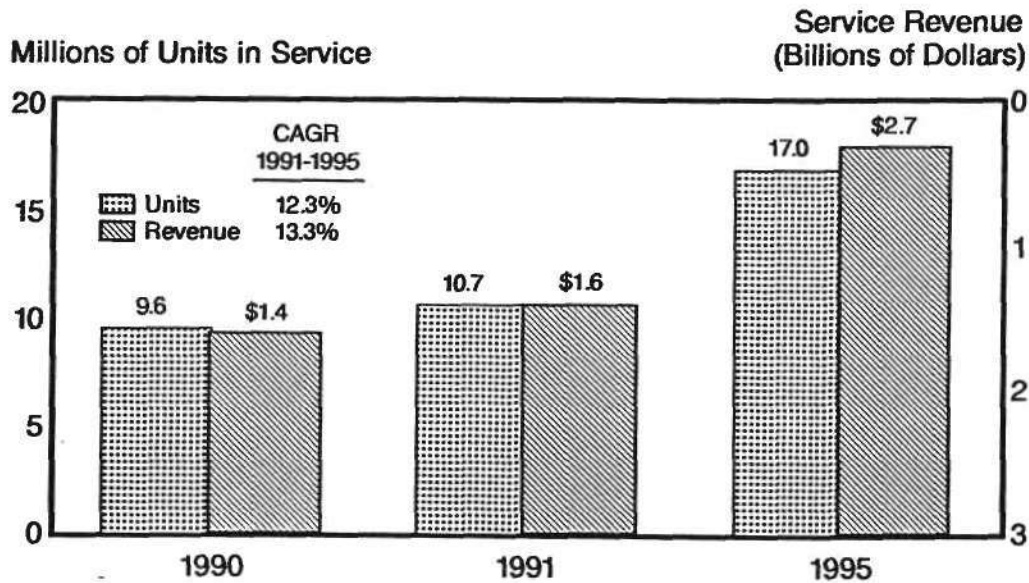
## **PAGING**

---

- Evolution from "paging" to messaging market
- Supplement to, not substitute for, alternative forms of wireless communication
- Deployment of new technologies
  - FM sideband
  - Wristwatch pager
- Nationwide paging services
- Integration with other functions such as voice mail

**Notes:**

## ESTIMATED U.S. PAGING MARKET



Source: Dataquest

## PERSONAL COMMUNICATIONS

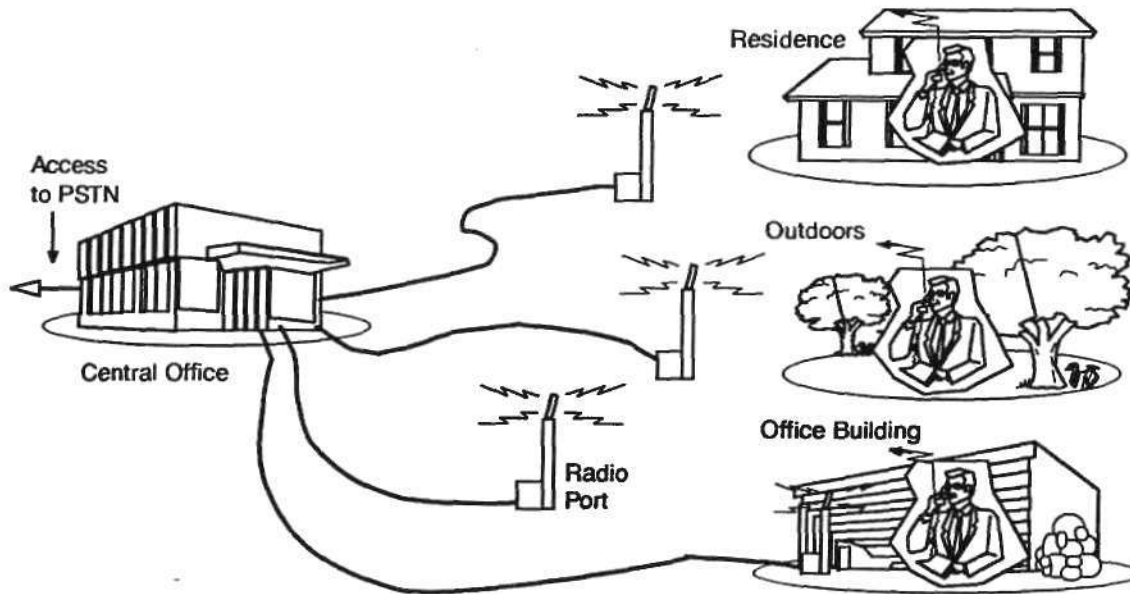
### Definition

- Anywhere
- Anyone
- Anytime

- Cordless telephone systems
  - CT2, Telepoint
  - DECT (CT3)
- PCN
  - Satellite systems

**Notes:**

## **POSSIBLE CT2 AND PCN INTEGRATION WITH PSTN**



---

### **CT2**

---

- Concept developed in the United Kingdom
- Attractive substitute for public pay phone
- Four licenses issued in United Kingdom
- DECT standards nearing completion
  - Improvement over CT2
- Window of opportunity in the United States

---

## **PCN**

---

- Extension of cellular concept
  - Microcells
- PCN being implemented in United Kingdom
- Digital Cellular System 1800 (DCS 1800)  
standard in Europe
  - Based on GSM
  - Under consideration by ETSI
- U.S. standards under consideration
  - CDMA the likely technology

**Notes:**

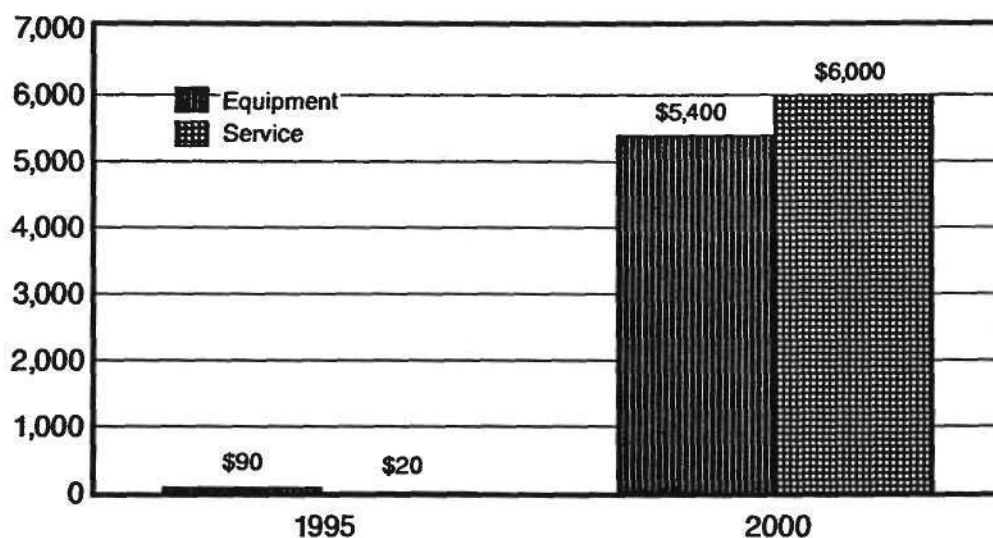
## PCN IN THE UNITED STATES

- Experimental PCN licenses granted by the FCC
  - PCN America (Millicom subsidiary)
    - Houston, Texas
    - Orlando, Florida
  - Graphic Scanning
    - Detroit, Michigan
    - Chicago, Illinois
    - White Plains, New York
  - Motorola
  - NYNEX
  - BellSouth
- License applications pending for:
  - American Personal Communications, Inc.
  - Ameritech
  - GTE
  - McCaw
  - Others

7100  
000.

## ESTIMATED U.S. PCN MARKET

Millions of Dollars



Source: Dataquest

**Source: Dataquest**

**Notes:**

03/01/96 09:25:01 AM

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## **FUNCTIONAL COMPARISON OF PERSONAL COMMUNICATIONS DEVICES**

---

	CT2	Paging	Cellular	PCN
Function	Originate	Receive	Originate/receive	Originate/receive
Communications Range	200m	Metro area	> 2 Miles	200m
Mobility	Limited; no handoff	High	Automobile	Pedestrian
Terminal Cost	Low (\$100)	Low (\$100)	High (\$400-\$700)	Low (\$100)
Terminal Size	Small	Small	Medium/Large	Small
Base Station Cost	Low	Medium	Very high	Low

Source: Dataquest

03/01/96 09:25:01 AM

---

## **PCN TRIALS**

---

- Test feasibility of technology
  - CDMA, spread spectrum
  - Microcell structure
- Explore 2-GHz operational issues
- Test user acceptance
  - Demand
  - Price
  - Functionality



## PERSONAL COMMUNICATIONS

### U.S. Regulatory Issues

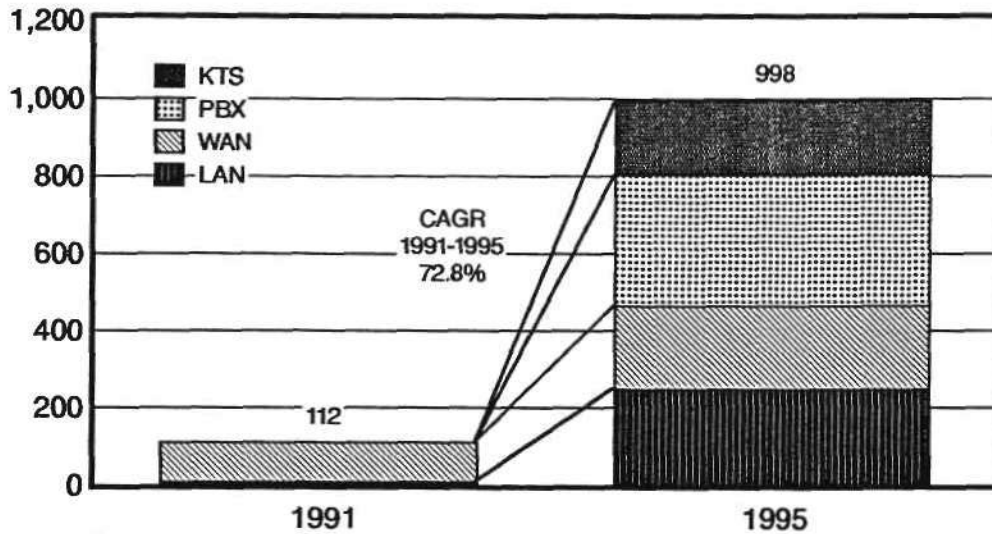
- Frequency allocation
- Industry structure
  - PCN entry
  - Telepoint entry
  - Licensing
  - Service regulation
- Standards and equipment licensing
- FCC Notice of Inquiry (June 1990)
  - Decision not likely before year-end 1991
- FCC Notice of Proposed Rule Making  
not expected before 1992/1993

*Europe? more likely*  
*Japan?*

Notes:

## ESTIMATED U.S. WIRELESS MARKET

Millions of Dollars



Source: Dataquest

## CONCLUSION

Personal communication is opening up  
new vistas – and new opportunities

Notes:

***Personal and Wireless  
Communications***

**Steve Sazegari  
Principal Analyst/Director  
Dataquest Incorporated**

**Gary Grandbois  
Senior Industry Analyst  
Dataquest Incorporated**

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## EUROPEAN PERSPECTIVE

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### AGENDA

#### THE SYSTEMS:

CT2  
DECT  
GSM  
DCS 1800

#### THE SEMICONDUCTORS

#### MARKET SUMMARY

---

### CT2

---

- Low cost digital cordless phone
- Originally British .... now European
- Existing manufacturers:
  - GPT
  - Motorola
  - Orbitel
  - Shaye
- CT2 is an interface ... not a network
- Not geographically contiguous

---

## CT2: THE FUTURE

---

- CT2 still expensive: \$350 dollars
- But better features:
  - High quality speech
  - More channels
  - No eavesdroppers
  - No fraud
- Rapid price erosion expected
- Consumer product: Japanese interest

**Notes:**

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## DECT

---

- DECT: Digital European Cordless Telephone
- Pan-European
- Spectrum fully allocated: 1.9GHz
- Very wide uptake expected

---

## CT2 vs DECT: THE DIFFERENCES

---

	CT2	DECT
Transmission protocol	FDMA	TDMA
Total channels	40	132
Maximum channels per basestation	8 approx	60 approx
Peak power	10mW (per channel)	12.5mW (per carrier)
Frequency	864-868 MHz	1.88-1.9 GHz
Data capacity	9.6kbps	>144kbps
Hand-over	No	Yes

Source: Dataquest

---

## DECT: ITS APPLICATIONS

---

- Wireless PABX extensions and handsets
- Very light handsets expected (<200g)
- Data communications: PC laptop transceivers
- Wireless LANs
- Companies to watch: Alcatel, Ericsson, Olivetti and Philips

**Notes:**



---

## CELLULAR vs CORDLESS KEY DIFFERENCES

---

	DIGITAL CELLULAR	DIGITAL CORDLESS
Cell size	<70km	<100m
Handset power	1-20W	10mW
Equalization	Yes	No
Voice coding	RPE-LTP	ADPCM
Channel data rate	6.5 - 13kbps	32kbps

Source: Dataquest

---

## GSM

---

- GSM: Groupe Speciale Mobile
- Skeleton services in: Denmark, Finland, Germany and Sweden
- Will replace wide diversity of analog systems
- Network competition will boost GSM
- Operator duopolies expected in most countries

---

## GSM vs RIVALS

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- 五

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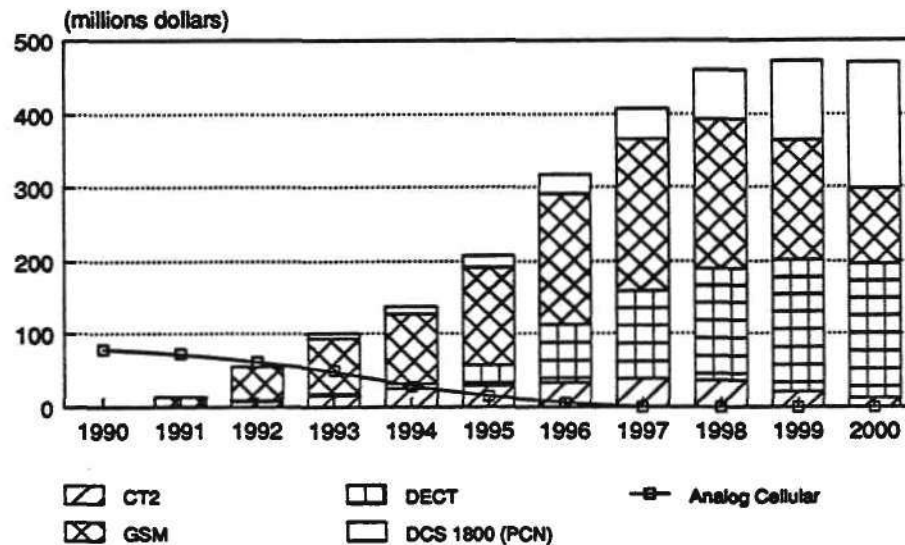
---

## DCS 1800

---

- DCS: Digital Cellular System
- A derivative of GSM:
  - Higher frequency
  - Greater bandwidth
  - Smaller cells/lower power
  - Infrastructure sharing
- Three operators licensed in the UK
  - Services start late 1992
  - Positioned to compete with local loop

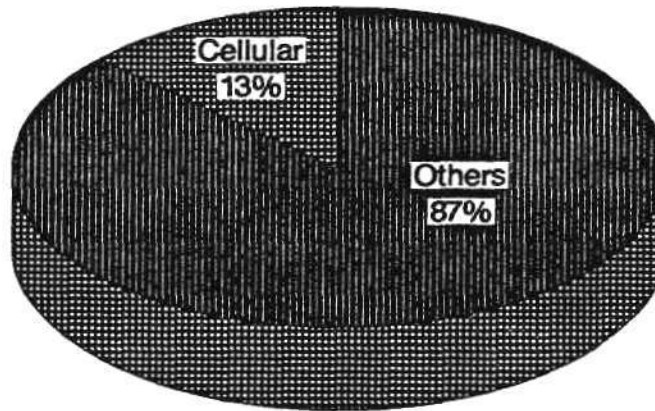
Forecast Semiconductor Consumption  
by European Handset Standard



Source: Dataquest

## TELECOMMUNICATIONS

Analog and Mixed-Signal Revenue



1990 = \$1,122 Million

Source: Dataquest

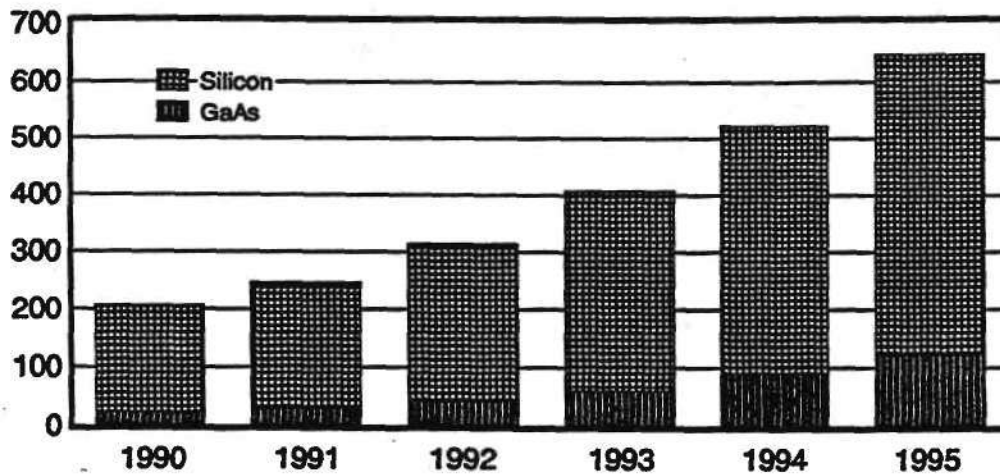
Notes:

## PERSONAL COMMUNICATIONS

Semiconductor Forecast

*Worldwide*

Millions of Dollars



Source: Dataquest

## PERSONAL COMMUNICATIONS

### Semiconductors in Cellular

1990 Revenue (\$M)	207
1990-1995 CAGR (%)	26
Discrete (%)	19
Analog and Mixed (%)	21.5
Digital (%)	38

Source: Dataquest

---

**SYSTEM COMPLEXITY  
ANALOG vs GSM**

---

	ANALOG	GSM
Number custom chips	3	5-6
Total chips	14	12
Silicon area (sq.mm)	110	330 (excl. RAM/ROM)
Equivalent gates	10k	150k
Analog filter poles	40	10
MIPS - control processor	0.2	1
MIPS - DSP	-	60
Program size (kbytes)	50	200
Number DACs	2	8
Number ADCs	4	7

Sources: Dialog Semiconductor

**Notes:**

## ESTIMATED SEMICONDUCTOR CONTENT 1ST GENERATION GSM CLASS IV TRANSPORTABLE

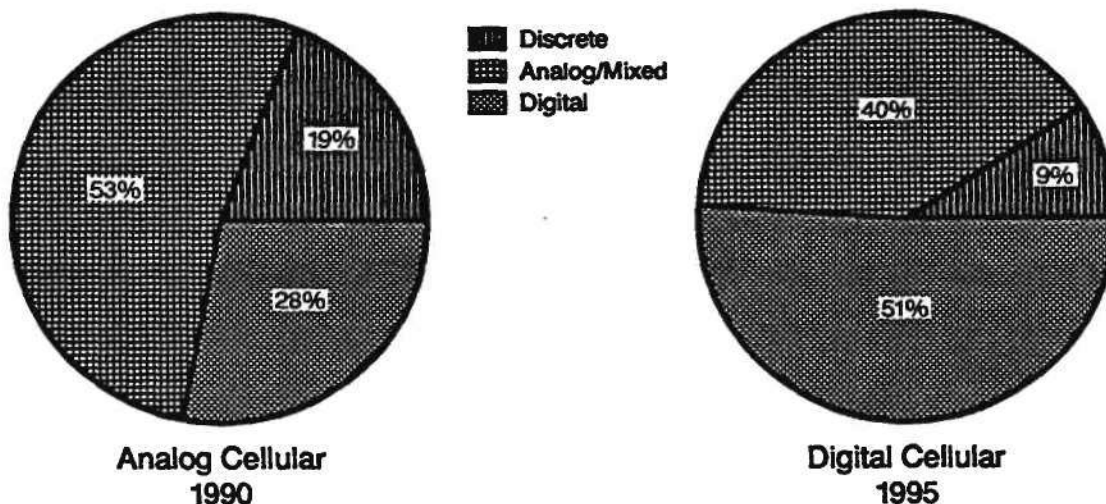
Speech codec	CMOS DSP/ASIC	\$ 18
Channel equalizer	CMOS DSP/ASIC	\$ 18
Frequency synthesizer	CMOS DSP/ASIC	\$ 14
Channel codec	CMOS ASIC	\$ 14
Channel modulator	Bipolar ASIC	\$ 15
Baseband conversion	BiCMOS ASIC	\$ 14
Other		\$ 58
<b>TOTAL SEMICONDUCTOR</b>		<b>\$151</b>

Source: Dataquest

ESTIMATED SEMICONDUCTOR CONTENT

## PERSONAL COMMUNICATIONS

### Semiconductor Content Forecast by Type

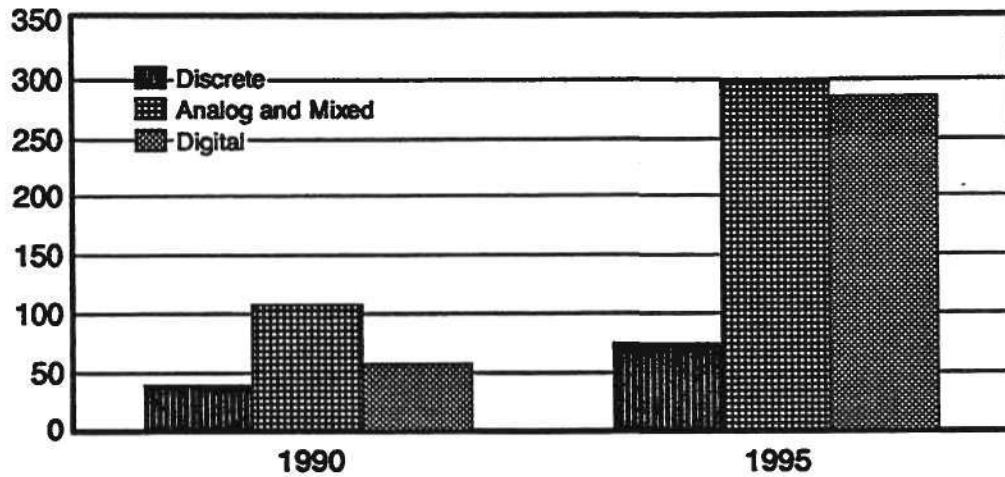


Source: Dataquest

## PERSONAL COMMUNICATIONS

### Semiconductor Forecast by Type

Millions of Dollars



Source: Dataquest

Notes:



*Computer Storage*

**Phil Devin  
Principal Analyst/Director  
Dataquest Incorporated**

**Nick Samaras  
Principal Analyst/Director  
Dataquest Incorporated**

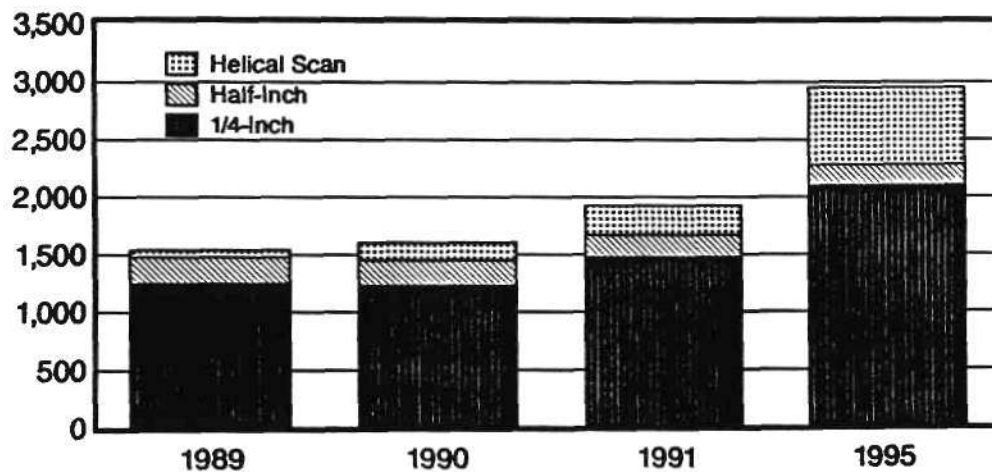
## AGENDA

- Forecasts and trends
- Total tape market
- 1/4-inch cartridge
- Helical scan
- Half-inch R/R and cartridge
- Summary and conclusions

## TOTAL TAPE DRIVE MARKET

Estimated Worldwide Unit Shipments

Thousands of Units



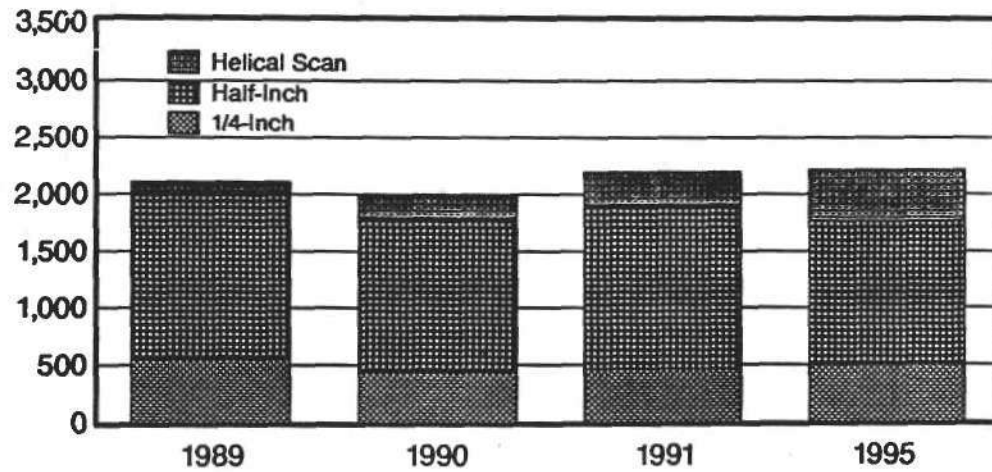
Source: Dataquest

83020000 MAG 00/0001.YAL

## TOTAL TAPE DRIVE MARKET

Estimated Worldwide Factory Revenue

Millions of Dollars



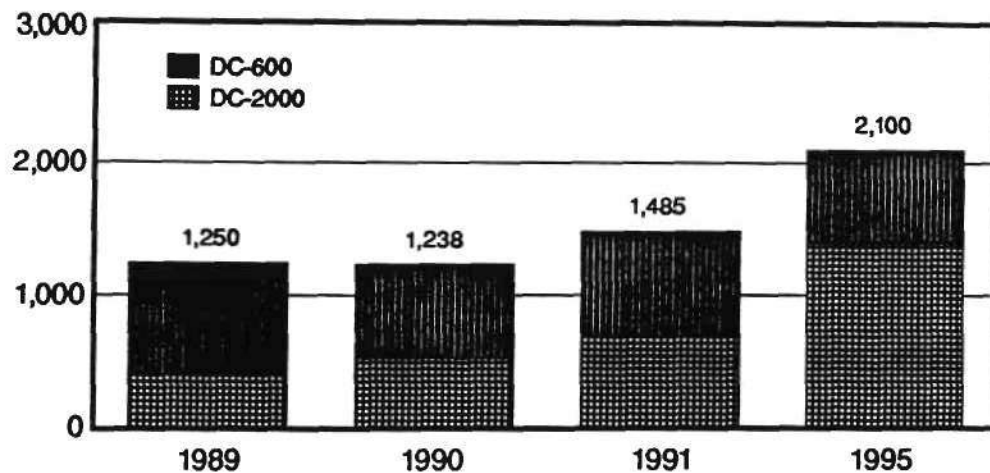
Source: Dataquest

Notes:

## 1/4-INCH CARTRIDGE TAPE DRIVES

Estimated Worldwide Unit Shipments

Thousands of Units



Source: Dataquest

---

## 1/4-INCH CARTRIDGE TRENDS AND ISSUES

---

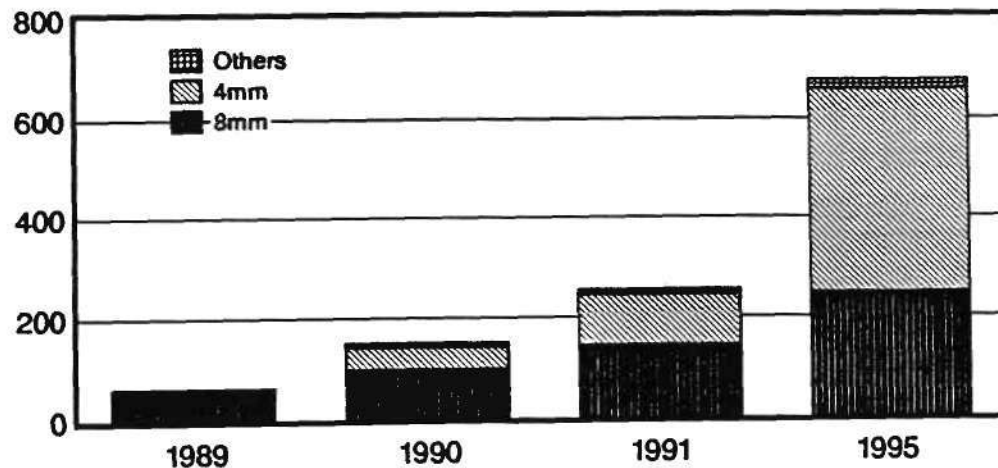
- DC-600
  - Low end of market going away
  - Market entry delays impact shipments
  - Under siege from other technologies
  - Major system companies continue support
- DC-2000
  - Positioned for high growth
  - Additional vendors will enter market
  - Increased competition

83022012 840 000001.YAL

## HELICAL SCAN TAPE DRIVE MARKET

Estimated Worldwide Unit Shipments

Thousands of Units



Source: Dataquest

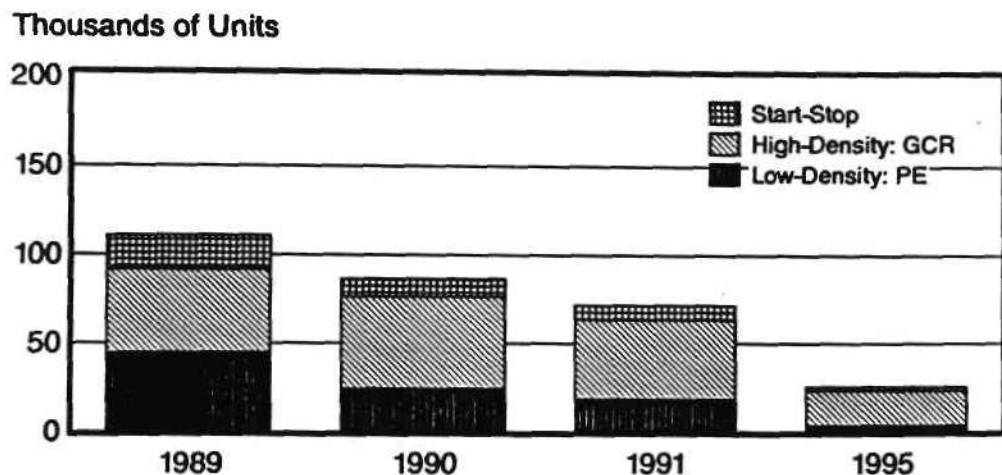
Notes:

## HELICAL SCAN MARKET TRENDS AND ISSUES

- 4mm
  - Pricing eroding rapidly
  - 3.5-inch drives beginning to ship
  - Competition continues strong
  - OEM acceptance, but volumes still low
- 8mm
  - Moving upscale
  - Increased threat from DAT
  - Widely endorsed by OEM and distribution channels
- Others
  - New products may stimulate market

## HALF-INCH REEL-TO-REEL TAPE DRIVE MARKET

Estimated Worldwide Unit Shipments



Source: Dataquest

---

## HALF-INCH REEL-TO-REEL MARKET TRENDS AND ISSUES

---

- Declining, but still considered an interchange standard
- Start-stop – New markets in Eastern Bloc
- 1991 – Last year of R&D and new product introductions
- 1990 – Peak year for GCR, significant decline in PE drives

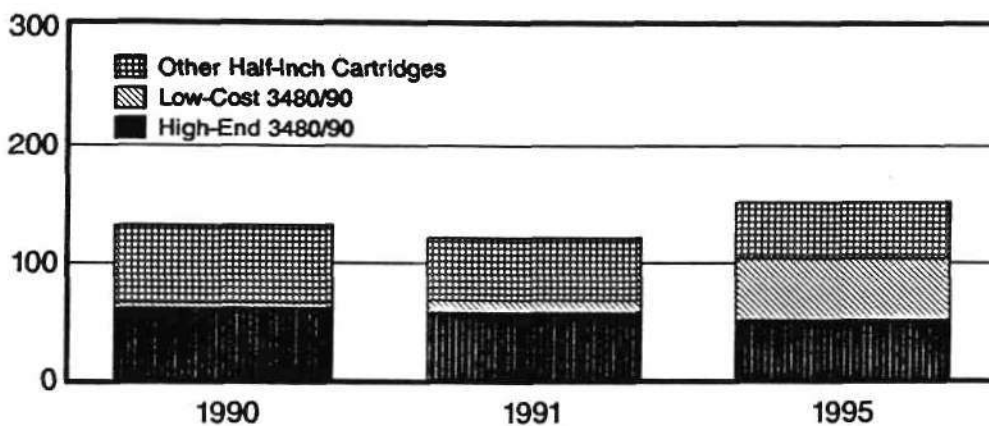
Notes:

83020020 IMQ 06/01/91 YAL

## HALF-INCH CARTRIDGE TAPE DRIVE MARKET

Estimated Worldwide Unit Shipments

Thousands of Units



Source: Dataquest

83020020 IMQ 06/01/91 YAL

---

## HALF-INCH CARTRIDGE MARKET TRENDS AND ISSUES -- HIGH END 3480/90

---

- Declining market
  - Negative mainframe growth
  - Low-cost drives in midrange
- IBM increases cartridge capacity
- 3480 phasing out in 1991
- PCMs increase share of market



CONFIDENTIAL

---

## HALF-INCH CARTRIDGE MARKET TRENDS AND ISSUES -- LOW-COST 3480/90

---

- Slow ramp in shipments -- future optimistic
- Sales channels have new requirements
- OEM sales slow but growing
- Expect price erosion from more competition

Notes:

---

## **SUMMARY**

---

- Wide range of products, competition among technologies will continue
- System vendors required to offer users a choice
- 1/4-inch cartridge sales impacted by 4mm and 8mm and market delays
- Half-inch reel – long life expected
- 4mm gaining ground with OEM acceptance

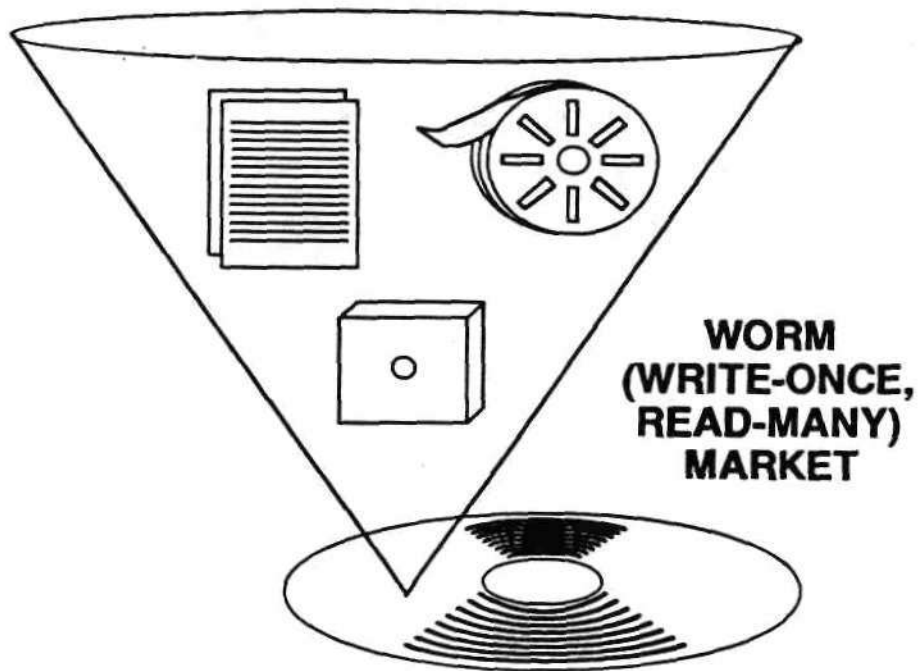
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## **CONCLUSIONS**

---

- LAN server and workstations will be a battleground for 2GB technologies
- Half-inch cartridge: IBM and Digital standards dominate
- Vendors must get closer to the end user
- No other technology will be as universally accepted as reel-to-reel
- Capacities match disk capacities
- If you can't decide on a flavor, buy two drives

DISKETTE AND COMPACT DISC



Notes:

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### **WORM TRENDS AND ISSUES**

---

- 12-inch market showing flat to very modest growth
- Expected to continue this way
- 12-inch drive and media price appropriate only to minicomputer systems
- 12-inch drive and media size contrary to current trends

---

### **WORM TRENDS AND ISSUES**

---

- ATG, Hitachi, Kodak (14-inch), Sony, and Toshiba increased storage capacity/side
- LMSI uses dual heads for minimum time to data
- Market will choose

---

## WORM TRENDS AND ISSUES

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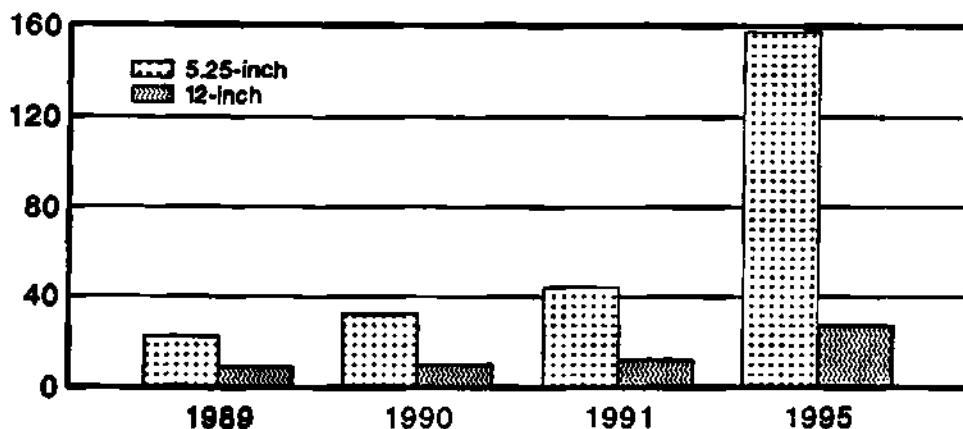
- Automated libraries (jukeboxes)
  - Leverage the usefulness of WORM drives
  - Most applications are image management/archiving
- Available sizes now vary from 5 cartridges to more than 2,000 cartridges
- More than 20 companies now in library business

Notes:

## **WORLDWIDE OPTICAL DISK DRIVE FORECAST**

### **WORM Drive Shipments**

Thousands of Units



Source: Dataquest

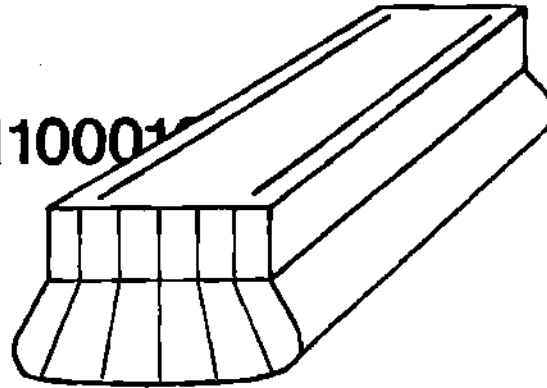
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## **WORM MARKET CONCLUSIONS**

---

- 12-inch market will grow very slowly because of device size, cost, and lack of standards
- 5.25-inch market will grow at a better pace but is also limited by lack of standards and impact of rewritable drives
- Write-inhibited rewritable drives may fill the need for write-once drives by also filling the need for standard format
- Automated libraries (jukeboxes) will continue to grow in importance in this market

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## **REWITABLE TRENDS AND ISSUES**

---

- **5.25-inch magneto-optical drives**
  - Sony, Ricoh price/volume leaders
  - HP, Maxoptix performance leaders
- **Performance**
  - Still far slower than Winchester drives
  - Little danger to Winchester market
- **Direct overwrite -- still elusive in MO drives**
  - Panasonic has it on phase change

---

## **FORECAST ASSUMPTIONS**

---

- **No direct overwrite on MO drives until 1994-1995**
- **Phase change erasures stay limited to approximately 100K**
- **3.5-inch media price less than half 5.25 price**



## FORECAST ASSUMPTIONS

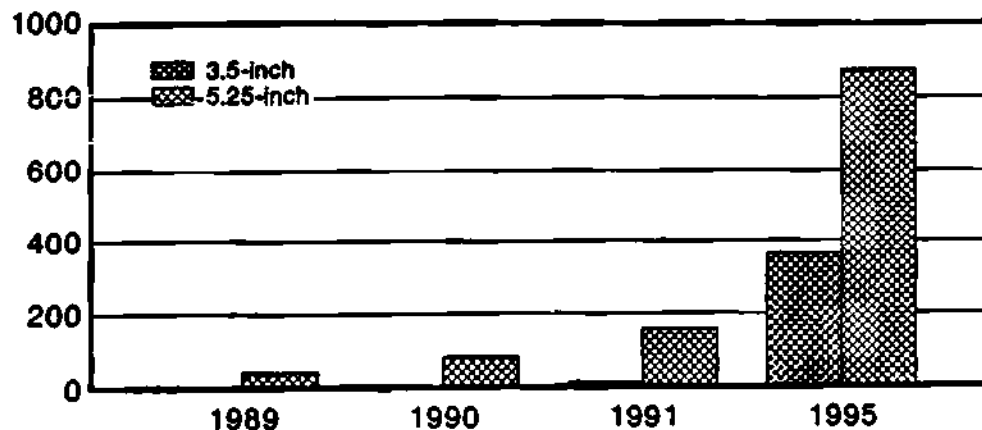
- **5.25-inch drives**
  - Head start
  - CAGR = 61% (units)
- **3.5-inch drives**
  - Late start
  - CAGR = 134% (units)
- **ASP declines 20% per year**

**Notes:**

## **WORLDWIDE OPTICAL DISK DRIVE FORECAST**

### **Rewritable Disk Drive Shipments**

Thousands of Units



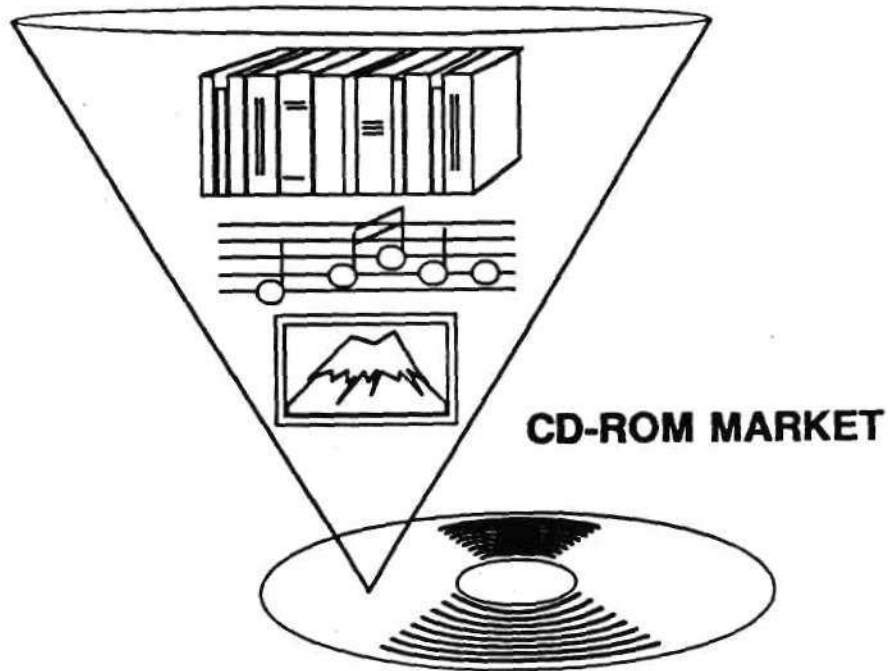
Source: Dataquest

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### **REWITABLE MARKET CONCLUSIONS**

---

- Market acceptance of 5.25-inch rewritable drives has been good compared with WORM drives
- Performance of rewritable drives is still well below Winchester drives -- does not impact this market to any significant degree
- 3.5-inch market starts in 1991
- 3.5-inch market growth rate exceeds 5.25-inch -- principal impact on removable magnetic products



Notes:

Notes:

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## **CD-ROM TRENDS AND ISSUES**

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- CD-ROM drive shipments continue to accelerate toward 3 million-units-per-year level by 1995
- Publication titles activity is very heavy in the public and private sectors
- Government is emerging as one of the most active producers as well as users of CD-ROM data

---

## **CD-ROM TRENDS AND ISSUES**

---

- Number of titles is in the thousands including corporate data distribution
- Desktop publishing systems now available to create CD-ROMs -- prices dropping
- By 1994, no desktop PC in business environment will be considered complete unless it has a CD-ROM
- CD-ROMs available below \$500 retail price

---

## FORECAST ASSUMPTIONS

---

- When most desktop PCs have CD-ROM drives, a critical mass will lead to next growth stage
- Then, CD-ROMs will be used for software distribution
  - Operating systems
  - Application programs
  - Multimedia interactive instruction and games
- CD-ROM disk format is universally accepted
  - Ideal for interchange of software

Notes:

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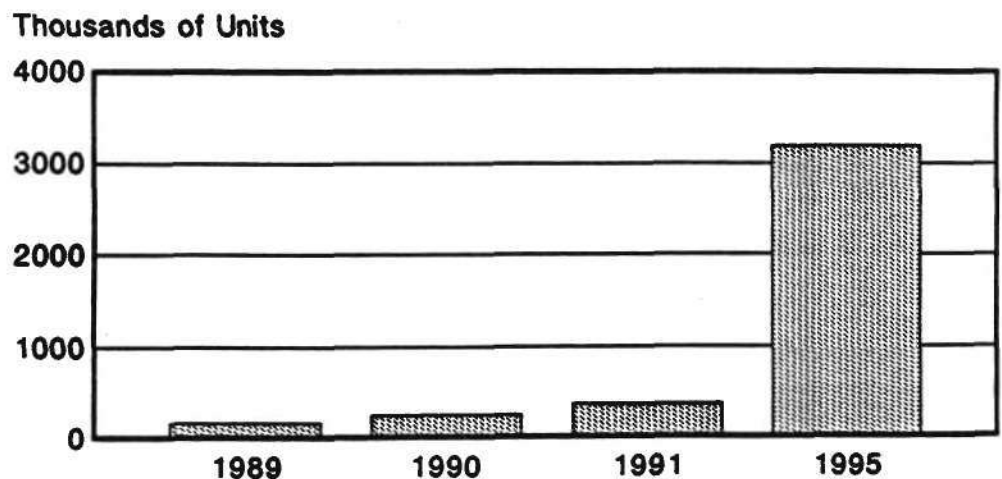
## FORECAST ASSUMPTIONS

---

- In like quantities, CD-ROM disks will cost no more than microfloppies
  - Probably less
- In like quantities, CD-ROM drives will cost no more than FDDs
- CD-ROM will be multipurpose
  - Reference library
  - Corporate data distribution
  - Software library
  - Multimedia interactive instruction and games
- Too much capacity?
  - No such thing

## WORLDWIDE OPTICAL DISK DRIVE FORECAST

CD-ROM Shipments



Source: Dataquest

---

## CD-ROM MARKET CONCLUSIONS

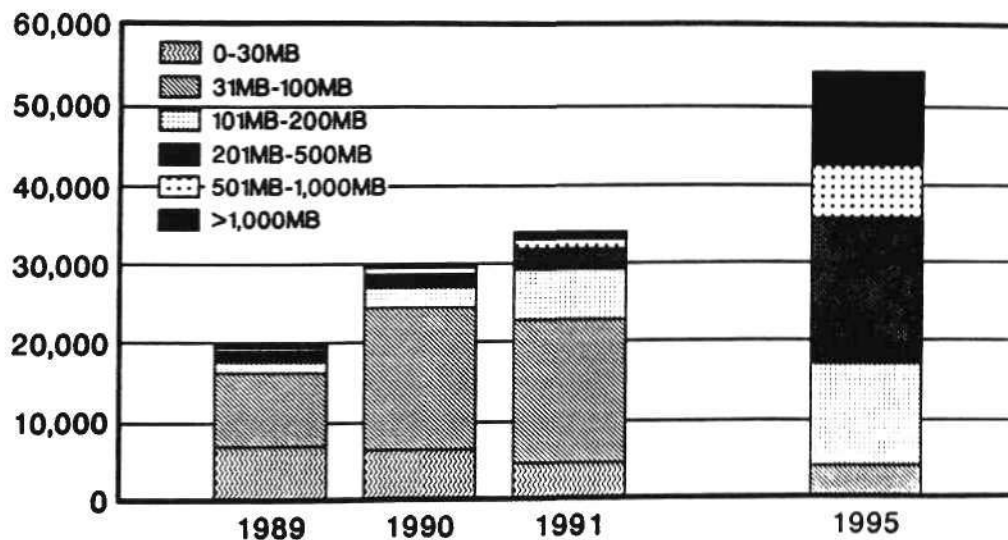
---

- CD-ROM drive and publication industries are growing well
- Widespread availability of publications and corporate data will make CD-ROMs essential on PCs in business use by 1993-1994
- Drive population will hit critical mass at that point -- hockey stick
- Mass market at that point will be software distribution and home entertainment systems -- 3 million units in 1995
- CD-ROM drive demand will soar to 40 million units/year by end of decade

Notes:

## ALL RIGID DRIVES BY CAPACITY

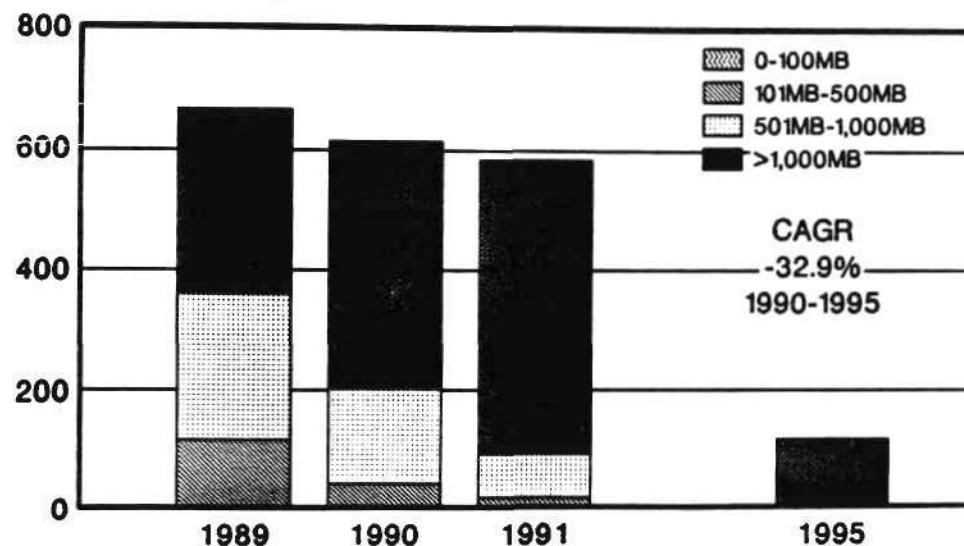
Thousands of Units



Source: Dataquest

## 8- TO 14-INCH SALES BY CAPACITY

Thousands of Units

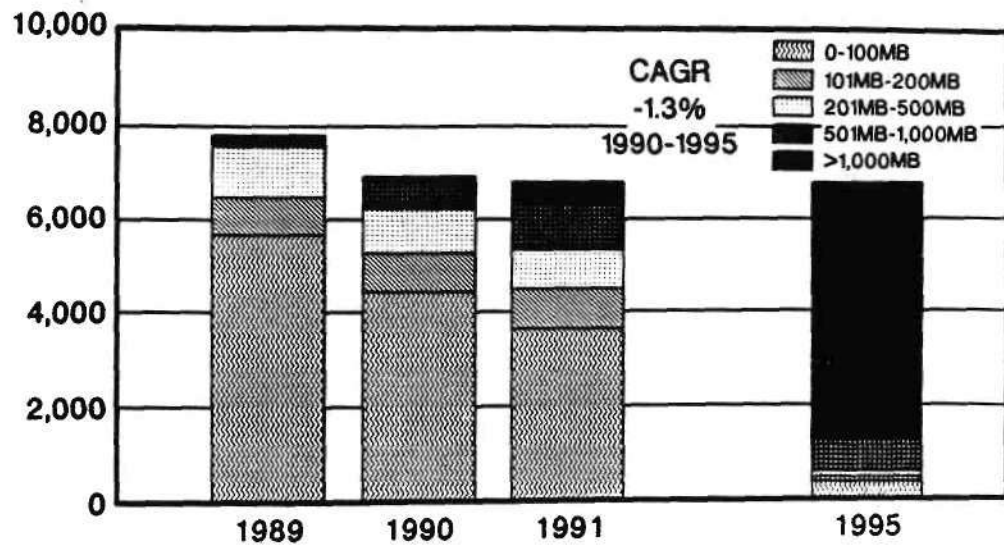


Source: Dataquest



### 5.25-INCH SALES BY CAPACITY

Thousands of Units

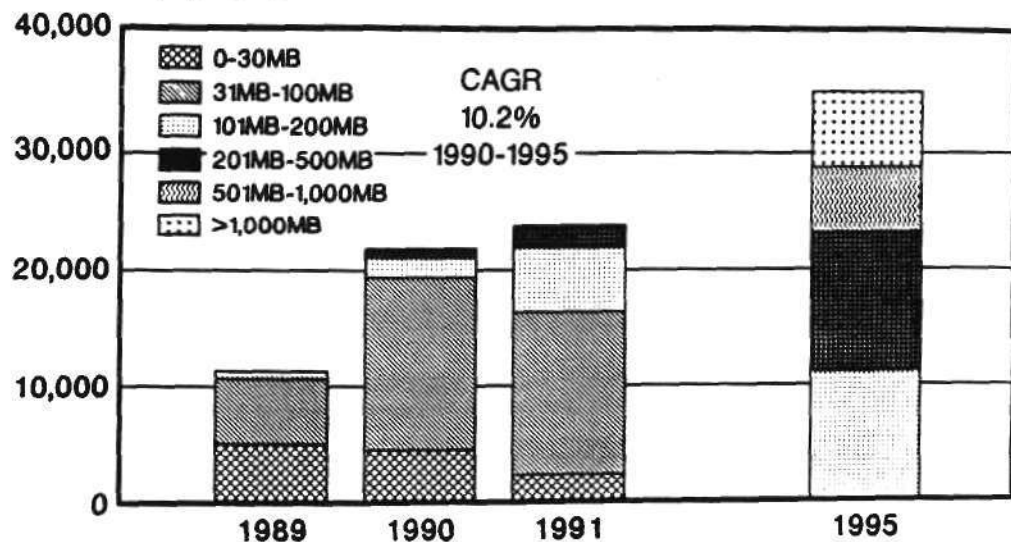


Source: Dataquest

Notes:

### 3.5-INCH SALES BY CAPACITY

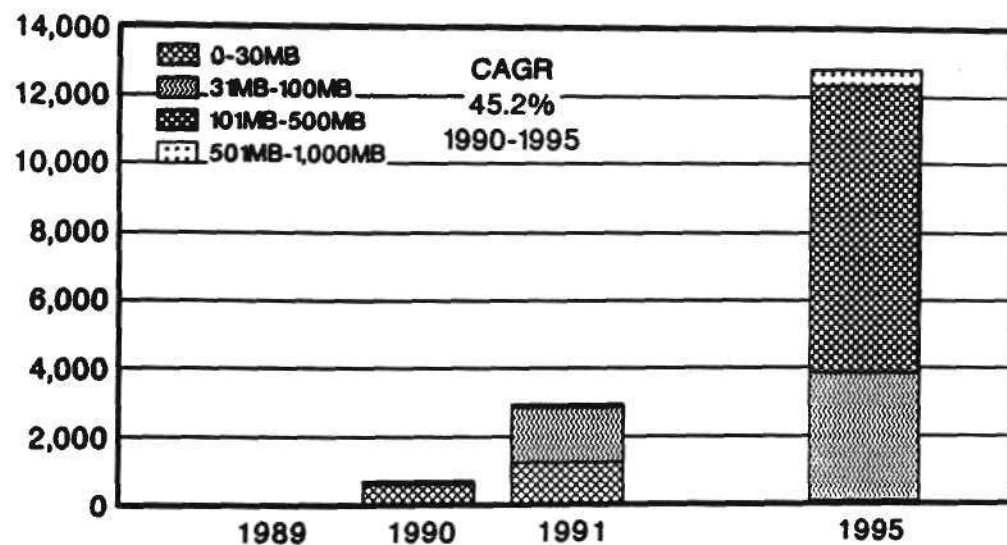
Thousands of Units



Source: Dataquest

### 2.5-INCH SALES BY CAPACITY

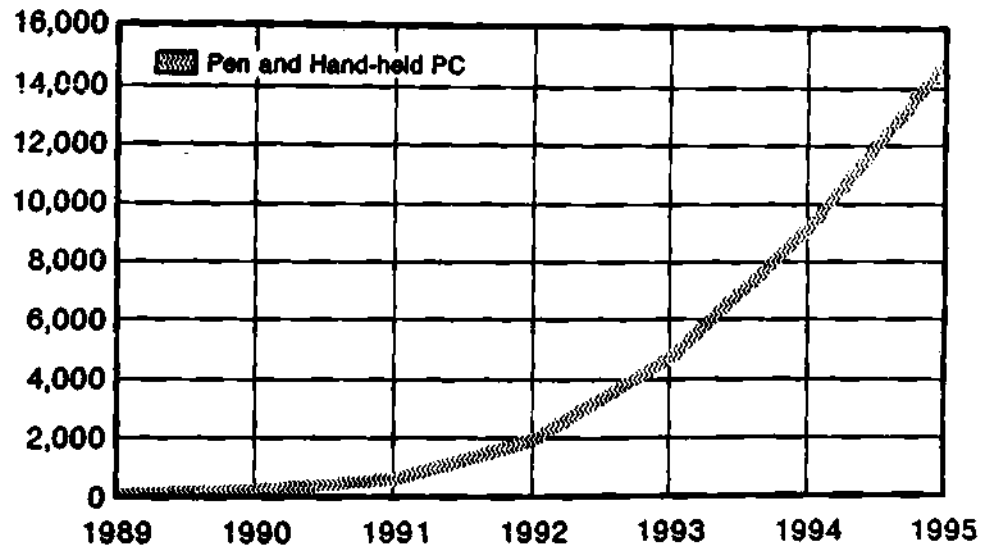
Thousands of Units



Source: Dataquest

## TOTAL MARKET FOR 1.8-INCH

Thousands of Units



Source: Dataquest

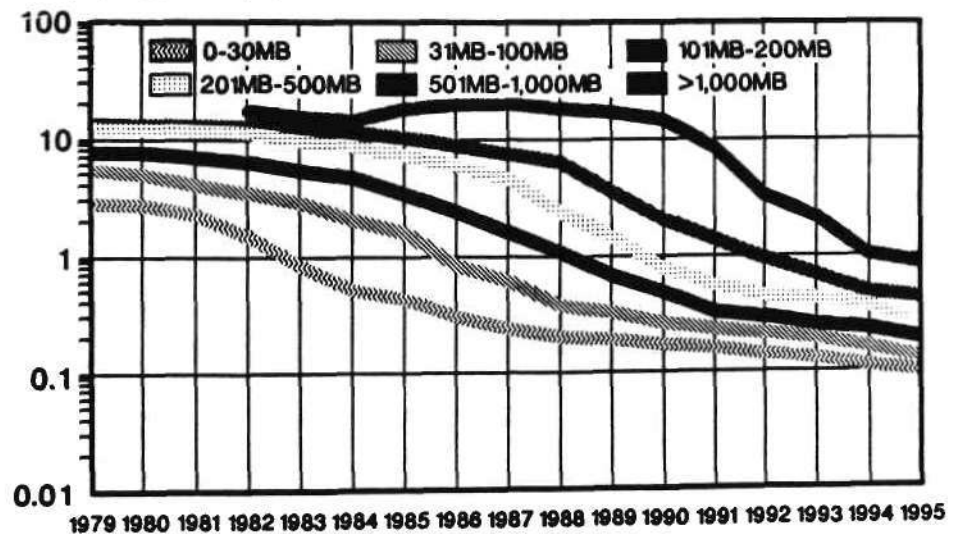
Notes:

## FORECAST ASSUMPTIONS

- Prices tend to fall at 22% annually
- Form-factor penetration rates repeat
- Most popular price point is \$240 (factory)
- Storage revenue follows system growth rates
- 1991 and 1995 recessions

## RIGID DISK FACTORY PRICES BY CAPACITY

Thousands of Dollars



Source: Dataquest

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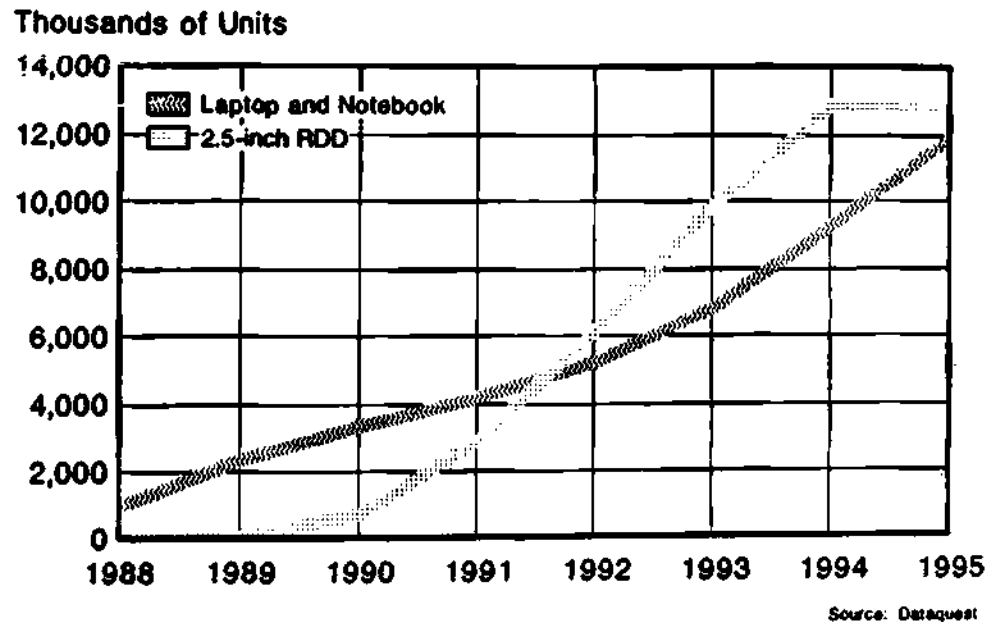
***Controversy of the Year***

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**Notes:**

## **CAN 2.5-INCH DEMAND CONTINUE?**



---

### **SUMMARY**

---

- Large-diameter disk sales are doomed
- 5.25-inch will replace them
- 3.5-inch future is assured
- Industry dynamics understandable
- Money is still scarce for storage companies

## CONCLUSIONS

- 

[illegible]

*Computer Storage*

**Phil Devin**  
**Principal Analyst/Director**  
**Dataquest Incorporated**

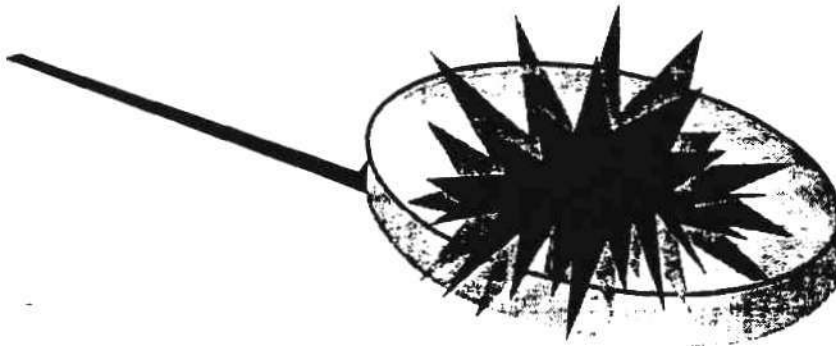
**Nick Samaras**  
**Principal Analyst/Director**  
**Dataquest Incorporated**



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## **FLASH MEMORY**

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## **FLASH SEMICONDUCTOR DISKS**

---

- Take less power than RDDs
- Are faster to access than RDDs
- Do not require battery to hold data on power down
- Have good industry standards for interconnect

**"Pretty soon, nobody will make a 10MB or 20MB hard disk. The cards will eat into the disk drive market from below."**

**Lou Hebert  
Product Manager, Intel Corporation  
July 7, 1991**

Notes:

---

## **LOOK OUT, DISK DRIVES!**

---

### **August 1991 Prices**

	<u>Capacity (MB)</u>	<u>OEM Price (\$)</u>	<u>End-User Price (\$)</u>	<u>Technology</u>
Intel	4	650		Flash card
Poqet	4		1,400	Flash card
3M	4		10	Diskette, 3.5"
Seagate	40	132	179	3.5" disk drive
Seagate	420	680	1,200	3.5" disk drive
Syquest	44		79	Disk cartridge
Syquest	44		330	Disk drive

---

## **FLASH SEMICONDUCTOR DISKS**

---

- Cost 100x more than RDDs
- Are 30x slower to update than RDDs
- Wear out and must be replaced after 100,000 updates

---

## SUMMARY

---

- If you need flash – you will pay for it
- Broad acceptance as mass storage  
in portable computing impossible  
because of price

Notes:

*Computer Storage*

**Phil Devin  
Principal Analyst/Director  
Dataquest Incorporated**

**Nick Samaras  
Principal Analyst/Director  
Dataquest Incorporated**

---

## **AGENDA**

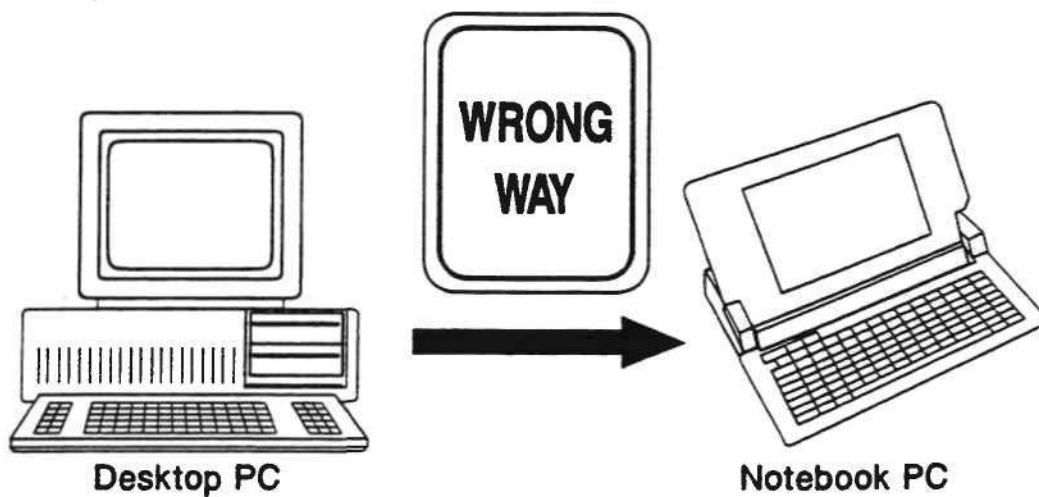
---

- RDD perspective
- Semiconductor perspective
- Conclusions

---

## **DOWNSIZING**

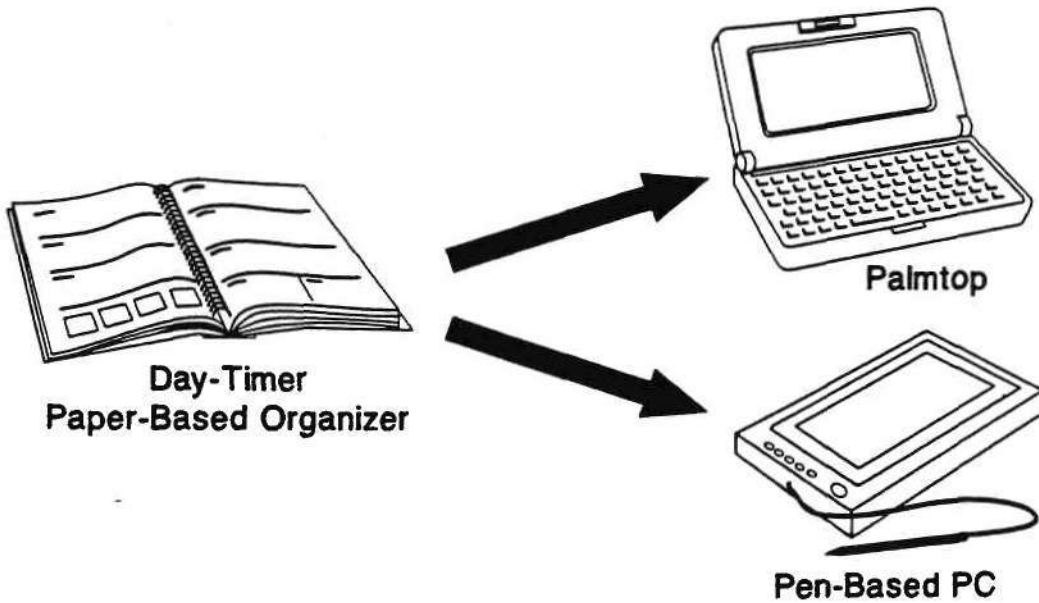
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## EMULATION OF FUNCTION

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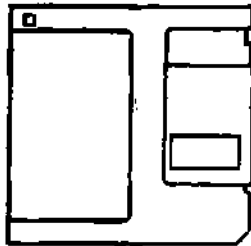


Notes:

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## THE COST OF USING INFORMATION

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3.5" Floppy



Memory Card

	<u>Cost</u>
Floppy:	\$1
Notebook:	\$3,000
<u>Total</u>	<u>\$3,001</u>

	<u>Cost</u>
Memory Card:	\$300
Palmtop:	\$600
<u>Total</u>	<u>\$900</u>

---

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***The Floppy Is More Expensive!***

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## CONCLUSIONS

---

- SSD will not replace HDD
- Memory cards are an enabling technology
- Growth in storage will come from new markets

Notes:

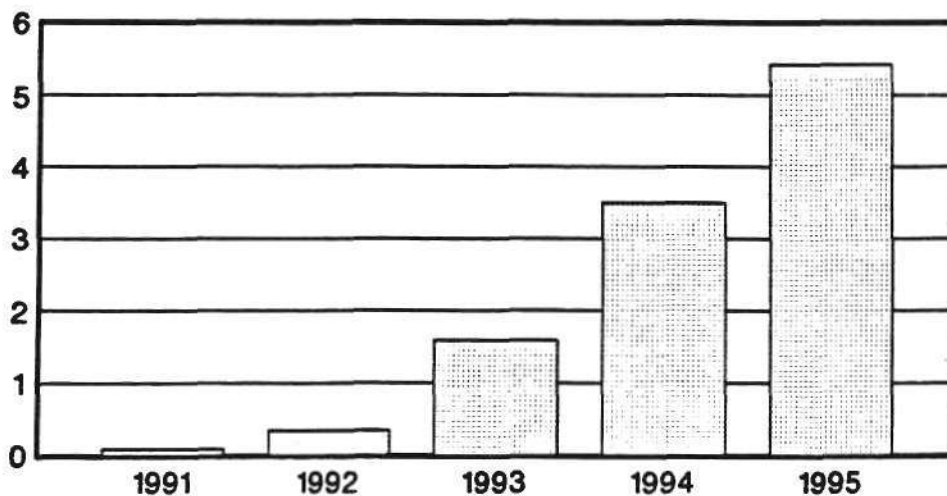
## ELECTRONIC PHOTOGRAPHY



## PEN-BASED PCs

Worldwide Forecast

Millions of Units

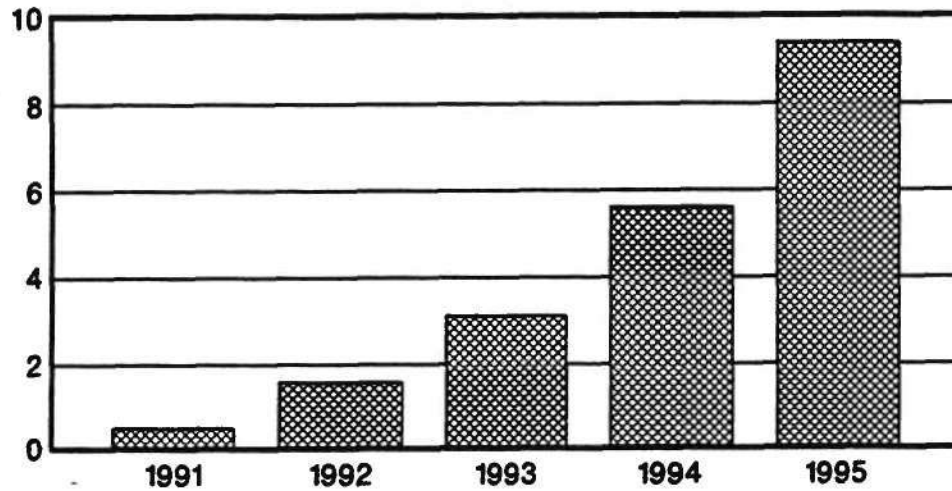


Source: Dataquest

## HAND-HELD PCs

Worldwide Forecast

Millions of Units



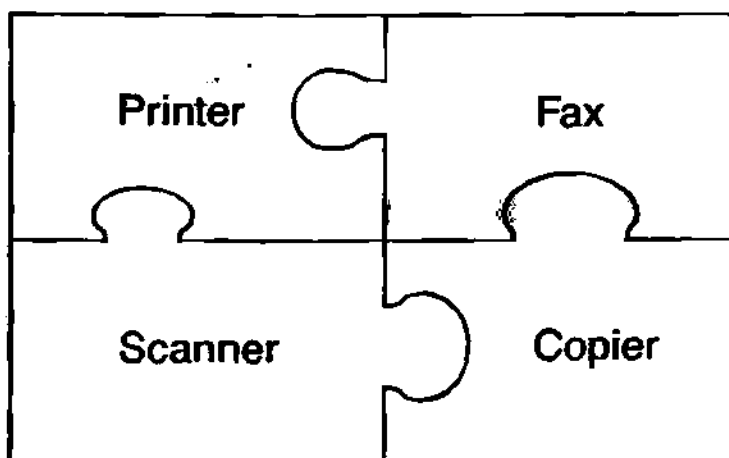
Source: Dataquest

Notes:

*Office Automation Markets*

**Richard C. Norton  
Vice President/Director  
Dataquest Incorporated**

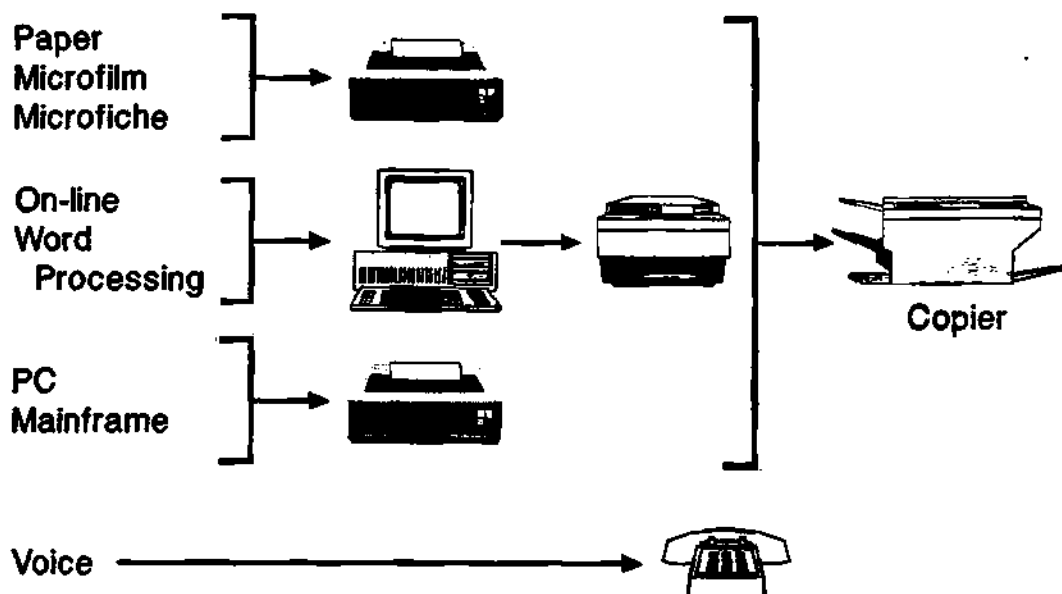
## THE MULTIFUNCTIONAL PUZZLE



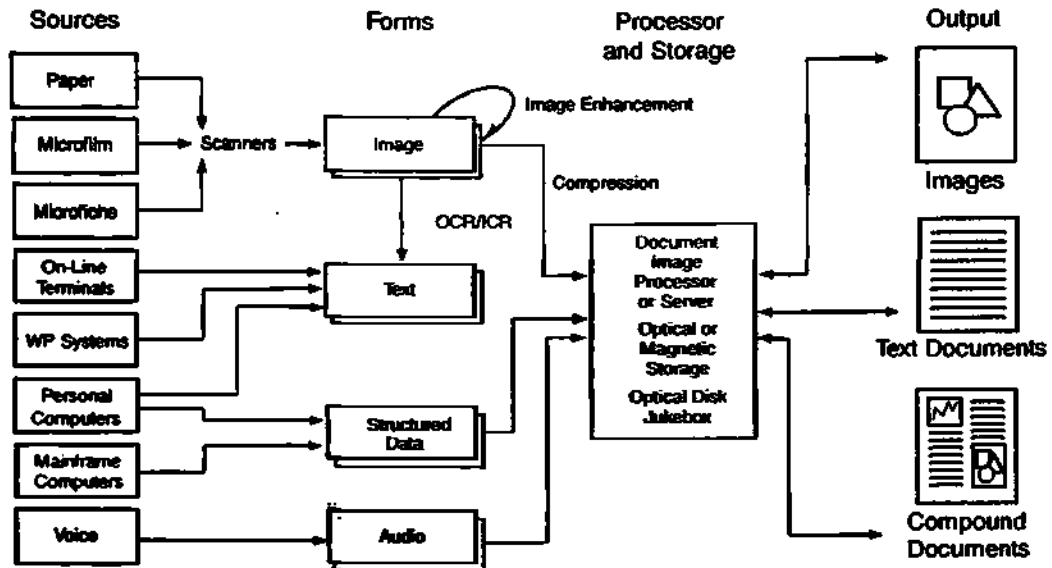
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## TODAY'S OFFICE

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## TOMORROW'S OFFICE

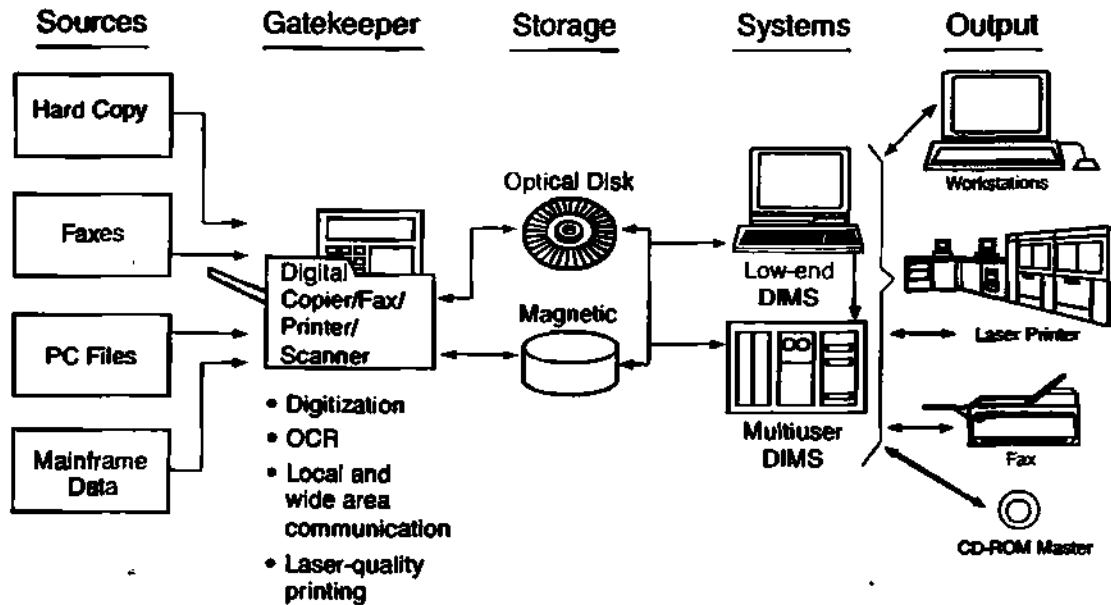


Source: Plexus Software  
Dataquest

Notes:

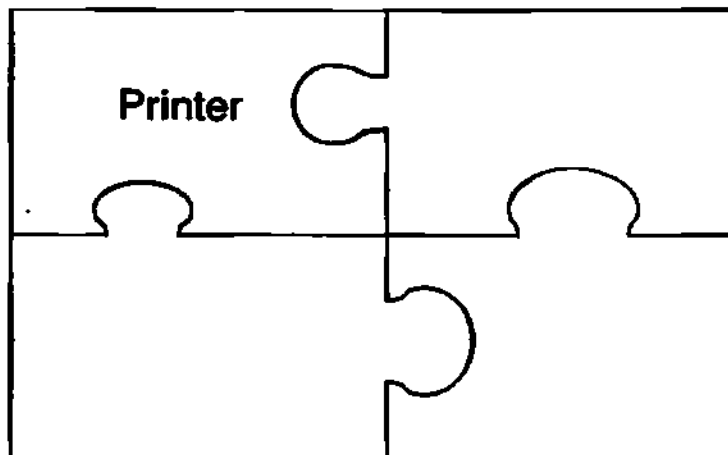
800004.MMS 10/25/91/NUR

## TOMORROW'S DIGITAL GATEWAY



800006.MMS 09/25/91/NUR

## THE MULTIFUNCTIONAL PUZZLE

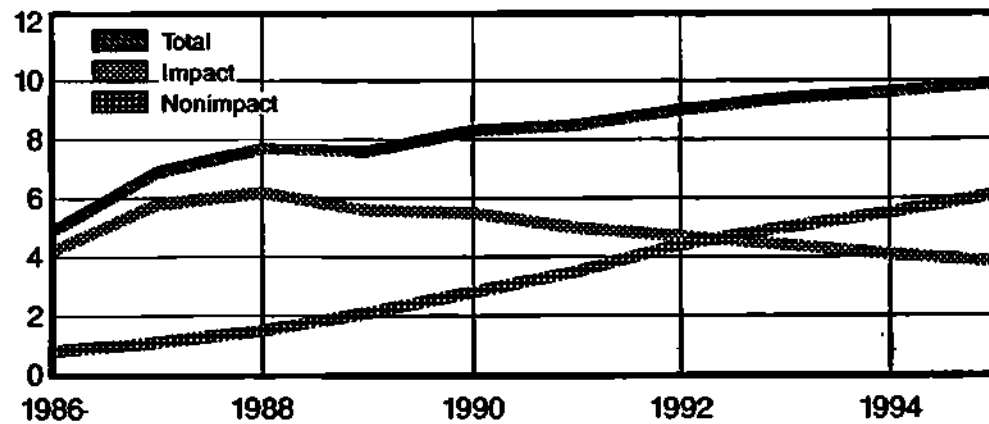


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## ESTIMATED NORTH AMERICAN PRINTER SHIPMENTS

Impact versus Nonimpact

Millions of Units



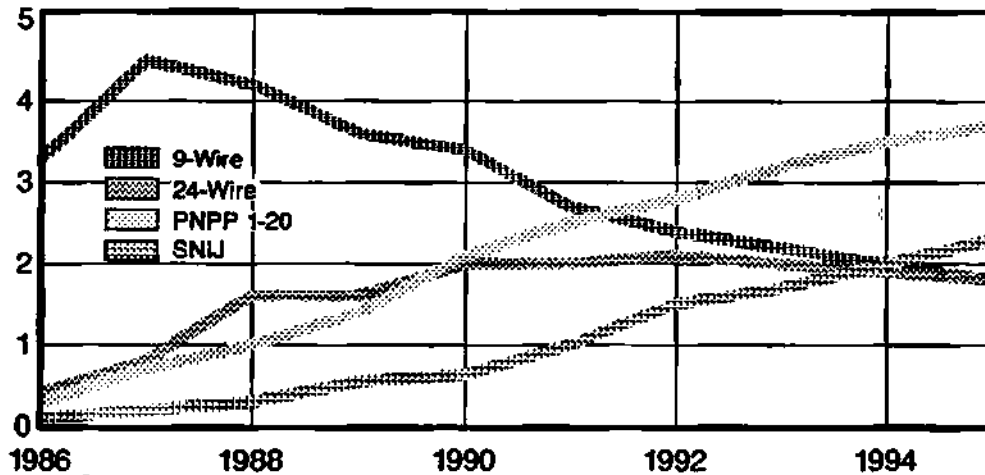
Source: Dataquest

Notes:



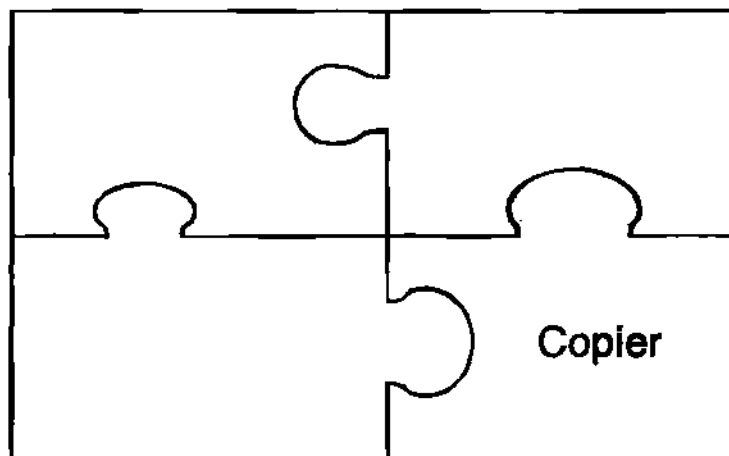
## NORTH AMERICAN DESKTOP PRINTER SHIPMENTS FORECAST

Millions of Units



Source: Dataquest

## THE MULTIFUNCTIONAL PUZZLE



000001.MG 05/22/91 14:01

**PLAIN PAPER MARKET SEGMENTATION**

<u>Segment</u>	<u>Speed (cpm)</u>	<u>Aver. Mo. Copy Vol.</u>	<u>Average Price (Base Unit) (US\$)</u>
PC	1-12	400	1,260
1	1-20	2,000	2,700
2	21-30	6,600	4,400
3	31-44	12,500	7,100
4	45-69	21,000	13,700
5	70-90	69,000	17,745-75,000 <sup>1</sup>
6	91+	180,000	78,300-220,000 <sup>1</sup>

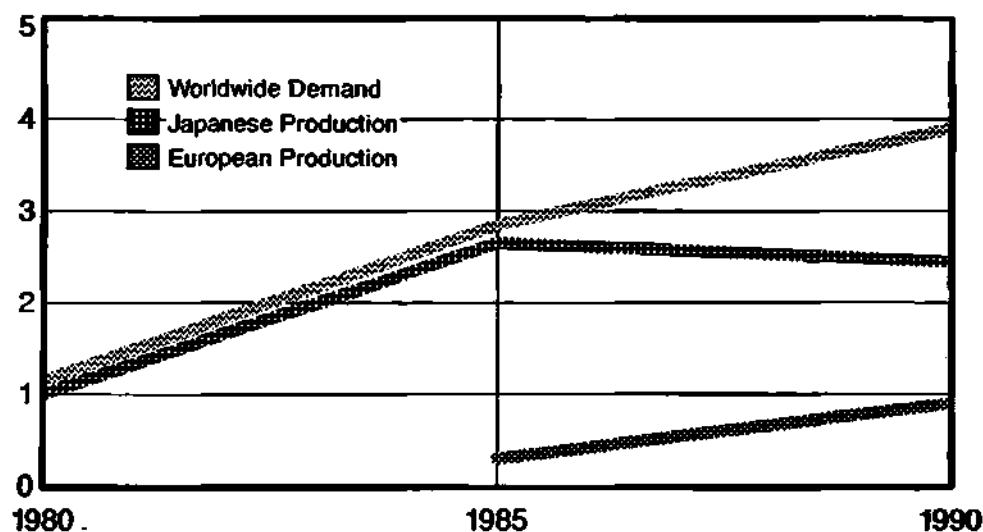
<sup>1</sup>Ranges from base units to fully featured systems

Source: Dataquest

Notes:

## COPIER UNIT ESTIMATES

Thousands of Units



Source: Dataquest

ESTIMATED U.S. PPC PLACEMENTS<sup>1</sup>

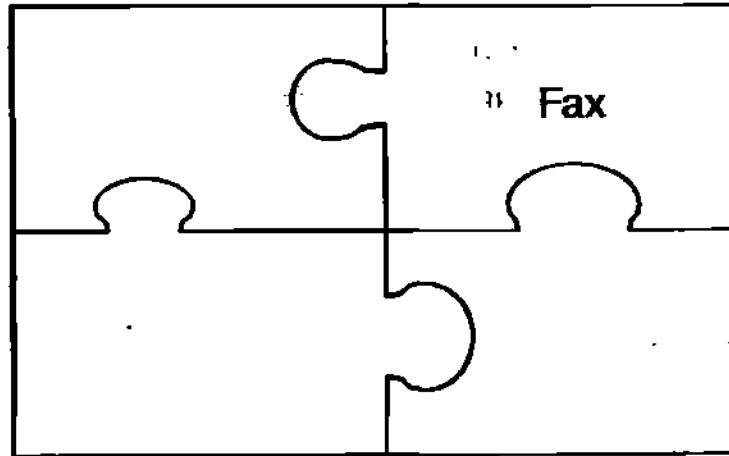
(Thousands of Units)

Segment	1985	1990	1995	CAGR%	
				1985-1990	1990-1995
PC	206.0	255.5	290.0	4.4	2.6
1	485.8	490.8	460.0	0.2	-1.3
2	201.1	212.0	230.0	1.1	1.6
3	83.6	132.2	155.0	9.6	3.2
4	42.7	88.9	125.0	15.8	7.0
5	21.7	18.9	17.0	-2.7	-2.1
6	5.9	13.9	8.0	18.7	-10.5
Total	1,046.8	1,212.2	1,285.0	3.0	1.2

<sup>1</sup>Gross sales and net rental additions

Source: Dataquest

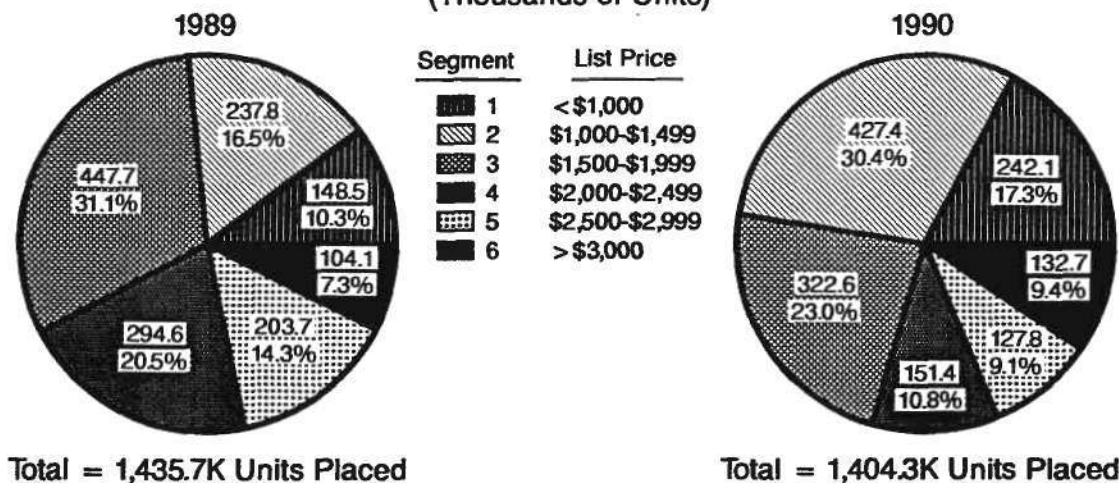
## THE MULTIFUNCTIONAL PUZZLE



Notes:

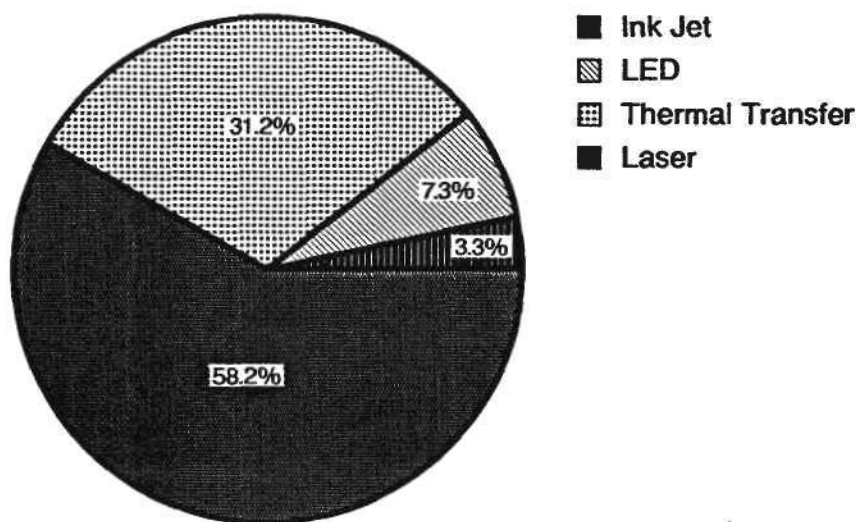
## 1990 U.S. FAX MARKET SHARE BY PRICE SEGMENT

(Thousands of Units)



Source: Dataquest

## ESTIMATED 1990 PRINTING TECHNOLOGY FAX MARKET SHARE

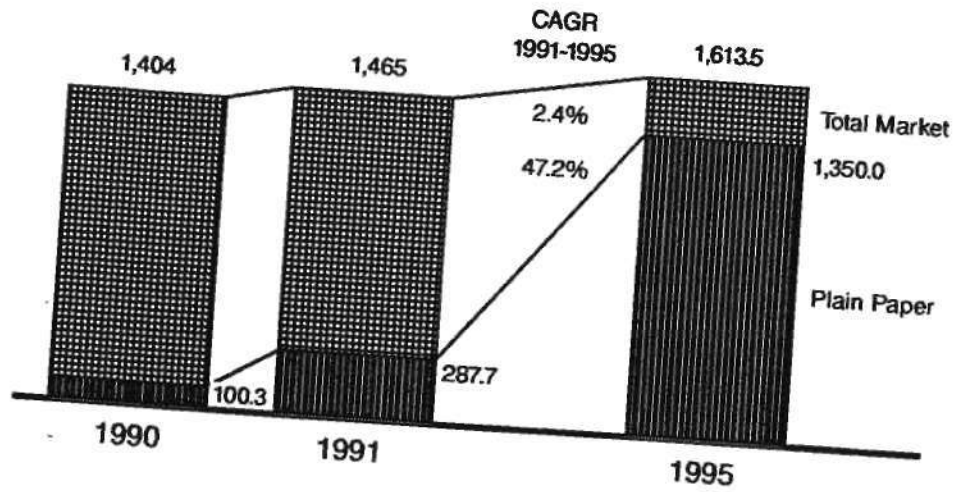


Source: Dataquest

800015.BMG 09/29/91:NUR

# ESTIMATED TOTAL U.S. FACSIMILE TRANSCIVER MARKET

(Thousands of Units)



Source: Dataquest

Notes:

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## **FAX CARDS**

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- 246,800 boards shipped in 90
- Revenue -- \$97 million
- Installed base -- 365,000
- Forecast -- 8 million boards in 1995,  
CAGR = 87%

Source: Dataquest

---

## **PC FAX OFFERS**

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- Higher copy quality
- Confidentiality
- Customization
- Sophisticated facsimile features
- Efficiency for worker
- Desktop fax

## VOICE + FAX INTEGRATION

- **1990 -- 112 systems shipped in United States (1,464 ports)**
- **\$8.7 million revenue in 1990**
- **81,378 systems in 1995, CAGR = 99.4%**
- **\$424.3 million in 1995**

**Source: Dataquest**

**Notes:**



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### **VOICE + FAX OFFERS**

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- Never-busy fax machine
- Broadcasting
- Voice annotation
- Redirection/fax forwarding
- Fax mail boxes
- Confidentiality
- Fax on demand

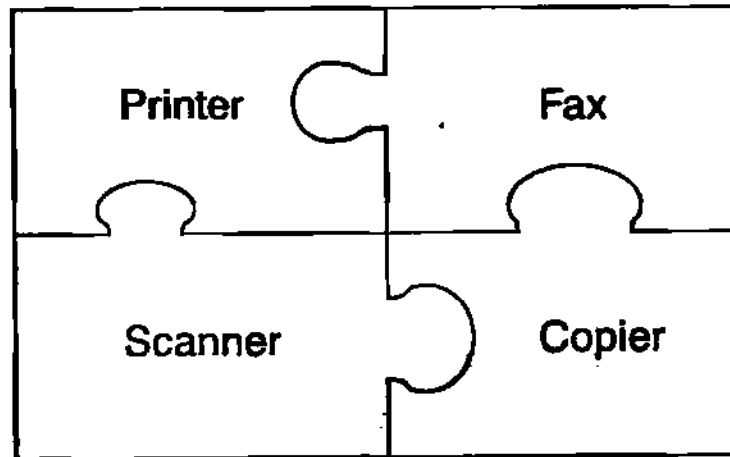
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### **PRINTER FAX DEVICES**

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- Peripherals
- Cards
- Receive-only units
- Software -- PC capability

## THE MULTIFUNCTIONAL PUZZLE



Notes:

## WHO BUYS MULTIFUNCTIONAL PRODUCTS?

	Small Company	Midsize Company	Large Company
Copier	Manager	Office Services	CRD Office Services
Printer	Manager	MIS	MIS
Fax	Manager	Manager Office Services	Telecom

## MULTIFUNCTIONAL PRODUCTS

### Japan

Low end  
Handwritten originals  
Paper distribution exclusively  
Copier led  
Standalone  
Dealer distribution  
Purchasing priority at workstation  
Copier  
Fax  
Printer  
Scanner?

### United States

High end  
PC/printer-generated originals  
Some electronic alternatives  
Printer led  
Modular/standalone  
Direct distribution  
Purchasing priority at workstation  
Printer  
Fax  
Scanner  
Copier

**Notes:**

## **Attendees**

*Larry Le Vieux*  
Vice President

*Don Macleod*  
Senior Vice President

*Jaine Martin*  
Marketing Director

*Dave Matteucci*  
Director

*Mike McCullough*  
Marketing Director

*Dave McKinnon*  
Vice President

*Norm Miller*  
Director

*Ian Olsen*  
Marketing Director

*Jim Owens*  
Senior Vice President

*Demetris Paraskevopouo*  
Director

*Randy Parker*  
Senior Vice President

*George Reyling*  
Business Unit Director

*Dick Sanquini*  
Senior Vice President

*George Scalise*  
Senior Vice President

*John Schabowski*  
Marketing Manager

*Wayne Schwartz*  
Vice President

*John Schweizer*  
Business Unit Director

*Barry Small*  
Vice President

*Luke Smith*  
Vice President

*Mike Sodergren*  
Marketing Director

*Gary Tietz*  
Business Center Director

*Anne Wagner*  
Marketing Director

*Bob Whelton*  
Vice President and General Manager

*Ann Wilkinson*  
Director

## Staff Directory

### SEMICONDUCTOR COMPONENTS GROUP

**John Jackson**

Vice President and Director  
Focus: Semiconductor industry trends

**Jerry Banks**

Director and Principal Analyst  
Focus: Semiconductor industry trends, microprocessors, ASICs, PLDs, nonvolatile memories

**Ron Collett**

Director and Principal Analyst  
Focus: ASICs, electronic design automation, PLDs, semiconductor industry trends

**Sam Young**

Director and Principal Analyst  
Focus: Memories, semiconductor industry trends

**Marc Elliot**

Senior Industry Analyst  
Focus: *DQ Monday*, semiconductor industry trends

**Patricia Galligan**

Senior Industry Analyst  
Focus: Company analysis, PLDs, semiconductor industry trends

**Gary Grandbois**

Senior Industry Analyst  
Focus: Analog, mixed-signal ICs, semiconductor packaging, gallium arsenide semiconductors, semiconductor industry trends

**Jim Handy**

Senior Industry Analyst  
Focus: Static RAMs, specialty memories

**Mary Olsson**

Senior Industry Analyst  
Focus: Packaging, nonvolatile memories

**Ken Lowe**

Senior Industry Analyst  
Focus: Microprocessors, microcontrollers, PC logic chip sets, graphics

**Gene Miles**

Dataquest Associate  
Focus: Gallium arsenide semiconductors, materials, and technology trends

**Anna Cahill**

Industry Analyst  
Focus: Analog, semiconductor industry trends

**Bryan Lewis**

Industry Analyst  
Focus: ASICs, electronic design automation, PLDs

**Junko Matsubara**

Industry Analyst  
Focus: Japanese semiconductor industry

### SEMICONDUCTOR MANUFACTURING AND APPLICATIONS GROUP

**Joseph Grenier**

Group Director  
Focus: Semiconductor manufacturing issues

**Mark Giudici**

Director and Principal Analyst  
Focus: Semiconductor procurement issues

**Nick Samaras**

Director and Principal Analyst  
Focus: Semiconductor applications (data processing segment, smart cards), nonvolatile memories

**George Burns**

Senior Industry Analyst  
Focus: Capital investment, R&D, wafer fab trends

**Mark Fitzgerald**

Senior Industry Analyst  
Focus: Semiconductor materials

## Staff Directory

### **Krishna Shankar**

Senior Industry Analyst  
Focus: Semiconductor manufacturing,  
semiconductor applications

### **Greg Sheppard**

Senior Industry Analyst  
Focus: Semiconductor applications (military/  
aerospace, automotive)

### **Peggy Marie Wood**

Senior Industry Analyst  
Focus: Semiconductor equipment

### **Ronald Bohn**

Senior Industry Analyst  
Focus: Semiconductor pricing trends

### **Jeff Seerley**

Industry Analyst  
Focus: Semiconductor manufacturing, wafer  
fab trends

## **EUROPEAN SEMICONDUCTOR AND DESIGN AUTOMATION GROUP**

### **Bipin Parmar**

Group Director  
Focus: European semiconductor industry  
trends

### **Jonathan Drazin**

Senior Industry Analyst  
Focus: Emerging semiconductor applica-  
tions, data processing segment, communica-  
tions segment, plant locations

### **Jim Eastlake**

Senior Industry Analyst  
Focus: European semiconductor forecast,  
discretes, analog, government policies, trade  
issues, vendor analysis, capital and R&D  
expenditure

### **Mike Glennon**

Senior Industry Analyst  
Focus: ASICs, microcomponents, semicon-  
ductor design and test, cost models

### **Jim Tully**

Senior Industry Analyst  
Focus: European electronic design  
automation

### **Petra Gartzzen**

Industry Analyst  
Focus: European computer-aided design

### **Byron Harding**

Industry Analyst  
Focus: Memories, pricing trends, semicon-  
ductor packaging

### **Mike Williams**

Industry Analyst  
Focus: Automotive segment, consumer  
segment, European OEM manufacturing  
database

### **Kazunori Hayashi**

Group Director  
Focus: Japanese semiconductor industry  
trends

### **Kunio Achiwa**

Senior Industry Analyst  
Focus: Capital spending, semiconductor  
manufacturing, semiconductor equipment

### **Susumu Kurama**

Senior Industry Analyst  
Focus: Semiconductor device trends,  
Japanese semiconductor industry trends

### **Kun Soo Lee**

Research Analyst  
Focus: Electronic equipment production,  
semiconductor applications

### **Akira Minamikawa**

Research Analyst  
Focus: Memories, analog ICs, Japanese  
semiconductor distribution

## **TAIWANESE SEMICONDUCTOR RESEARCH**

### **Dan Heyler**

Industry Analyst  
Focus: Taiwan semiconductor industry,  
Korean semiconductor industry, Asian  
semiconductor markets

## Staff Directory

### RESEARCH OPERATIONS

#### **Data Handling: Supply-Side**

##### **Pat Cox**

Manager

Focus: Market share issues, semiconductor market share

##### **Rebecca Burr**

Industry Analyst

Focus: Fab database, semiconductor equipment, silicon market share, semiconductor equipment and materials forecast

##### **Irene Perez**

Industry Analyst

Focus: *Company Backgrounders by Dataquest*

##### **Ken Dalle-Molle**

Industry Associate

Focus: Semiconductor market share, microcomponents, analog

##### **Ade Olorunsola**

Industry Associate

Focus: Memories, semiconductor market share

#### **Data Handling: Demand-Side**

##### **Ken Newbury**

Manager

Focus: Applications and end-user data

#### **Forecasting**

##### **Ken Thornton**

Manager

Focus: Forecasting issues

##### **Terry Birkholz**

Industry Analyst

Focus: Forecasting issues, semiconductor industry forecast

##### **Penny Sur**

Industry Analyst

Focus: Semiconductor industry forecast, electronic equipment forecast, semiconductor consumption by application market forecast, I/O ratios

### SEMICONDUCTOR CUSTOM CONSULTING

##### **Stan Bruederle**

Vice President and Director

Focus: Product strategy planning and analysis, competitive analysis

##### **Andrew Prophet**

Associate Director

Focus: ASIC technology, foundries, business strategies and alliances

##### **Howard Bogert**

Senior Staff Analyst

Focus: Emerging technologies (multi-chip modules, neural networks, ferroelectric memories), semiconductor manufacturing trend analysis

### SEMICONDUCTOR MARKETING

##### **Alice Leeper**

Associate Director

Focus: All semiconductor services



### ***Dataquest***

Dataquest is a leading market research and consulting company specializing in electronics industries. Dataquest has tracked the semiconductor industry since 1974. The Semiconductor Group develops, maintains, and updates databases that cover the total spectrum of semiconductor products and markets.

The company collects, interprets, and analyzes data from our offices in Japan, England, Taiwan, and Korea, as well as San Jose, California, in order to provide country-by-country, regional, and global perspectives to our research.

Accurate, in-depth information and analysis on market size, characteristics, and potential are available for a wide range of high-technology products. Dataquest products range from cost-effective industry services and multiclient studies to market-specific reports, newsletters, and conferences. Clients with specialized requirements can also choose to utilize our custom consulting and primary research programs.

### ***Products of Special Interest***

The following are just some of the products and services we think would be of interest to today's audience. For a more complete discussion of how we could serve your specific needs, please contact your Dataquest marketing manager or Craig Willison, Vice President of Sales, at (408) 437-8331.

### **Industry Services**

- Semiconductors *Worldwide*
  - Products, Markets, and Technologies
- Semiconductors *Asia*
- Semiconductors *Europe*
- Semiconductors *Japan*
- Semiconductor Application Markets *Worldwide*
- Semiconductor Application Markets *Europe*
- Semiconductor Equipment, Manufacturing, and Materials
- Semiconductor Procurement

### **Focused Product Segments**

- Analog: Linear and Mixed-Signal ICs
- ASICs
- Gallium Arsenide Semiconductors
- Memories
- Microcomponents

### **Custom Research**

- Consulting
- Primary Research

### **Multiclient Studies**

- Personal and Wireless Communications in the United States
- Japanese Emerging Fabs: Capital Investment Analysis
- Multichip Modules: Issues and Trends