Semiconductor Equipment and Materials Service

Our Rapidly Changing Industry: Status 1988

PROCEEDINGS AT SEMICON/WEST

Dataquest Incorporated

May 25, 1988

Dunfey San Mateo Hotel

Dataquest

a company of The Dun & Bradstreet Corporation

SEMICON/West Seminar
May 25 through 25, 1988
San Mateo, California

List of Attendees

AG Associates	R. Bruce Springer, Director, Client Services
ASM International	Herbert Lakens, Marketing Director
ASM Lithography, Inc.	Richard Aurelio, President David Sikes, General Manager/Executive Vice President
ATEQ Corporation	Doug Marsh, Vice President, Sales & Marketing
Advanced Micro Devices, Inc.	Oolep Indreko, Director, Strategic Technology Planning C. Richard Deininger, Director, Manufacturing Technology
Advantest America, Inc.	Frederick Bihler, President
Aeroquip Corporation	Ed Gantzer, Product Manager Tom Smigielski, Market Demand Planner
Air Products & Chemicals, Inc.	Dean Duffy, Program Manager John C. W. King, Group Manager, Electronics Systems
Airco Electronic Gases	Jeffrey D. Eagles, Manager, Electronic Business Team
Alan Patricof Associates, Inc.	Bill Bottoms, Senior Vice President & General Partner

American Semiconductor Equipment Tech.	Greg Reyes, President
Anelva Corporation	Hideo Mito, General Manager
Apple Computer, Inc.	John Jennings, Supply Base Manager, ASICS
Arthur Young & Company	Roger Dunbar, Partner-in-Charge Alton Page, Audit Principal
Ashland Chemical Company	James A. Duquin, Vice President and General Manager
BTU Engineering Corporation	Robert L. Klimm, Vice President, Marketing
Branson International Plasma Corporation	Lou Perrone, Vice President, Marketing & Technology
CNET	Danielle Chalendard, Engineer
Coopers & Lybrand	Jon Wellman, General Practice Manager
Cybeq Systems	Emile Kerba, Manager, Marketing & Sales Kanegi Nagai, Executive Vice President/General Manager
Eaton Corporation	George Mosnicka, National Sales Manager Jeoffrey Ryding, Vice President & Director Marketing, Sales & Services Robert Semmler, General Manager Walter Wriggins, Director, Marketing
E.I. DuPont de Nemours & Company	Daniel J. Kratzer, Marketing Programs Manager
EKC Technology, Inc.	Joyce M. Jensch, National Sales Manager

Electronic News	Jeff Dorsh
Electronic Engineering Times	Loring Wirbel, Editor
ENI	Edward L. Maier, Director, Business Planning
Equitable Life Leasing Co.	Steve Grundon, Vice President Marketing Services & Development Ellie Sanchez, Market Research Analyst
FSI International	Leena R. Orpo, Communications Specialist Mary Jo Peters, Coordinator Public Relations
First Interstate Bank	Rose Marie Filicetti, Vice President Marc J. Verissimo, Vice President
Focus Semiconductor Systems, Inc.	Jerry Oberly, Vice President, Sales & Marketing
GaSonics	Phil Crabtree, Marketing Manager
Genus, Inc.	Ron Dornseif, Director, Strategic Programs William W.R. Elder, President and CEO Richard Hannigan, Executive Vice President and CFO Michael W. McCann, Director, Product Marketing Paul Reagan, Executive Vice President and COO
Genus/Ionex	Frank Deak, Vice President, General Manager Manny Sieradzki, Vice President, Marketing Norm Turner, Chief Scientist
Gould, Inc.	Joe O'Neill, Vice President, Sales

Hampshire Instruments, Inc.	Tom Kulczycki, Director, Sales & Marketing
Hewlett-Packard Company	Clint Hutchinson, Sales Manager
Hitachi America, Ltd.	K. Ueno, Senior Vice President
Honeywell Microswitch	Gamil Chelico, Manager, Strategic & Business Development Gary Tighe, Product Planner
Honeywell, Inc.	Larry Goldstein, Staff Engineer Eugene R. Hnatek, R & D Engineering Manager
Hualon Microelectronics Corporation	Yi-Jia Chen, Equipment Department Manager C. S. Peng Liank Wu, Product Engineering Department Manager
Hughes Aircraft Company	Carl Salanitro, Manager, Corporate Materials
Hyundai Electronics America	Iksu Kim, Director, Strategic Marketing
ICD Austria	Hubert Gammer, Director
IHI	Yukiya Nakagawa
IVS, Inc.	Chris Morrill, Vice President, Sales & Marketing
Insystems, Inc.	George Canavan, Vice President, Marketing
Intel Corporation	Amy Habib, Market Analyst Sarah Robinson, Research Analyst Jacques J. Vuye, International Marketing Manager

Keithley Instruments, Inc.	John Snyder, Senior Market Research Analyst
Kobe Development Corporation	Katsuhiko Inoue, Manager
L'Air Liquide	Gilles Moutardier, Engineer
Lam Research Corporation	Steve P. DeOrnellas, Vice President, Marketing Henk Evenhuis, Vice President-Finance & Administration, Chief Financial Officer
Liquid Air Corporation Alphagaz	Susan Schmertmann, Product Manager
Lucky Advanced Materials, Inc.	J. S. Choo, Senior Managing Director S. K. Hahn, President
Microelectronics Technology Company	Kazu Funahashi Akira Miura, President & General Manager Akifumi Nagao
Mitsubishi International Corp.	Raymond Phillips, Senior Vice President, Operations
Mitsubishi Metal Corporation	Kikuo Matsumoto, General Manager, New Materials Division
Monsanto Electronic Materials Company	Wendy Grossman, Manager, Market Analysis
Morton Thiokol, Inc.	Jim E. Dodsworth, Product Manager, Semiconductor Materials Group
NBK Corporation	Donna Felter, Vice President, Marketing and Sales
NEC Corporation	Kazuhiko Tsukada, Supervisor, Semiconductor Group Planning

Napson, Ltd.	Makoto Nakamura, Marketing Manager
Niigata MTI Company, Ltd.	Manoru Shibata, Vice President Masaharu Takeda, Sales Manager
Nikon Inc.	Chris Brandmaier, Assistant Manager, Industrial Section, Technological Department
Nikon Precision, Inc.	Rick La France, Director, Marketing
Northern Telecom Electronics Inc.	Valerie Kisak, Manager, Industry Economics
Orient Semiconductor Electronics, Ltd.	David Cheng, Vice President
Osaka Sanso Kogyo, Ltd.	Mike Solomon, General Manager
Perkin-Elmer Corporation	Robert McMenamin, Western Regional Marketing Manager
PlanTek	Larry Campbell, Senior Vice President
Prometrix Corporation	Paul Covec, Director, Marketing Talat Hasan, Vice President, Advanced Products Steve Westrate, International Marketing Manager
R&D Funding Corporation	Jonathan Baer, Investment Manager Lawrence Bill, Vice President Richard E. Moser, President
RCM Capital Management	Huachen Chen, Research Analyst
Ross-Dove Company, Inc.	Bruce W. Leister, National Account Executive

SEH America, Inc.	Isao Iwashita, President
SGS-Thomson Microelectronics	Mike J. VanHoy, Vice President, Manufacturing Operations
Security Pacific Capital Corporation	James McElwee, Managing Partner
Seiko Instruments USA, Inc.	Hiroshi Fukino, President
Semiconductor Services	Carol Seaborn
Semiconductor Systems, Inc.	Jim Knudsen, Vice President, Engineering
Shinko Electric America, Inc.	David Mehlhoff, Marketing Manager
Sieber Kikai	Yasuo Komatsuzaki, Assistant Manager
Siemens Components, Inc.	Peter Leditznig, Vice President, Controller
SiSCAN Systems	Gerry Leever, Marketing Manager
Sigma Partners	Cliff Haas, Associate
Silicon Valley Group, Inc.	Jim Herlinger, Vice President & General Manager CVD Operations
Siliconix Incorporated	Joe Baranowski, I.C. Marketing Manager
Siltec Corporation	Stanley Myers, President & CEO
Siltec Silicon	Larry Hydrusko, Marketing Manager Dennis West, Vice President, Marketing & Sales

Solid State Technology Magazine	Sid Marshall, Editor
Taiwan Semiconductor Mfg. Co.	Klaus C. Wiemer, Vice President, Operations
Team International Ltd.	Gene J. Amato, President, CEO
Tegal Corporation	George Gorin, Vice President Craig Keith, Comptroller Corey J. Mullins, Marketing Manager
Tencor Instruments	Dale Guidoux Daniel Tam
Thesis Group	Jim Stewart, Vice President Clay Sutton, President
Tylan Corporation	Klaus Schuegraf, Vice President
Ultratech Stepper, Inc.	Ken Agarwal, Director, Marketing
Union Carbide Corporation	Charles Krichbaum, Marketing Manager, Bulk Gases
Union Carbide Corporation	Thomas Nelson, Applications Manager, Electronics Thomas L. Singman, Marketing Manager, Electronics Walter Willett, National Sales Manager
VLSI Technology, Inc.	Ken Chuang Vic Kulkarni
Wacker Siltronic Corporation	David H. Ward, Manager, Regional Sales
Western Digital Corporation	John V. Crosby, Vice President, LSI Manufacturing

Westpac Banking Corporation	Carol A. Howe, International Banking Officer William S. Reed, Vice President
Xilinx	Frank Myers, Vice President, Manufacturing
Xynetics	Gordon C. Westwood, Vice President, Marketing

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SEMICON/WEST SEMINAR

Our Rapidly Changing Industry: Status 1988

Agenda

Semiconductor Equipment and Materials Service
May 25, 1988
Dunfey San Mateo Hotel

7:30 a.m.	Registration and Continental Breakfast
8:00 a.m.	**Welcome and Introduction** Robert McGeary Director Semiconductor Equipment and Materials Service Dataquest Incorporated
8:15 a.m.	**Keeping an Eye on the Customer's Customer** Anthea Stratigos Associate Director Semiconductor User and Applications Group Dataquest Incorporated
8:40 a.m.	**Semiconductor Manufacturing Comes of Age** George Burns Industry Analyst Semiconductor Equipment and Materials Service Dataquest Incorporated
9:05 a.m.	**Capacity Analysis in North America** Mark Reagan Research Analyst Semiconductor Equipment and Materials Service Dataquest Incorporated
9:30 a.m.	**The Changing Structure of the Worldwide Fab Equipment Industry** Joseph Grenier Senior Industry Analyst Semiconductor Equipment and Materials Service Dataquest Incorporated
9:55 a.m.	Coffee Break
10:15 a.m.	**Semiconductor Materials: Perspective on Wafers** Dr. Peggy Marie Wood Industry Analyst Semiconductor Equipment and Materials Service Dataquest Incorporated
10:40 a.m.	**World Semiconductor Outlook** Gene Norrett Corporate Vice President and Division General Manager Components Division Dataquest Incorporated
11:05 a.m.	**Competitive Structure in Asia** Tom Wang Director Asia/Pacific Components Group Dataquest Incorporated
11:30 a.m.	**European Competitiveness Analysis** Bipin Parmar Senior Industry Analyst European Components Group Dataquest Incorporated
12:00 Noon	Adjourn

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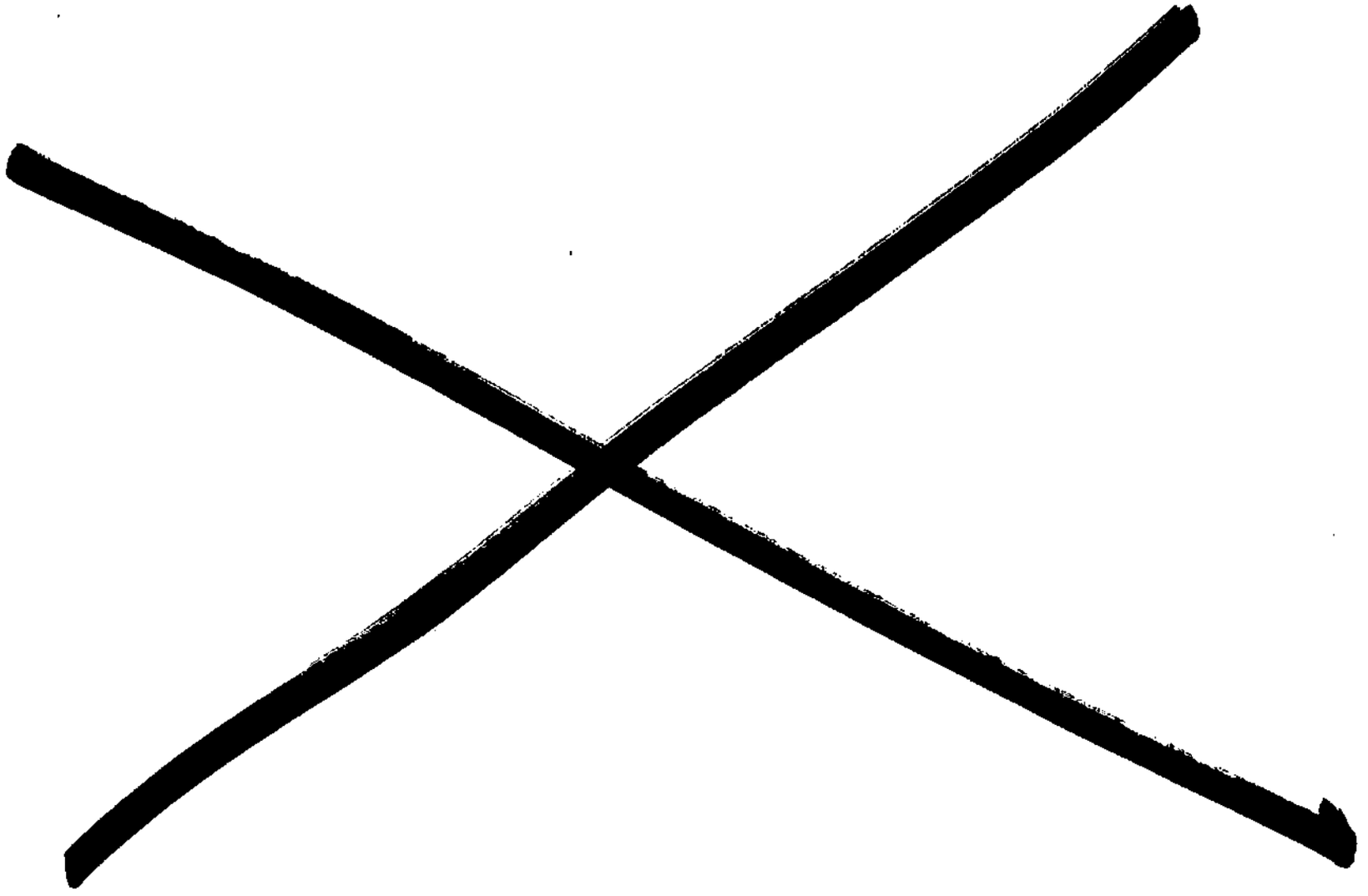
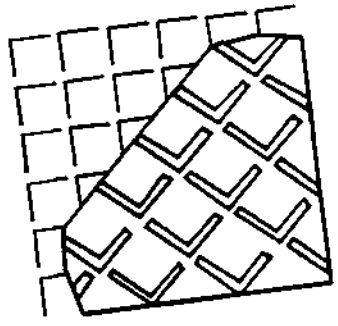


Our Rapidly Changing Industry:
Status 1988



SEMICONDUCTOR INDUSTRY STATUS -- 1988

ROBERT McGEARY

Director
Semiconductor Equipment and Materials Service
Dataquest Incorporated

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SEMINAR AGENDA

Time	Speaker	Subject
8:00 a.m.	Robert McGeary	Welcome
8:15 a.m.	Anthea Stratigos	The Customer
8:40 a.m.	George Burns	Semiconductor Manufacturing
9:05 a.m.	Mark Reagan	Capacity Analysis
9:30 a.m.	Joe Grenier	Changing Structure of Equipment Markets
9:55 a.m.	Break	
10:15 a.m.	Peggy Wood	Perspective on Silicon
10:40 a.m.	Gene Norrett	World Outlook
11:05 a.m.	Tom Wang	Asian Outlook
11:30 a.m.	To Be Announced	European Outlook

SEMS ACCOMPLISHMENTS

Founded May 1985

- Leading market research service for semiconductor equipment and materials
- Developed worldwide fabrication data base
- Developed comprehensive equipment vendor data base
- Developed worldwide data base on silicon production and consumption

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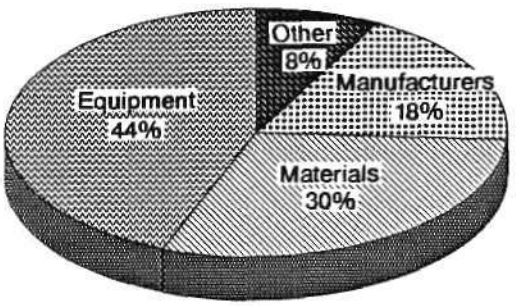
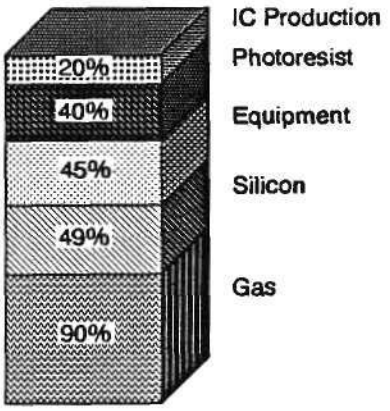
SEMS CLIENTS

Profile



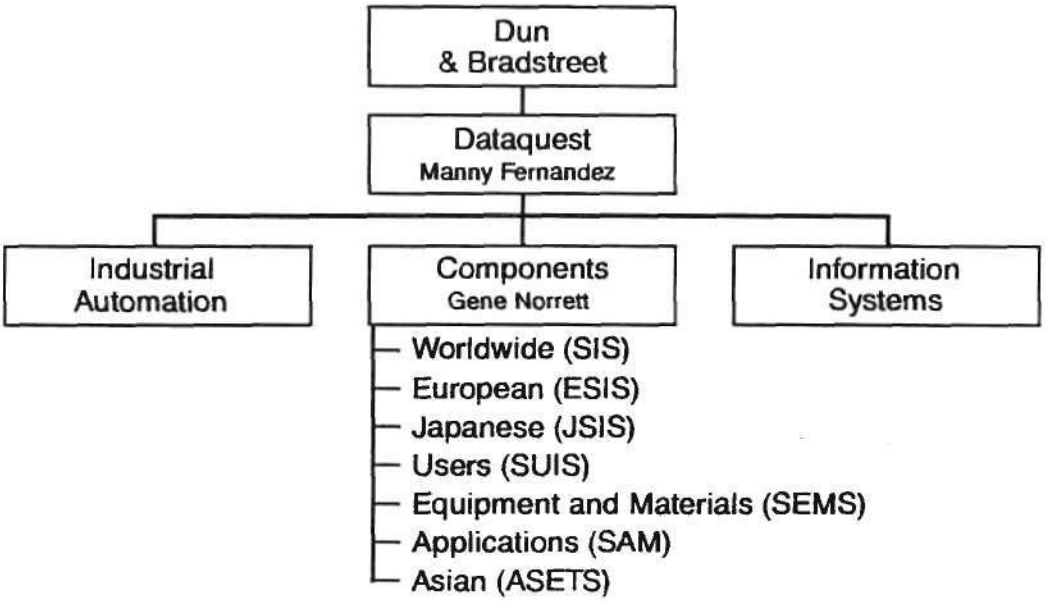
Subscription Base



Subscribers' Market Shares

Source: Dataquest

DATAQUEST COMPONENTS DIVISION ORGANIZATION



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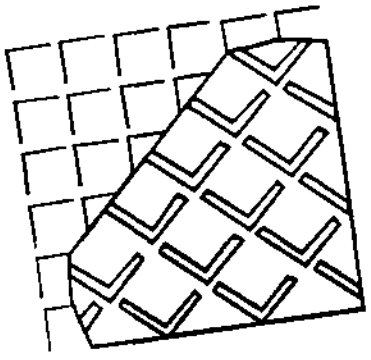

KEEPING AN EYE ON THE CUSTOMER'S CUSTOMER

ANTHEA C. STRATIGOS

Associate Director
Semiconductor User and Applications Group
Dataquest Incorporated

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You must either conquer and rule
or serve and lose,
Suffer or triumph,
be the anvil or the hammer.

Goethe

. . . But remember,
you haven't lost until
you've surrendered.

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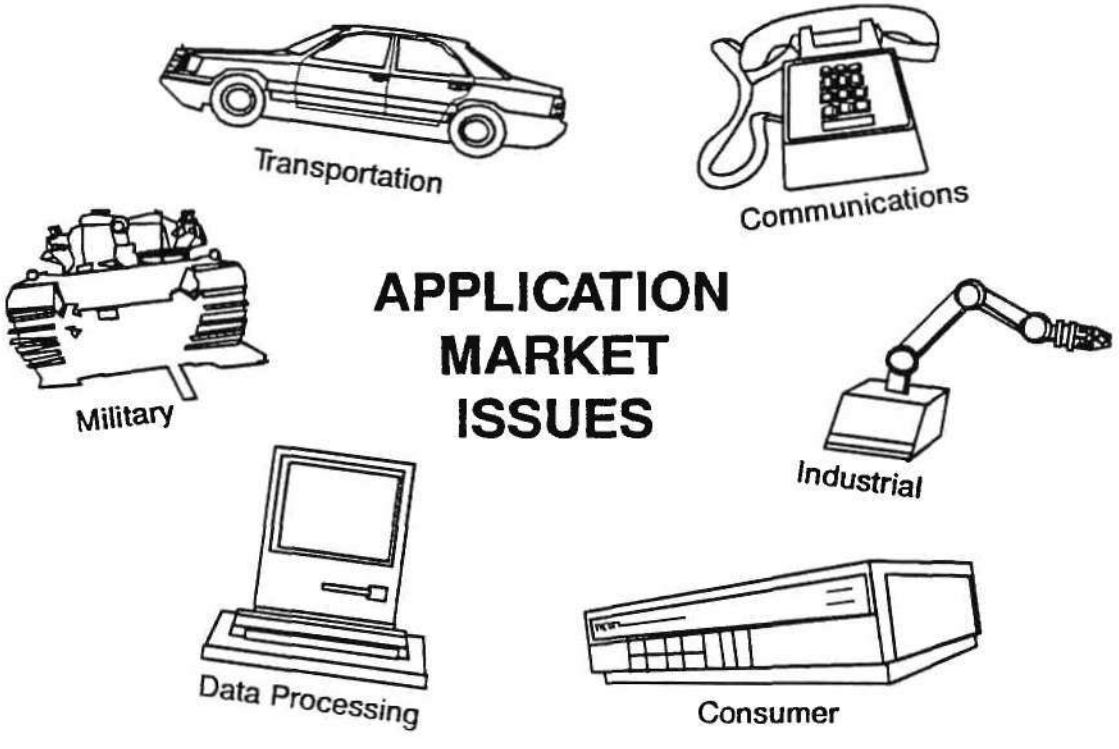
BECOMING THE BEST

- Keep listening to the customer
- Keep your eyes on the customer's customer



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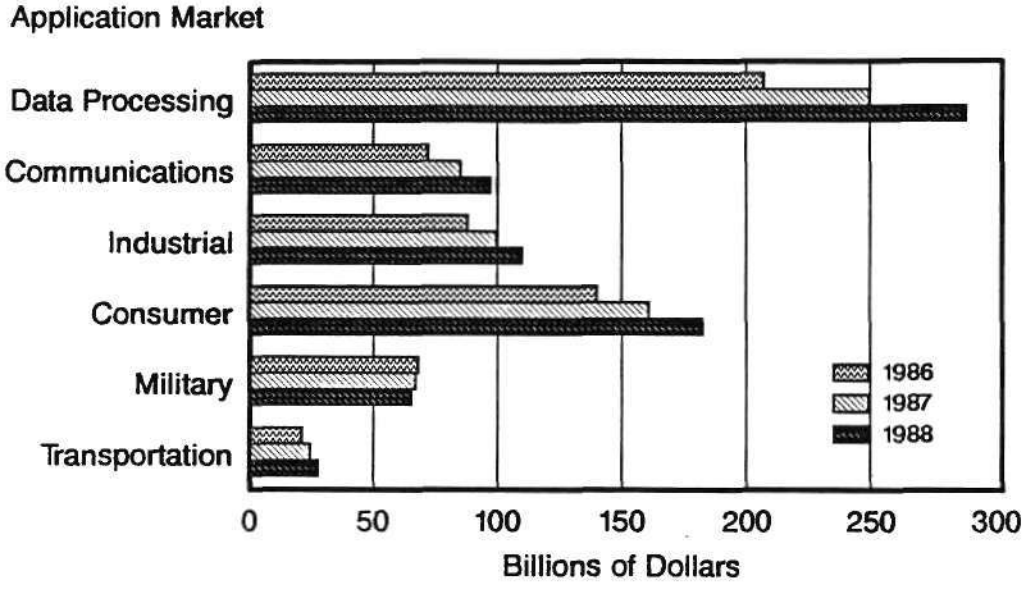
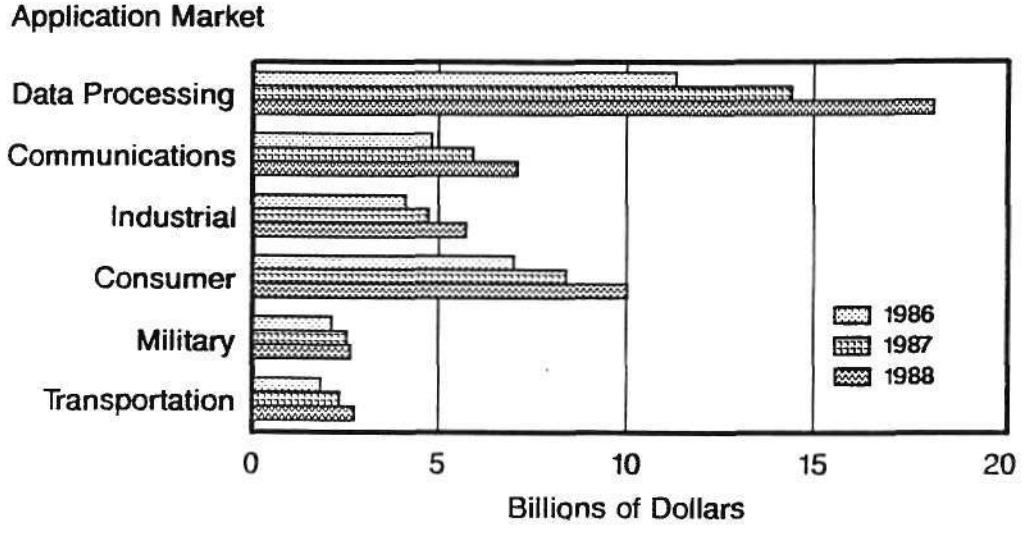
WORLDWIDE ELECTRONICS PRODUCTION



Source: Dataquest

WORLDWIDE SEMICONDUCTOR CONSUMPTION

By Application Market



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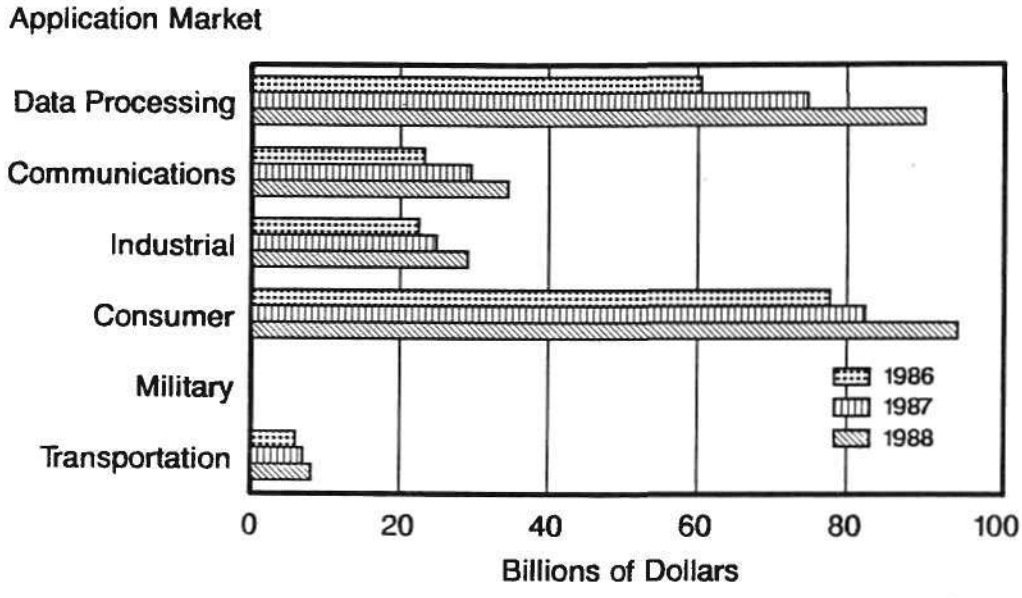
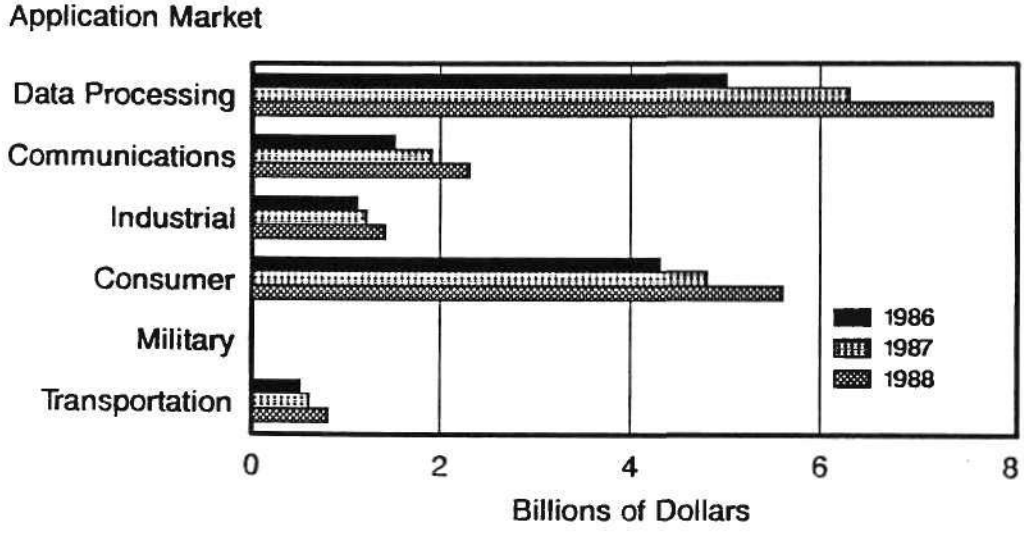
JAPANESE ELECTRONICS PRODUCTION



Source: Dataquest

JAPANESE SEMICONDUCTOR CONSUMPTION

By Application Market



Source: Dataquest

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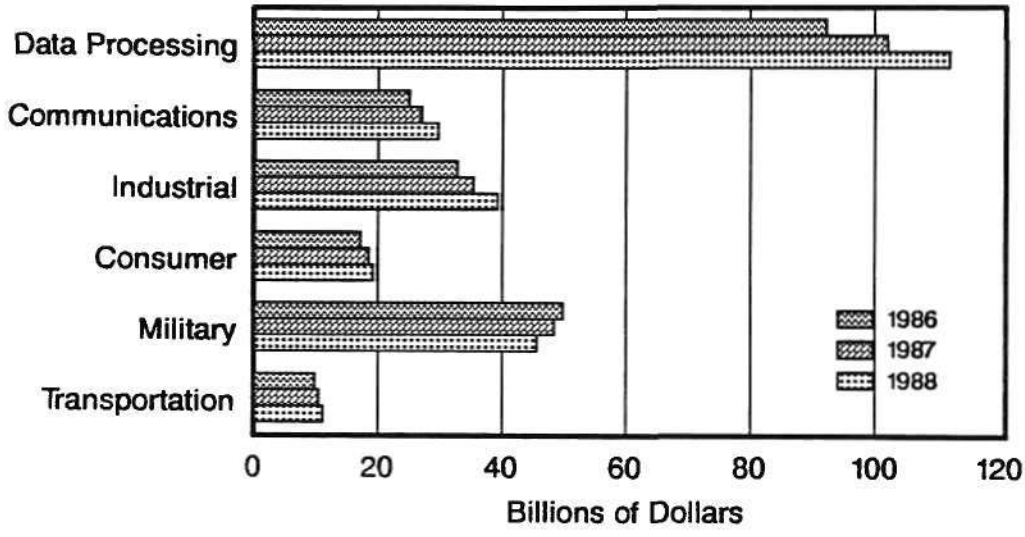
NORTH AMERICAN ELECTRONICS PRODUCTION

Application Market

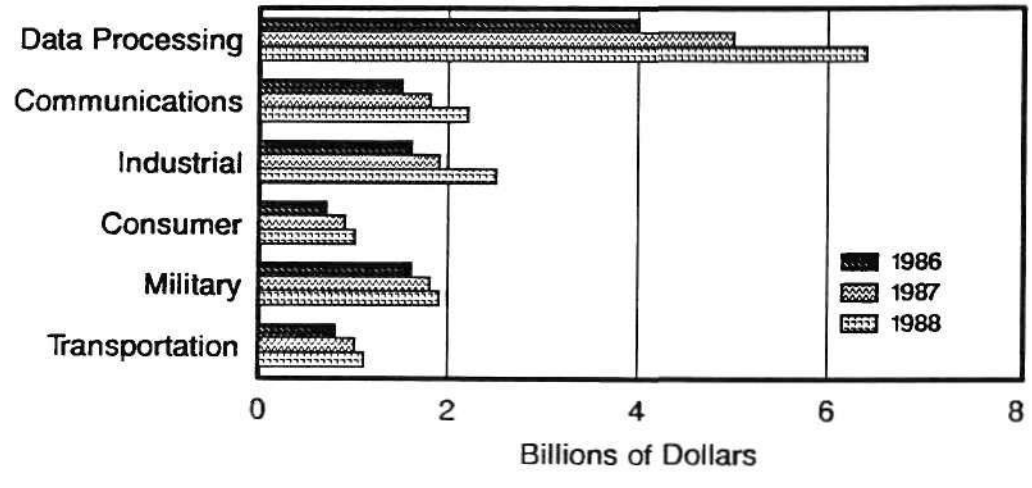


Source: Dataquest

NORTH AMERICAN SEMICONDUCTOR CONSUMPTION

By Application Market

Application Market



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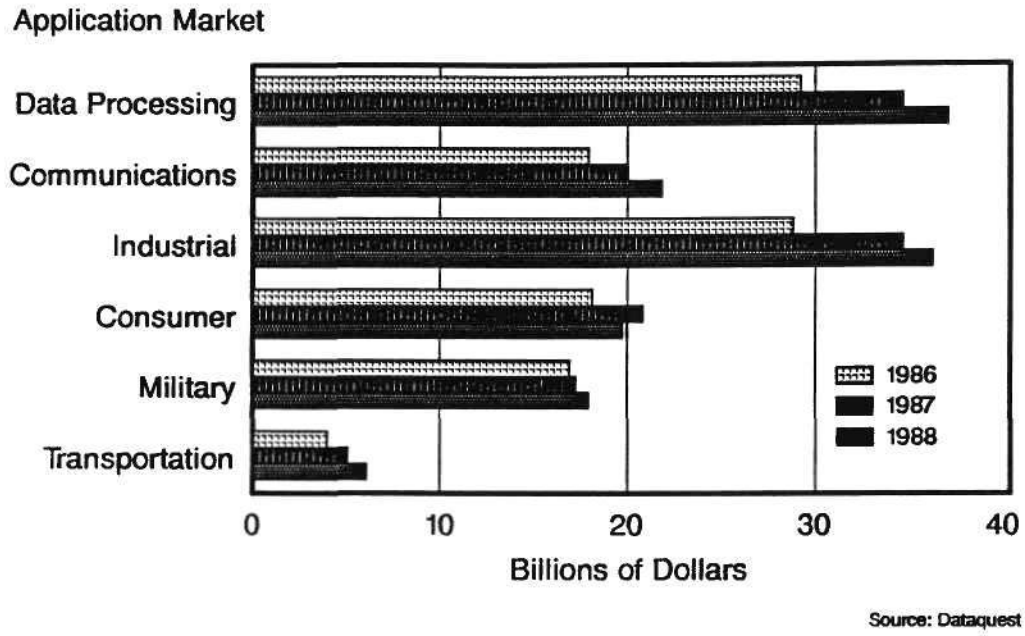
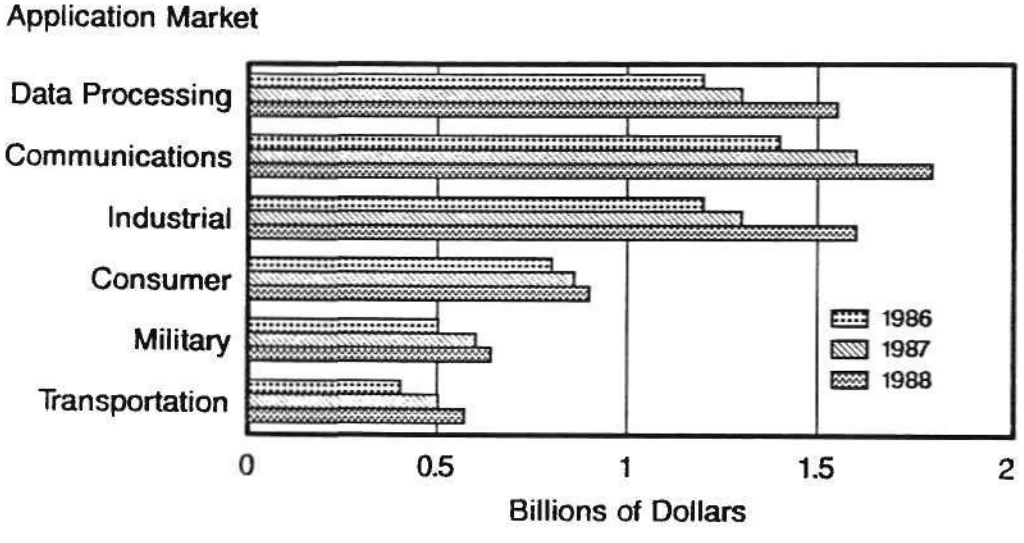
EUROPEAN ELECTRONICS PRODUCTION



Source: Dataquest

EUROPEAN SEMICONDUCTOR CONSUMPTION

By Application Market



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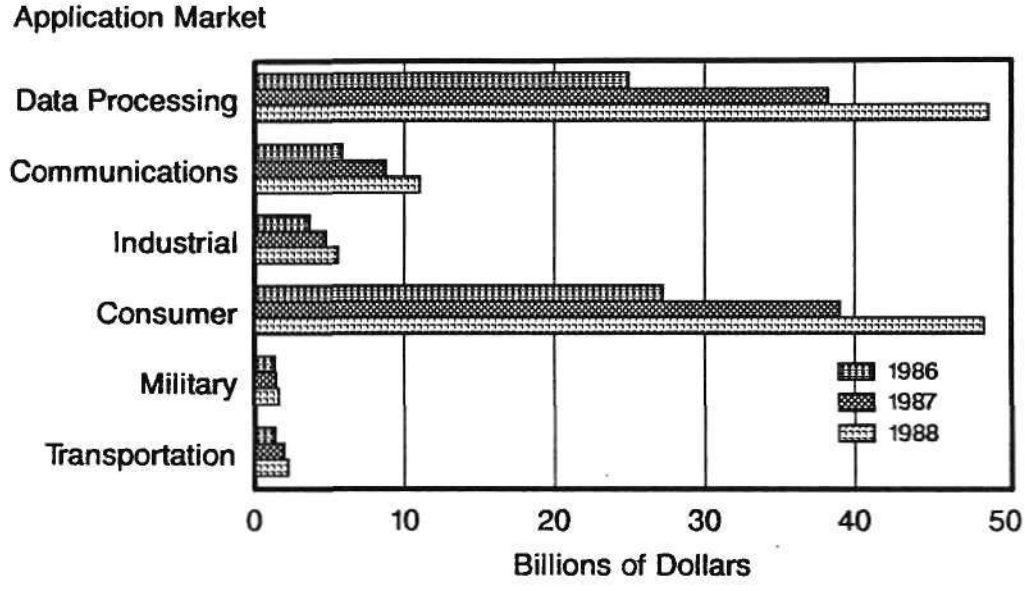
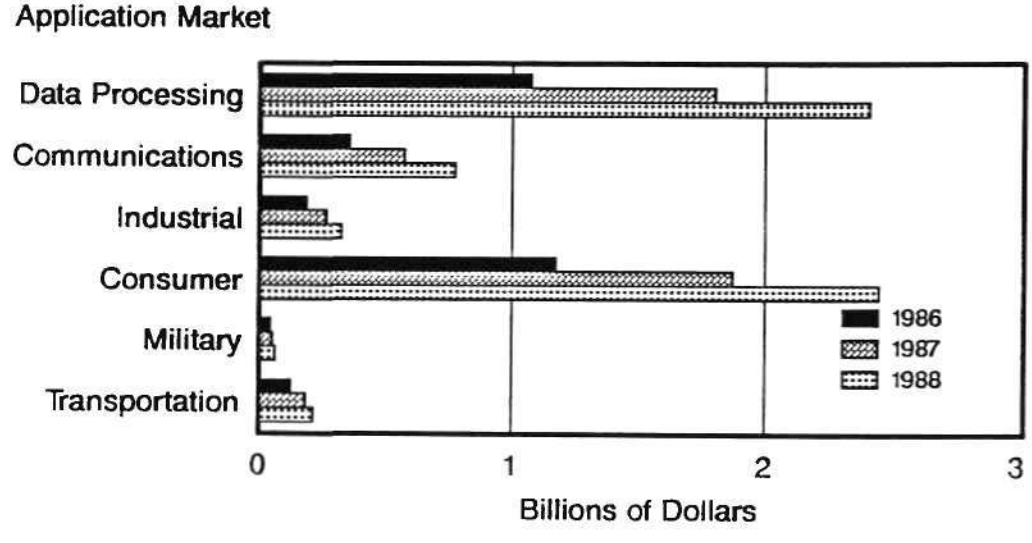
REST OF WORLD ELECTRONICS PRODUCTION



Source: Dataquest

REST OF WORLD SEMICONDUCTOR CONSUMPTION

By Application Market



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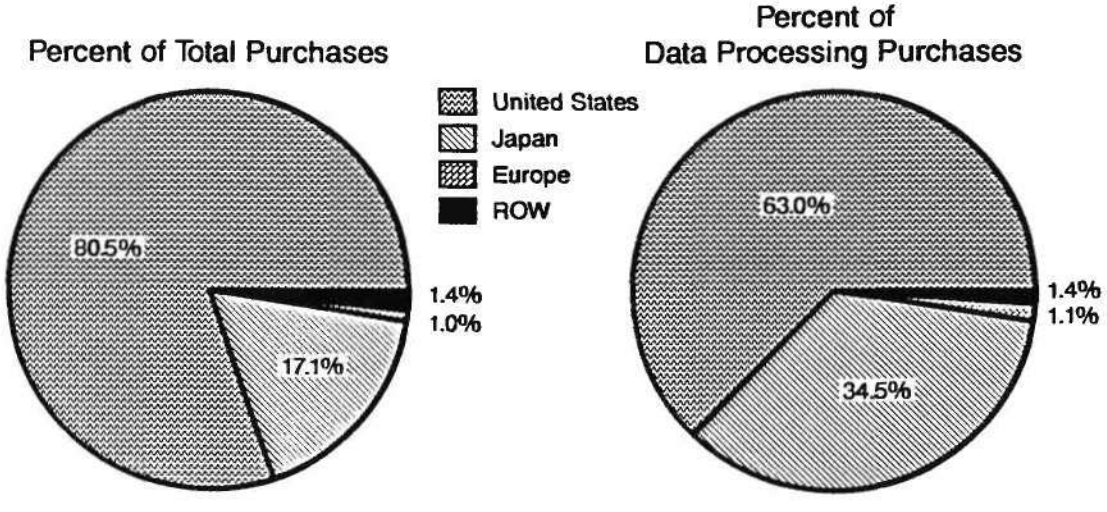
SEMICONDUCTOR USER ISSUES

REGIONAL SUPPLIER BASE



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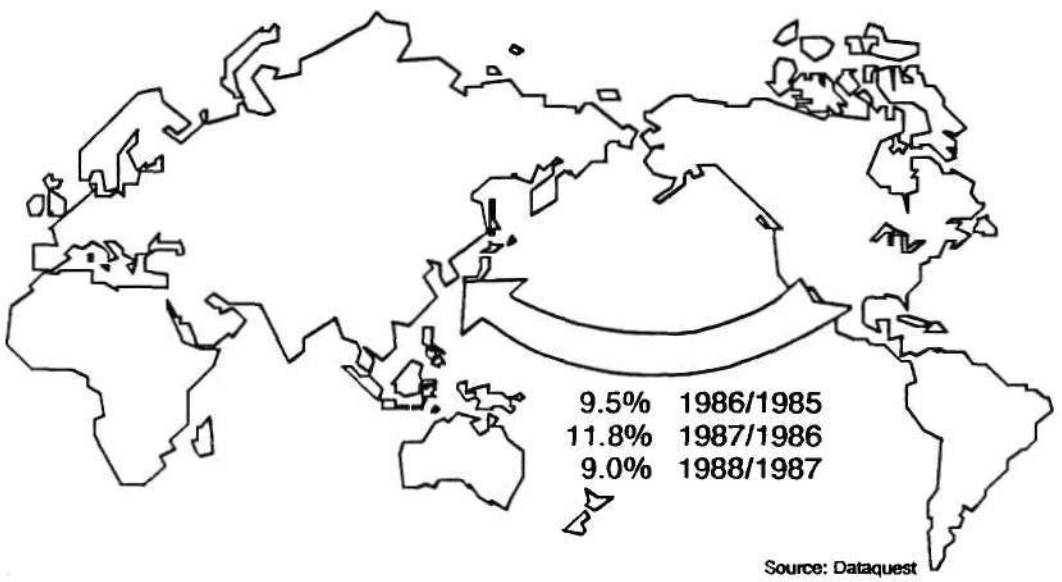
ANTICIPATED SHIFT TO OFFSHORE PRODUCTION

	1986	1987	1988
A Great Deal	8.4%	10.1%	3.3%
Some	35.9%	33.2%	34.0%
Not at All	55.7%	56.7%	62.7%

Source: Dataquest

ESTIMATED U.S. SEMICONDUCTOR CONSUMPTION MOVING OFFSHORE

(Percent of Total Dollars)



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THE MAJOR ISSUES

1986	1987
Pricing	Pricing
Quality/reliability	Availability/lead times
On-time delivery	Quality/reliability
Supply/availability/shortages	On-time delivery
JIT/inventory control	FMVs/trade agreement
Reducing vendor base	Cost control
Product obsolescence	JIT/inventory control
Second-sourcing	Surface mount
Forecasting	New products/obsolescence
	ASICs
	Offshore manufacturing and procurement

THE MAJOR ISSUES

1988

- Availability/lead times/shortages
- Pricing
- On-time delivery
- Cost control
- Memories
- Quality/reliability
- Reducing vendor base
- New products/obsolescence
- JIT/inventory control
- Fluctuating yen/currency exchange

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CONCLUSIONS

- Users expect continued growth in purchases
- Availability, lead times, and shortages are critical issues
- Closer vendor/buyer connections may temper the cycle
- The shift offshore may be slowing
- Cost control and manufacturing strategies still play critical roles in determining buyer action

WORKING PARTNERSHIPS ARE CRUCIAL

- Users need to:
  - Protect market
  - Access technology
  - Control costs

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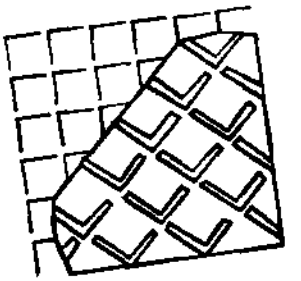

SEMICONDUCTOR MANUFACTURING COMES OF AGE

MEETING THE CHALLENGES OF INCREASING COST AND COMPLEXITY

GEORGE BURNS

Industry Analyst
Semiconductor Equipment and Materials Service
Dataquest Incorporated

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1987 U.S. CAPACITY UTILIZATION BY LINE GEOMETRY

Line Geometry	
< 3 Micron	0.87
> = 3 Micron	0.67

Source: Dataquest

NEW U.S. FABS

State	Number of Fabs
California	20
Texas	17
New Mexico	3
Oregon	3
Arizona	3
Colorado	3
Maine	3
Others	14
Total	66

Source: Dataquest

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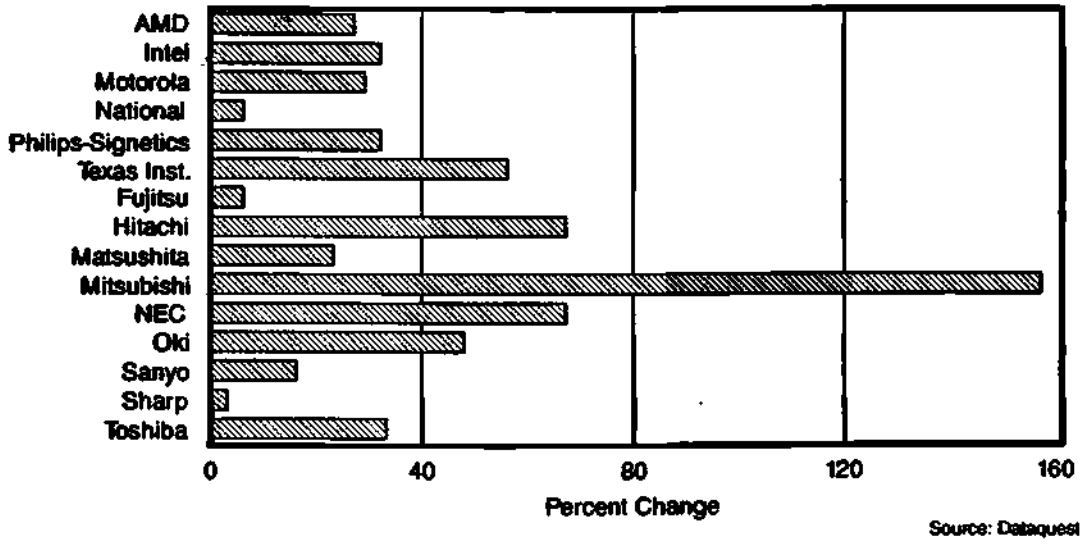
SEMICONDUCTOR MANUFACTURING COMES OF AGE

- Semiconductor demand at the leading edge
- Capital spending surging forward
- Industry-wide response increasing productivity
  - Equipment productivity
  - Culture
  - Cleanliness

U.S. AND JAPANESE COMPANIES PERCENTAGE INCREASE

Happy Days Are Here Again?



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SEMICONDUCTOR MANUFACTURING COMES OF AGE

- Semiconductor demand at the leading edge
- Capital spending surging forward
- Industry-wide response increasing productivity
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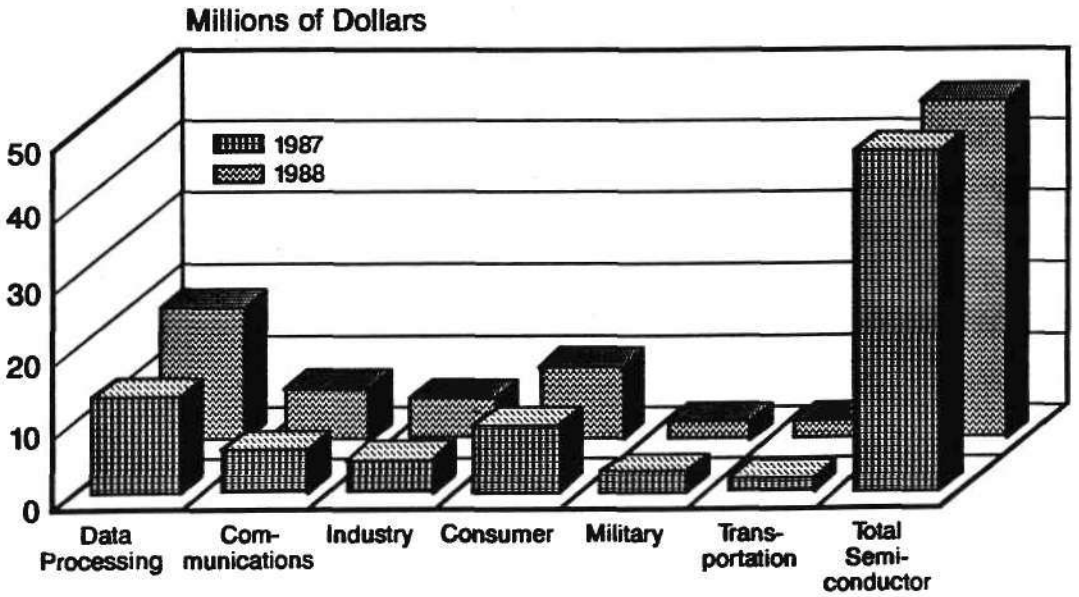
  - Cleanliness

SEMICONDUCTOR APPLICATION MARKET REVENUE



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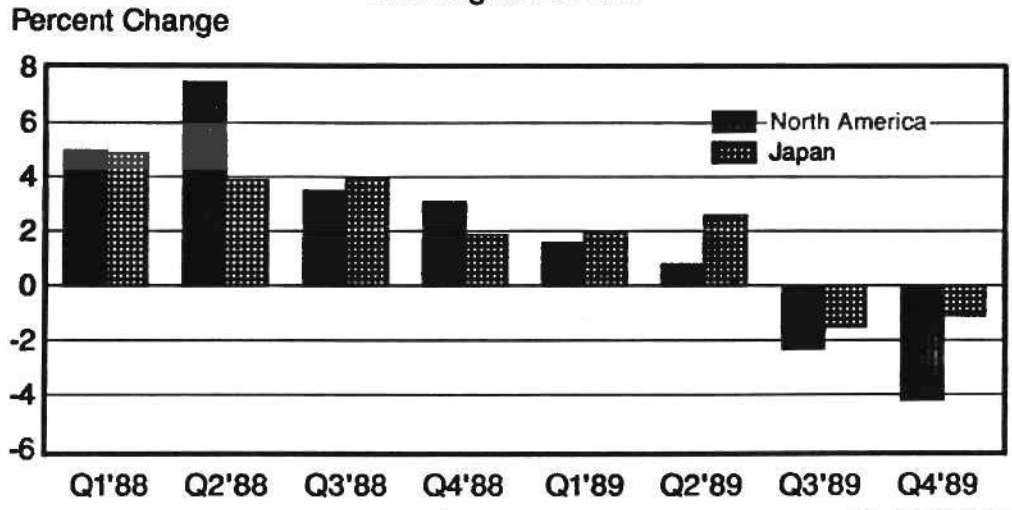
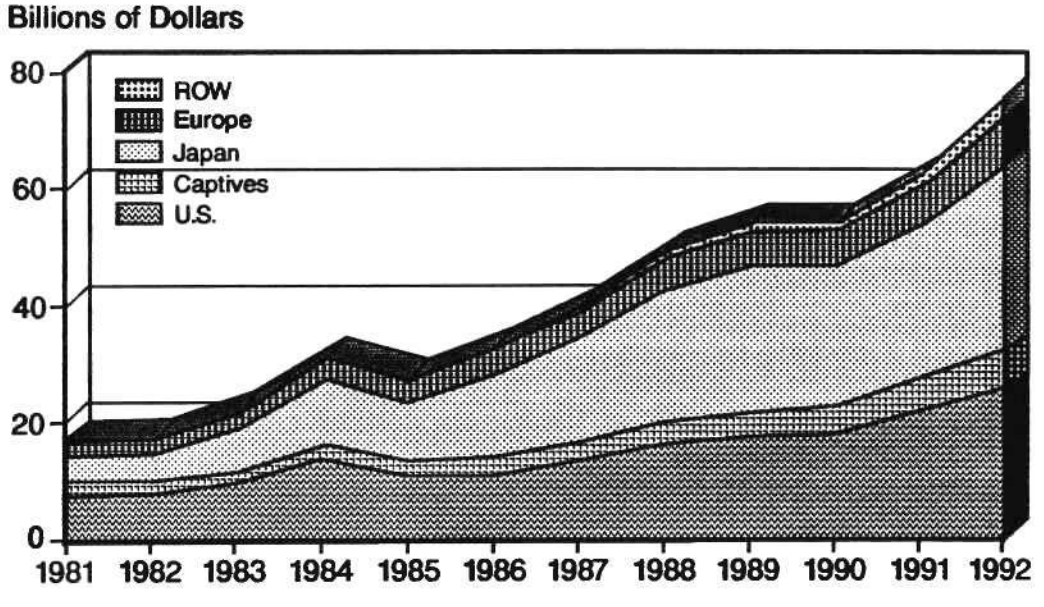
ESTIMATED WORLDWIDE SEMICONDUCTOR MARKET

Charting the Course



Source: Dataquest

ESTIMATED SEMICONDUCTOR PRODUCTION



Source: Dataquest

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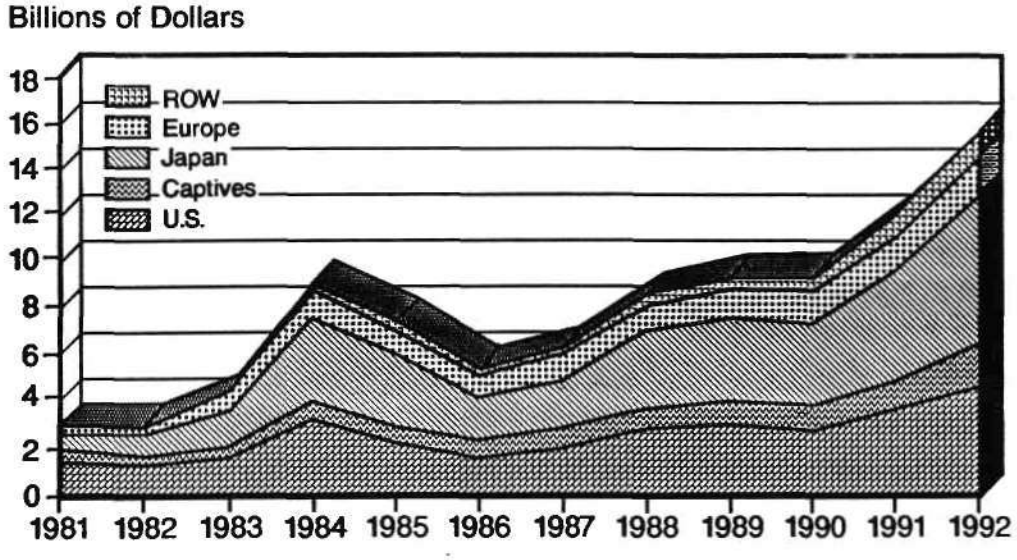
CAPITAL SPENDING

The Chip Cornucopia



Source: Dataquest

PERCENTAGE CHANGE IN CAPITAL SPENDING BY REGION

	1984	1985	1986	1987	1988	1989	1990	1991	1992
North America	108%	(34%)	(26%)	24%	45%	5%	(10%)	27%	36%
Japan	116%	(12%)	(45%)	22%	58%	7%	(1%)	35%	35%
Europe	93%	(18%)	9%	1%	8%	8%	10%	20%	15%
ROW	245%	1%	(38%)	30%	27%	20%	35%	30%	20%
Captive	52%	10%	0%	10%	9%	14%	12%	21%	27%
Worldwide Production	107%	(18%)	(28%)	17%	38%	8%	1%	29%	31%

Source: Dataquest

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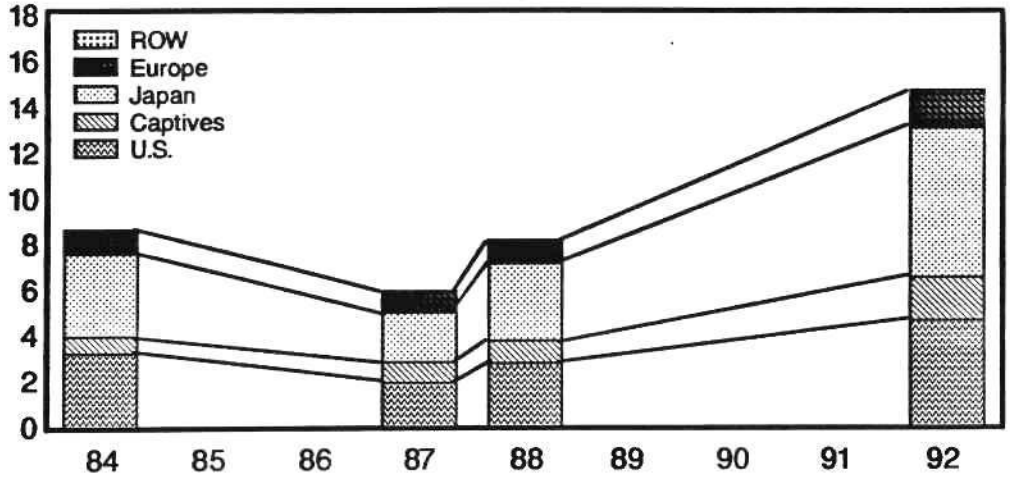
THE EBBS AND FLOWS OF CAPITAL SPENDING

Billions of Dollars

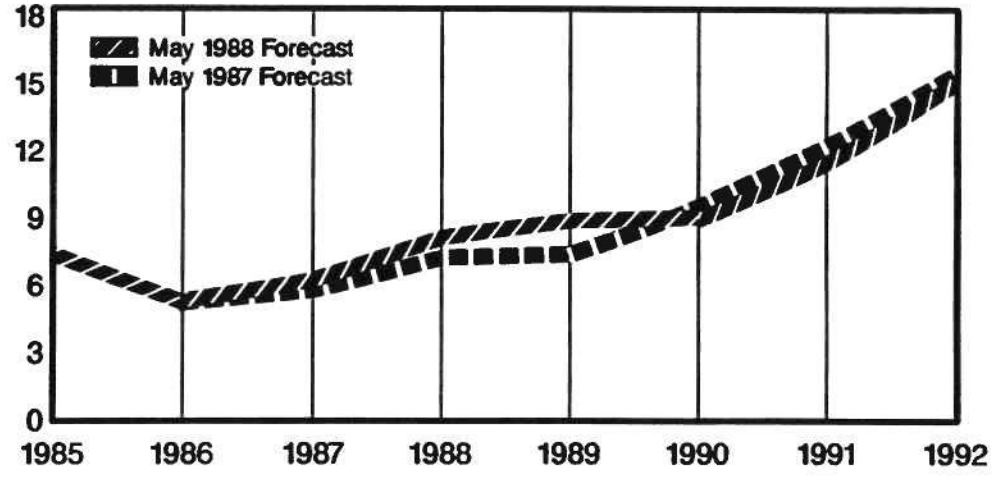


Source: Dataquest

FORECAST COMPARISON

Forecast 1987 vs. Forecast 1988

Millions of Dollars



Source: Dataquest

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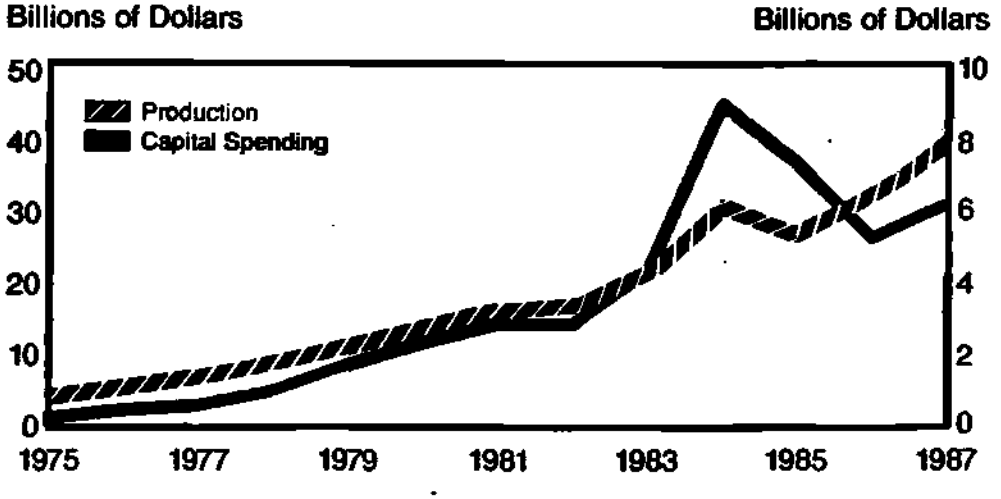
SEMICONDUCTOR MANUFACTURING COMES OF AGE

- Semiconductor demand at the leading edge
- Capital spending surging forward
- Industry-wide response increasing productivity
  - Equipment productivity
  - Culture
  - Cleanliness

GROWTH OF CAPITAL SPENDING AND PRODUCTION

A Tale of Two Decades



Source: Dataquest

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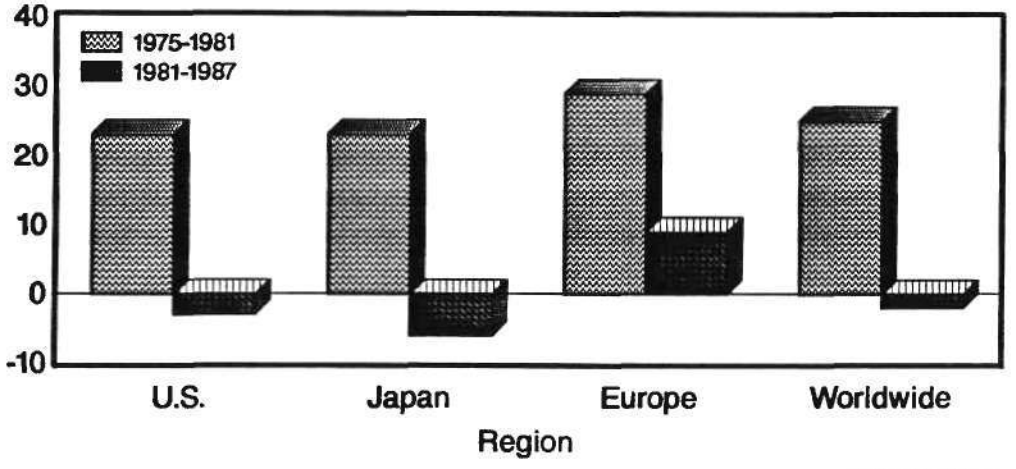
DIFFERENCE: CAGR OF CAPITAL AND PRODUCTION SIGNS OF INCREASING PRODUCTIVITY

CAGR Capital Less CAGR Production

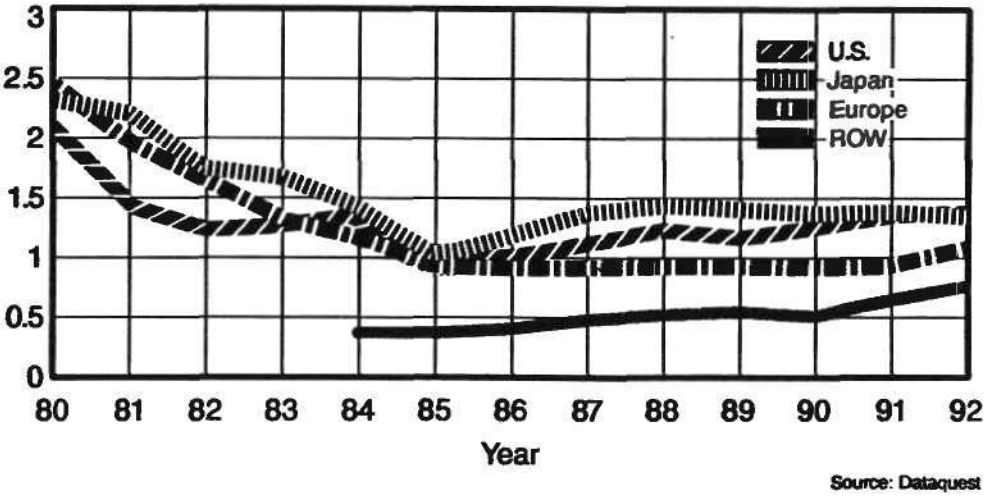


Source: Dataquest

REVENUE/PPE

The Productivity of Capital

Dollars per PPE



Source: Dataquest

REVENUE/PPE

The Productivity of Capital

Rev./PPE = In.^{2}/PPE x Rev./In.^{2}

Where PPE = property, plant, and equipment
and In.^{2}/PPE = equipment productivity
and Rev./In.^{2} = process productivity

Source: Dataquest

REVENUE PER SQUARE INCH

The Productivity of Silicon

- Rev./In.^{2} = f (yield, ASP, 1/(die size))
- Yield is increasing:
  - Automation
  - Cleanliness
  - Manufacturing culture
- Die size and ASP balance each other

Source: Dataquest

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EQUIPMENT PRODUCTIVITY

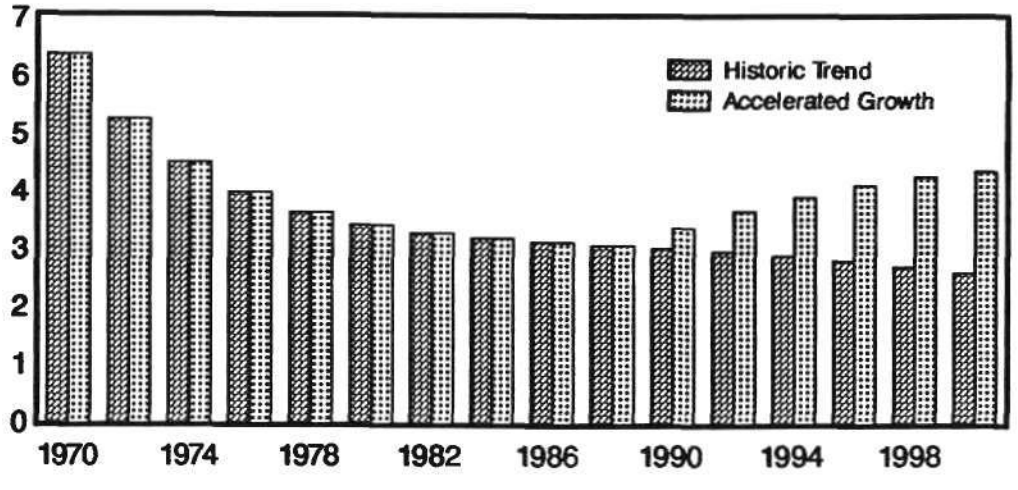
$In.^2/PPE = f$ (reliability, utilization, throughput)

- Reliability
  - Industry average is close to 90%
- Utilization
  - Industry average is less than 40%
  - Commodity products have high utilization
  - Multiproduct fabs are trying to increase by use of CIM
- Throughput
  - Movement from batch to single-wafer processing
  - Movement to larger wafer sizes
  - Net effect is that throughput is increasing
- PPE
  - ASPs are increasing

Source: Dataquest

ESTIMATED EQUIPMENT PRODUCTIVITY MODEL

Silicon Area per Dollar of PPE



Source: Dataquest

SEMICONDUCTOR MANUFACTURING

Summary and Conclusion

- Semiconductor demand will increase
  - Especially at the leading edge
- Capital spending will grow at a healthy rate
- Capital productivity will continue to increase
- Manufacturing technology is a competitive advantage

Source: Dataquest

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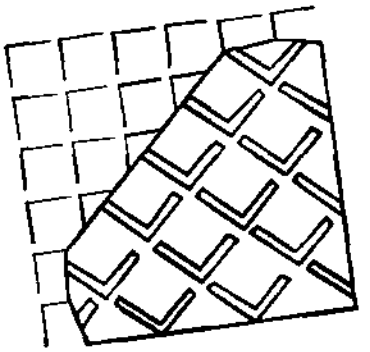
Our Rapidly Changing Industry:
Status 1988



CAPACITY ANALYSIS IN NORTH AMERICA

MARK REAGAN

Research Analyst
Semiconductor Equipment and Materials Service
Dataquest Incorporated

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AGENDA

- Description of the fab data base
- Capacity utilization by technology
- Fab lines by wafer size
- Profile of new fab lines 1985-1990s

AGENDA

- Description of the fab data base

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DATA FIELDS

- Company name
- Location
- Fab name
- Clean room size
- Clean room class
- Wafer size
- Average mask levels
- Wafer start capacity
- Actual wafer starts
- Test and blank wafers used
- R&D wafer starts
- Minimum linewidth
- Shifts per day
- Days per week

DATA FIELDS

- Type of fab line
- Turnaround time
- Machine operators
- Line yields
- Origin of ownership
- Percent positive resist
- Products produced
- Technology used
- Book value of equipment
- Installed equipment
- Average die size
- Factory-level software

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PRODUCTS

- Memories
- Micros
- Standard logic
- ASICs
- Analog
- Discretes
- Opto
- Power ICs

TECHNOLOGIES

- CMOS
- NMOS/PMOS
- BICMOS
- Bipolar
- GaAs/other III/Vs

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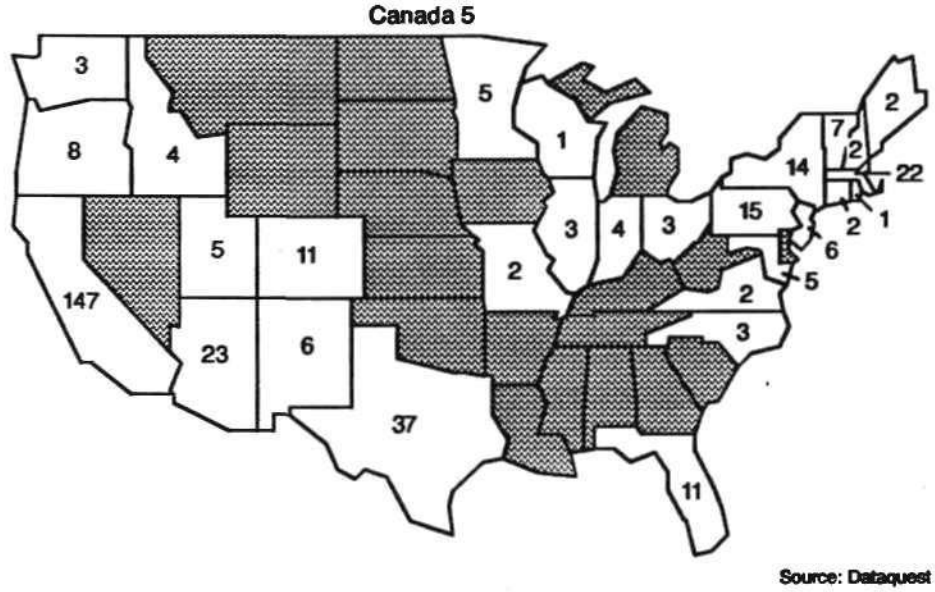
DATA SOURCES

- Annual phone survey
- Confidential industry sources
- Fab tours
- Component group analysts (San Jose)
- Dataquest analysts in Tokyo, London, Seoul
- Scanning more than 30 semiconductor periodicals

NUMBER OF FAB LINES INSTALLED

Includes Fabs Going into Production During 1988
and GaAs Lines; Excludes R&D Lines



Source: Dataquest

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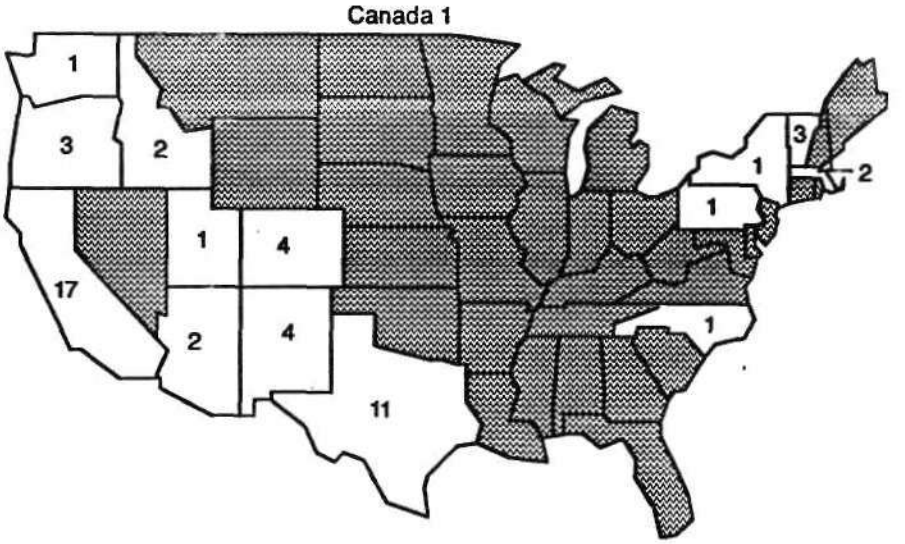
FAB LINES INTO PRODUCTION DURING 1989 AND BEYOND

Includes GaAs Lines; Excludes R&D Lines



Source: Dataquest

FAB DATA BASE CONTENTS

- 309 silicon fab lines
- 50 GaAs fab lines
- 76 R&D lines
- 53 fabs going into production after 1988
- 151 foundry relationships
- 76 foundry users

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AGENDA

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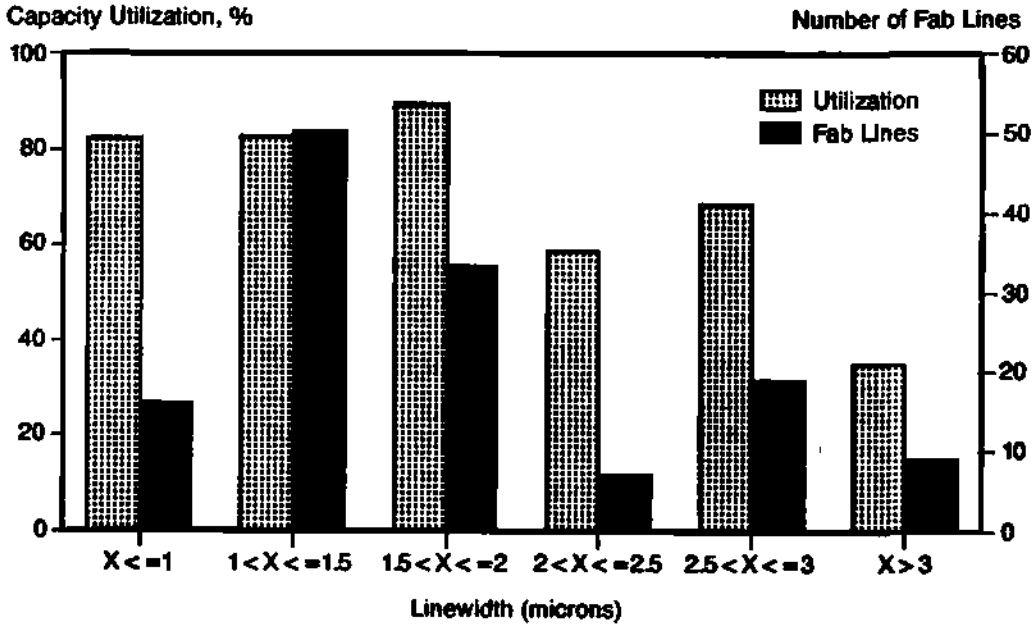
- Capacity utilization by technology

CMOS Q4 1987



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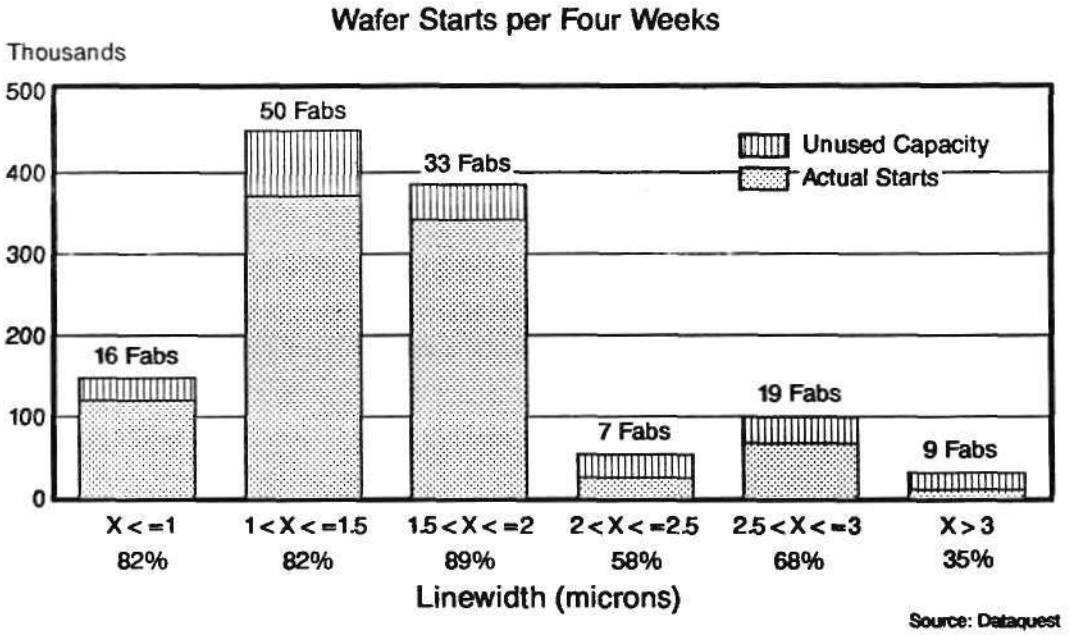
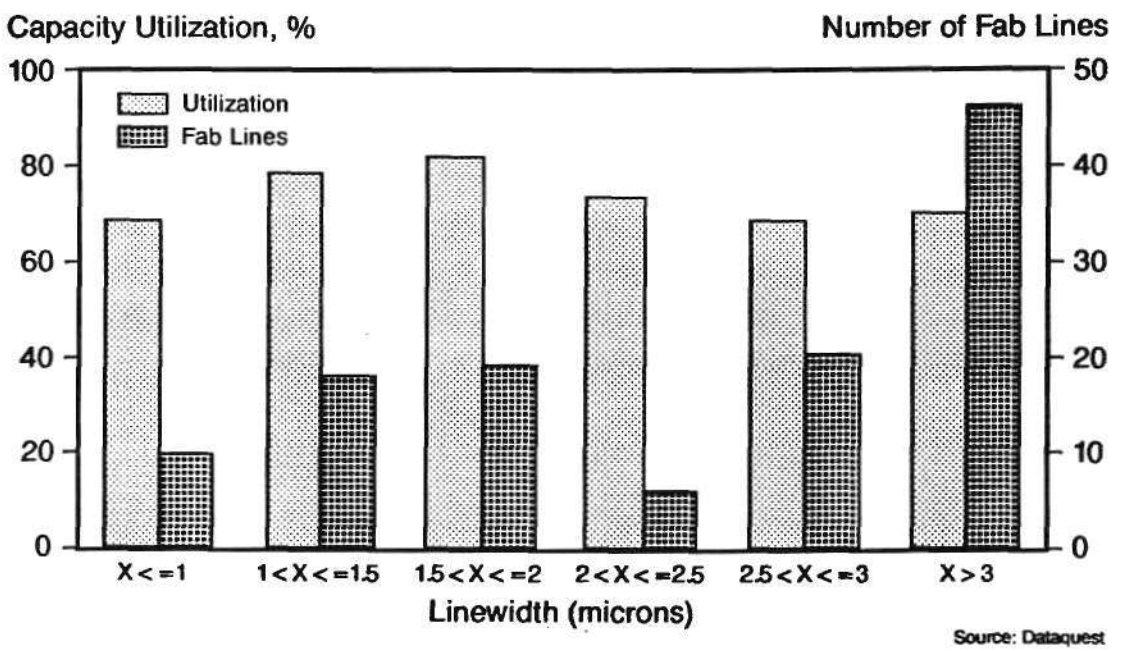
CMOS Q4 1987



Source: Dataquest

BIPOLAR Q4 1987



Source: Dataquest

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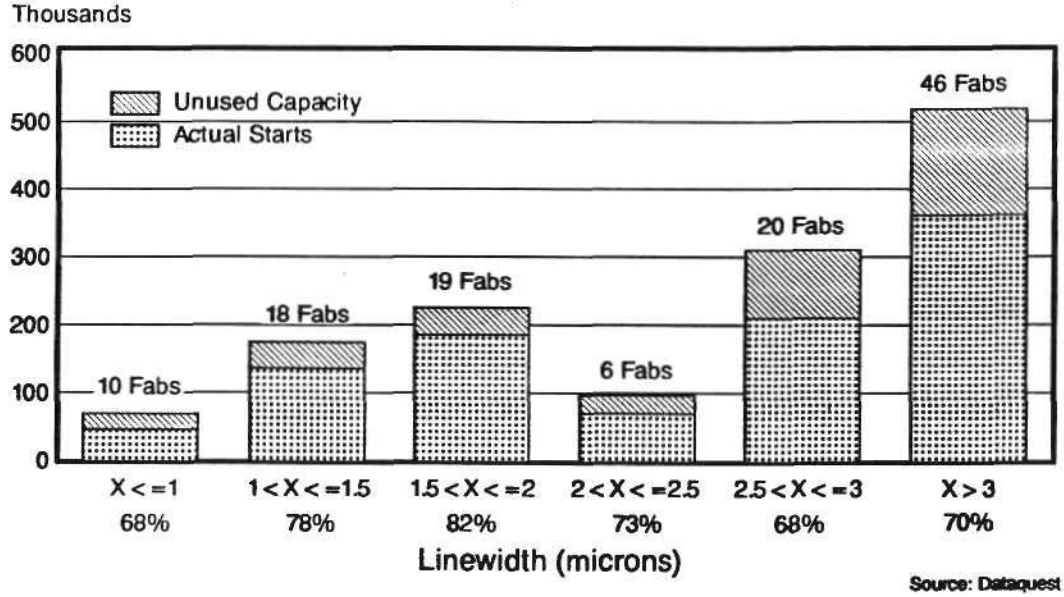
BIPOLAR Q4 1987

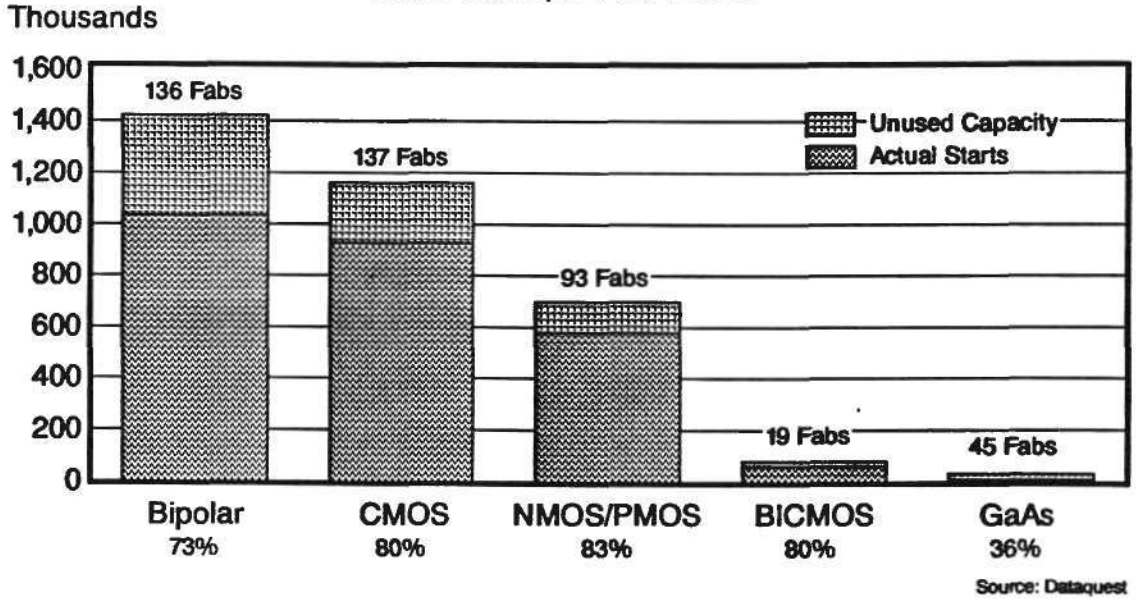
Wafer Starts per Four Weeks



Source: Dataquest

NORTH AMERICA Q4 1987

Wafer Starts per Four Weeks



Source: Dataquest

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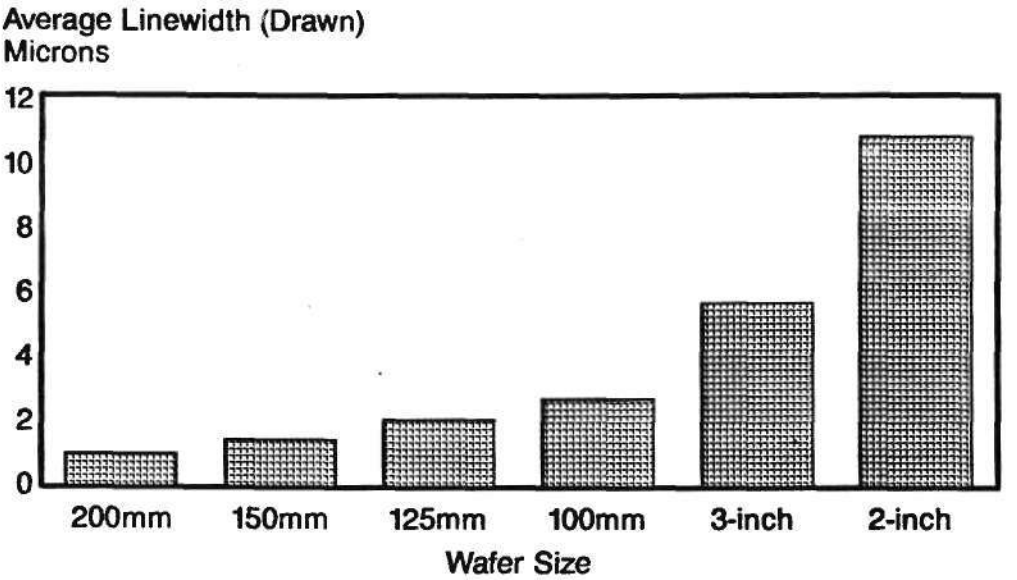
AVERAGE LINEWIDTH BY WAFER SIZE



Source: Dataquest

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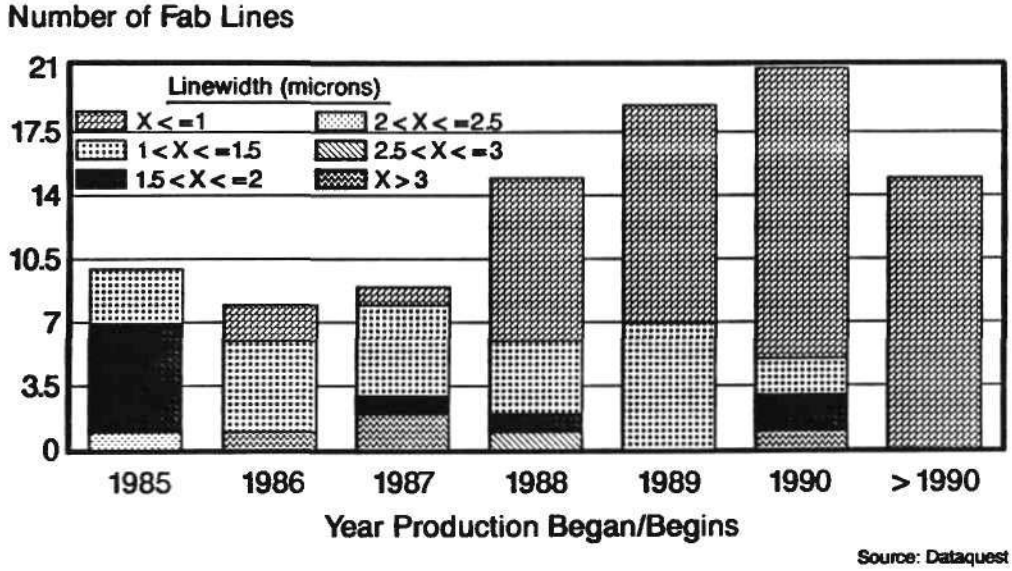
NEW SILICON PILOT AND FAB LINES

Actual and Announced



Source: Dataquest

CONCLUSIONS

- Majority of fabs running 4-inch wafers
- 6-inch technology has a long way to go
- Broad-based 8-inch production a long way off
- Vast majority of new fabs will be sub-1.6 micron, 6-inch, CMOS lines
- Utilization is highest in 1.1-2 micron range but a lot of capacity will be coming up

Source: Dataquest

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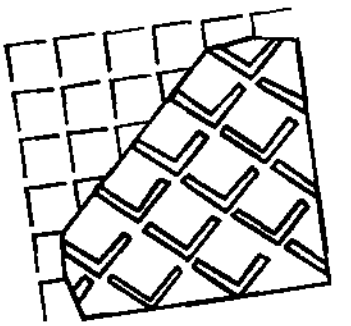

THE CHANGING STRUCTURE OF THE WORLDWIDE FAB EQUIPMENT INDUSTRY

JOSEPH GRENIER

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SEMI MEMBERSHIP

Total Membership	1,082
U.S. Company Membership	889
Percent Private	71%
Financial Size ($M)	
0 to $5	60%
$5 to $10	15
$10 to $25	14
$25 to $50	6
$50 to $100	3
$100 +	2
	100%

Source: SEMI

FAB EQUIPMENT MARKET -- 1986

(Millions of Dollars)

Lithography	
Track Equipment	
Dry Etch/Strip	
Deposition	
Diffusion/RTP	
Ion Implantation	
CD/Wafer Inspection	
Total 117 Companies	$2,029
Other Equipment	569
Total Fab Equipment Market	$2,598

Source: Dataquest

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FAB EQUIPMENT COMPANIES

1986 Revenue

Revenue ($M)	Number of Companies	Percent
0 to $5	59	50%
$5 to $10	14	12
$10 to $25	21	18
$25 to $50	12	10
$50 to $100	7	6
$100 to $200	3	3
$200 +	1	1
	117	100%

Source: Dataquest

FAB EQUIPMENT COMPANIES

1986 Rankings

Companies by Rank	Revenue ($M)	Percent
1-10	$1,046	52%
11-20	385	19
21-30	214	10
31-103	384	19
	$2,029	100%

Source: Dataquest

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FAB EQUIPMENT COMPANIES

Top Ten
(Millions of Dollars)

1982 Rank		1986 Rank	
Perkin-Elmer	$152	Perkin-Elmer	$220
Varian	89	Canon	141
Applied Materials	69	Applied Materials	125
GCA	64	Varian	115
Canon	60	Nikon	93
Eaton	56	GCA	86
Kokusai	43	General Signal	75
Thermco	33	Ulvac	71
General Signal	32	Eaton	61
Nikon	32	TEL Thermco	59
U.S. Companies	79%	U.S. Companies	65%
Japanese Companies	21%	Japanese Companies	35%

Source: Dataquest

TEN-COMPANY INDEX

- Applied Materials
- KLA
- Lam Research
- Machine Technology
- Materials Research
- Nanometrics
- Optical Specialties
- Perkin-Elmer
- Silicon Valley Group
- Varian

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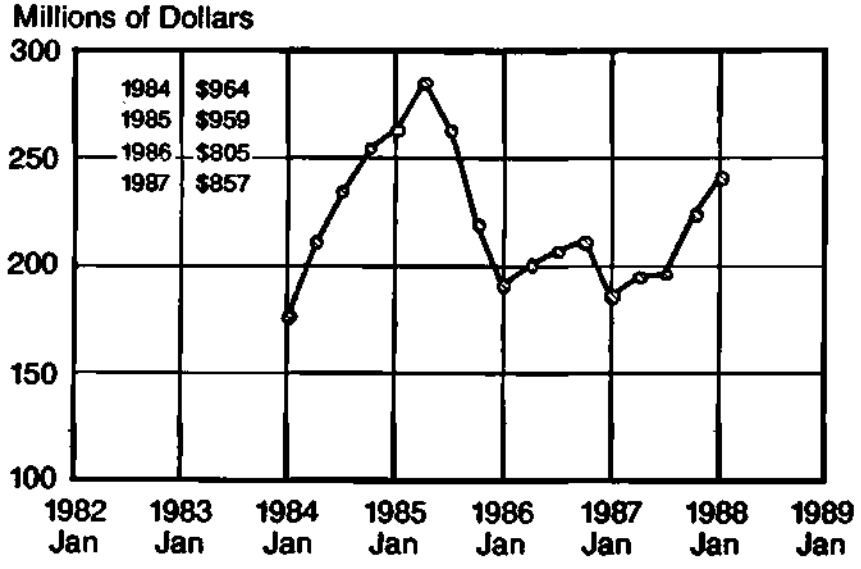
TEN-COMPANY INDEX

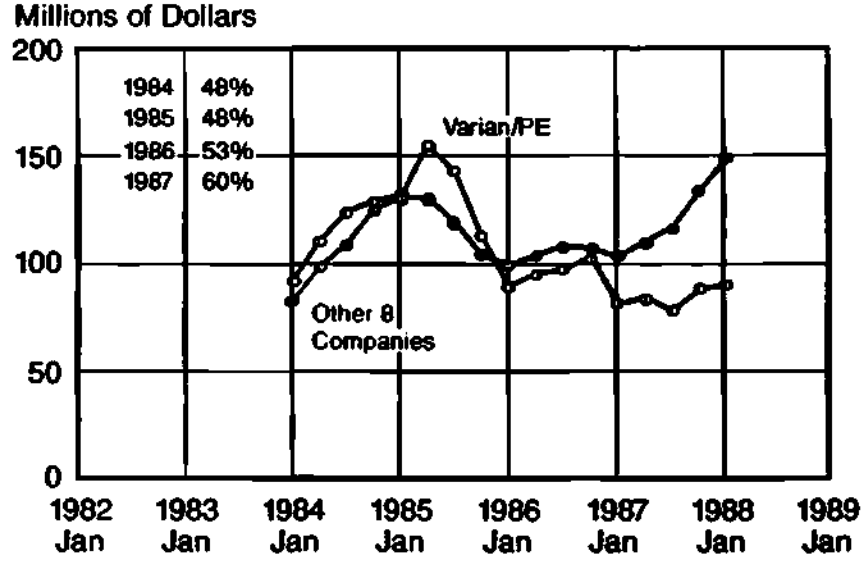
Quarterly Sales



Source: Dataquest

TEN-COMPANY INDEX

Quarterly Sales



Source: Dataquest

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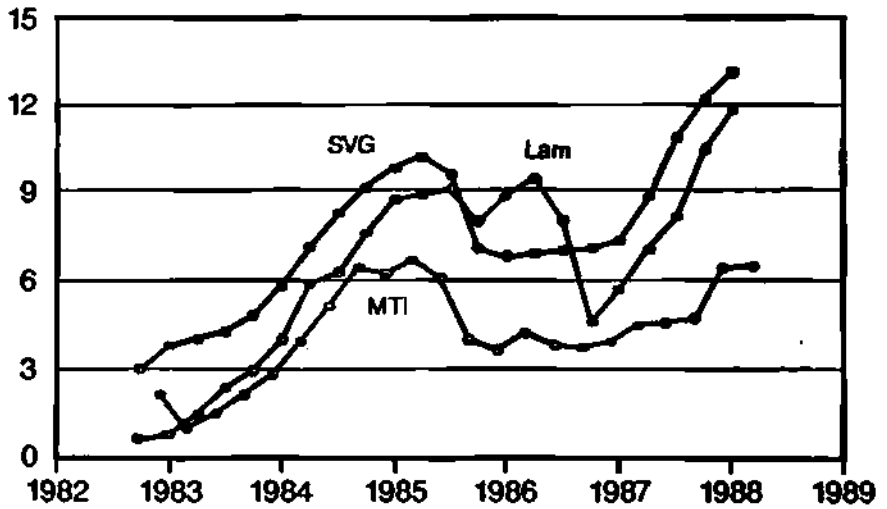
LAM, MTI, AND SVG

Quarterly Sales

Millions of Dollars

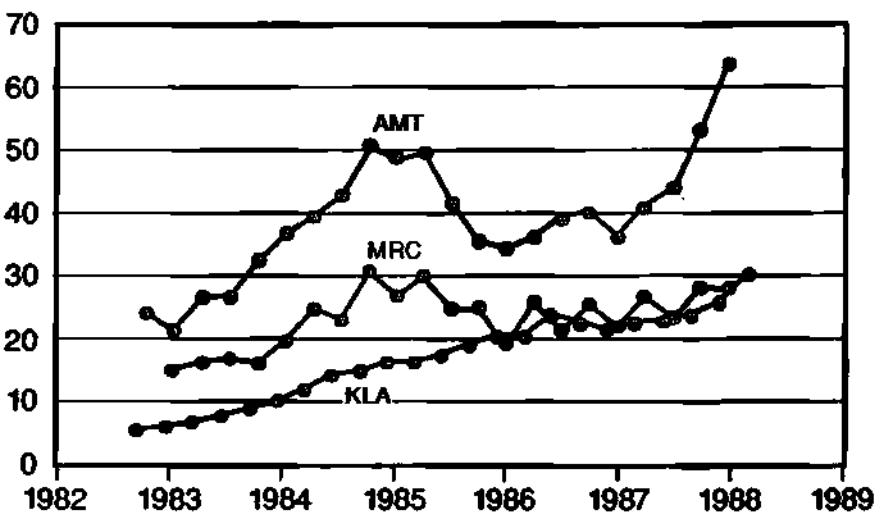


Source: Lam Research
MTI
Silicon Valley Group

AMT, KLA, AND MRC

Quarterly Sales

Millions of Dollars



Source: Applied Materials
KLA Instruments
MRC

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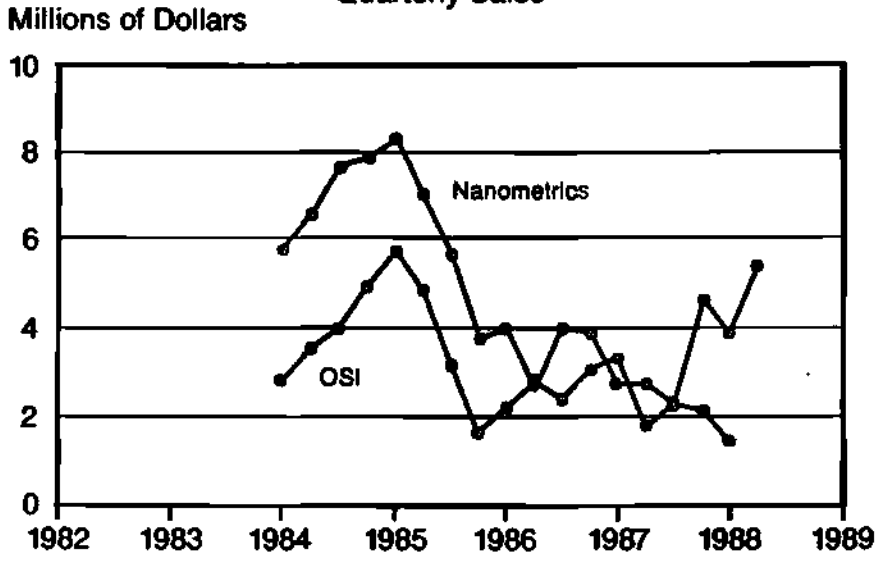
NANOMETRICS AND OSI

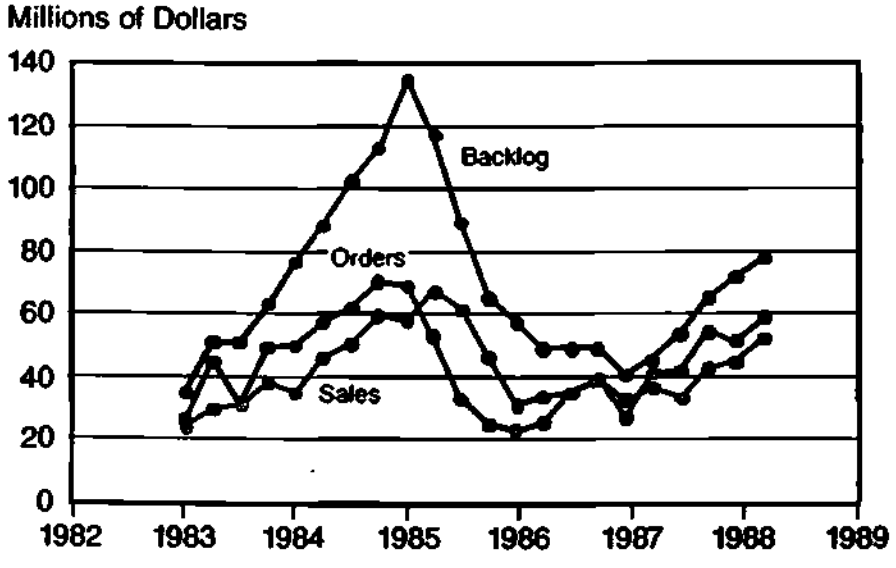
Quarterly Sales



Source: Nanometrics
Optical Specialties

VARIAN

Sales, Orders, and Backlog



Source: Varian

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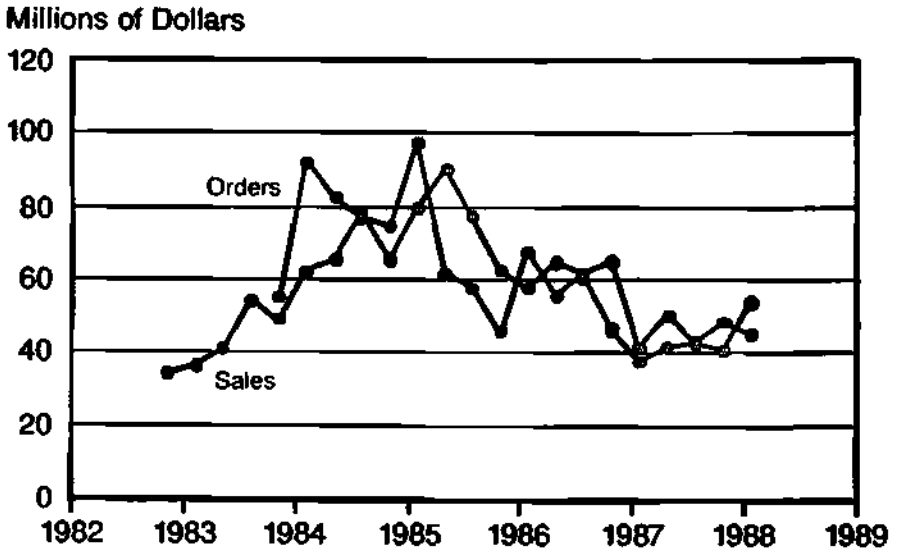
PERKIN-ELMER

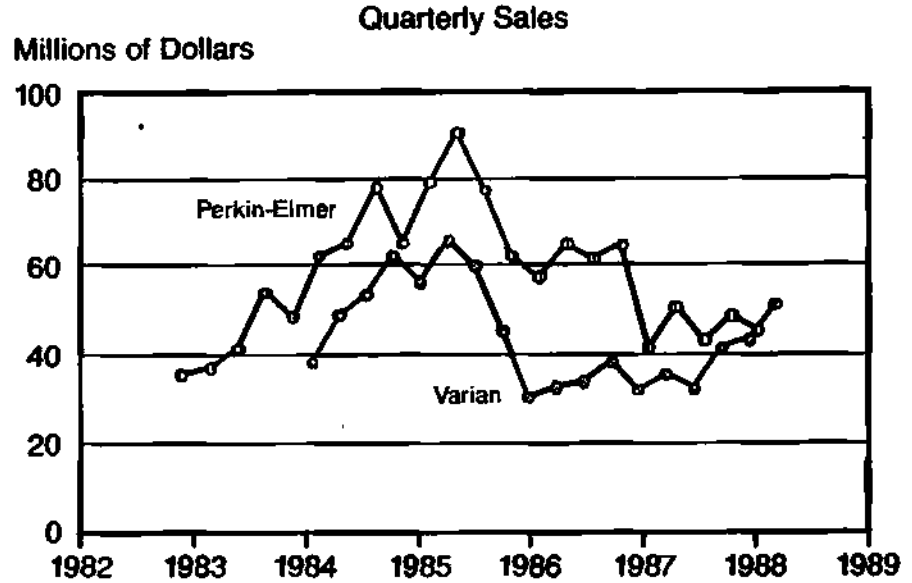
Sales and Orders



Source: Perkin-Elmer

PE AND VARIAN

Quarterly Sales



Source: Perkin-Elmer
Varian

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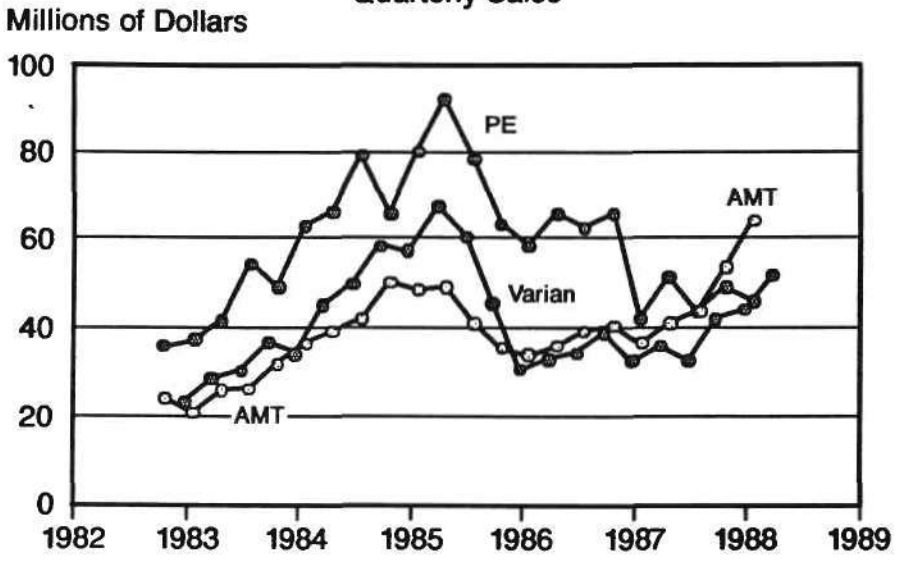
AMT, PE, AND VARIAN

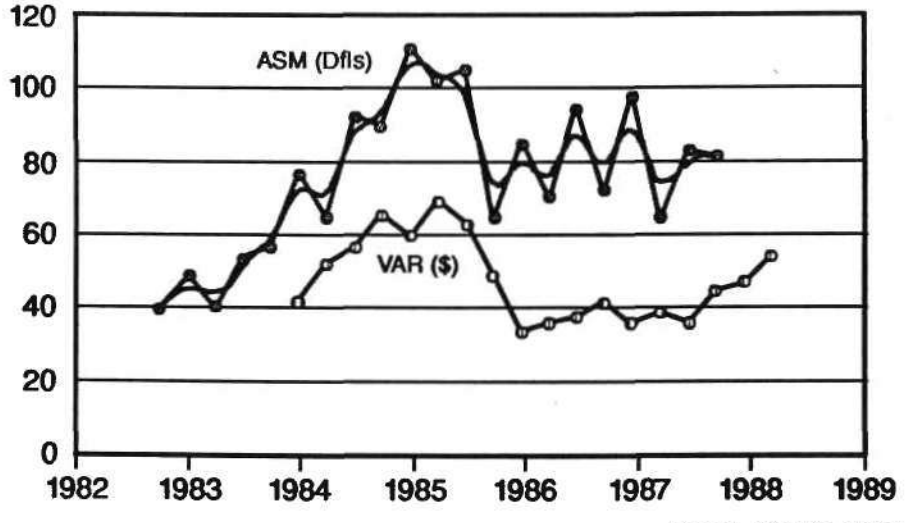
Quarterly Sales



Source: Applied Materials
Perkin-Elmer
Varian

ASM AND VARIAN

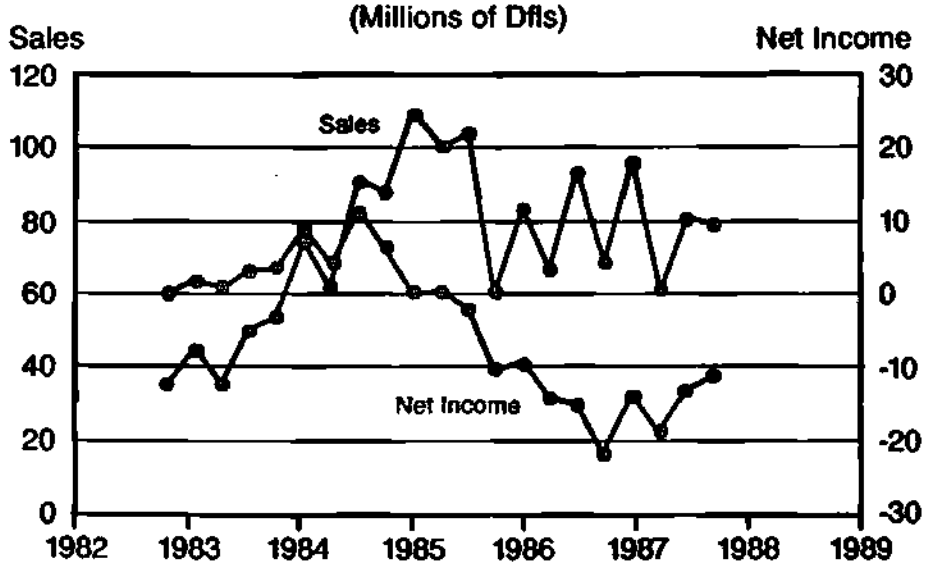
Quarterly Sales
(Millions of Dfls/$)



Source: ASM International
Varian

ASM INTERNATIONAL

Quarterly Sales and Income
(Millions of Dfls)



Source: ASM

SEMICON/JAPAN EXHIBITORS BY COUNTRY

	1982	1983	1987
Japan	232	327	542
United States	204	289	274
United Kingdom	11	15	21
West Germany	12	14	11
Other	16	30	27
Total	475	675	875

Source: SEMI

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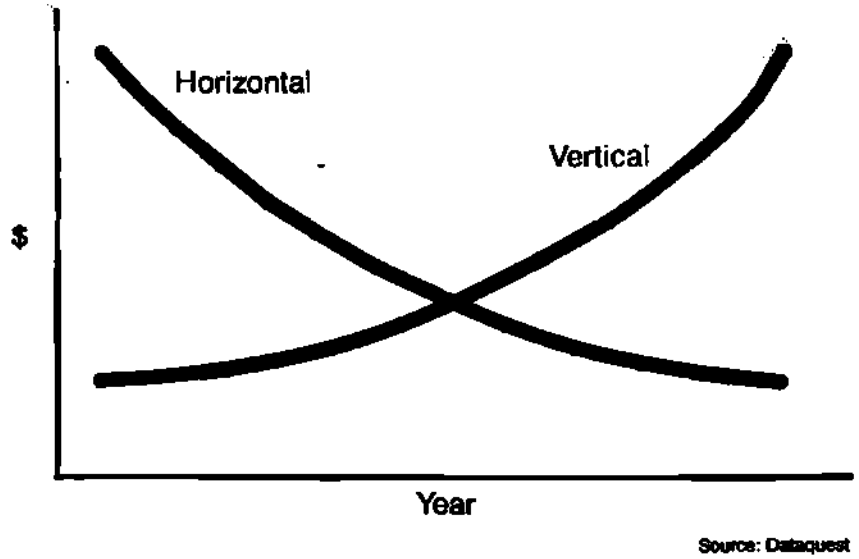
ADVANCED EQUIPMENT TECHNOLOGY BEING DEVELOPED BY THE JAPANESE

- Photo CVD
- Excimer lasers
- Ion beam technology
- Large-substrate processing equipment
- Vertical furnaces
- ECR equipment

Source: Dataquest

DIFFUSION FURNACE MARKET

Trends



Source: Dataquest

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JAPANESE VERTICAL FURNACES

	Diffusion		LPCVD	
ASM Japan	VDF-100	(Y35M)	VMP-100	(Y45M)
Dainippon Screen	DSF		?	
Denko Systems	SD (1)	(Y35M)	SC (1)	(Y45M)
	SD (2)	(Y60M)	TC (2)	(Y80M)
Disco	DWD 1000	(Y150M)	DWL 1000	
Koyo Lindberg	VFS-4000	(Y30M)	VFS-4001/7	
Kokusai	DD-802V	(Y44M)	DJ-802V	(Y55M)
TEL Sagami	VCF-610		VDF-610	
Ulvac-BTU	L2	(Y60M)	?	

Source: Dataquest

WORLDWIDE ECR ACTIVITY

Japanese Companies

Anelva
Ashida
Elionix
Hitachi
Japan Steel Works
Shimadzu
Sumitomo Metal
Tokki
Tokyo Ohka

European Companies

E.T. Electrotech
Plasma Technology

U.S. Companies

Lam Research
(marketing agreement)
Materials Research
(licensing agreement)
Veeco (source only)

Source: Dataquest

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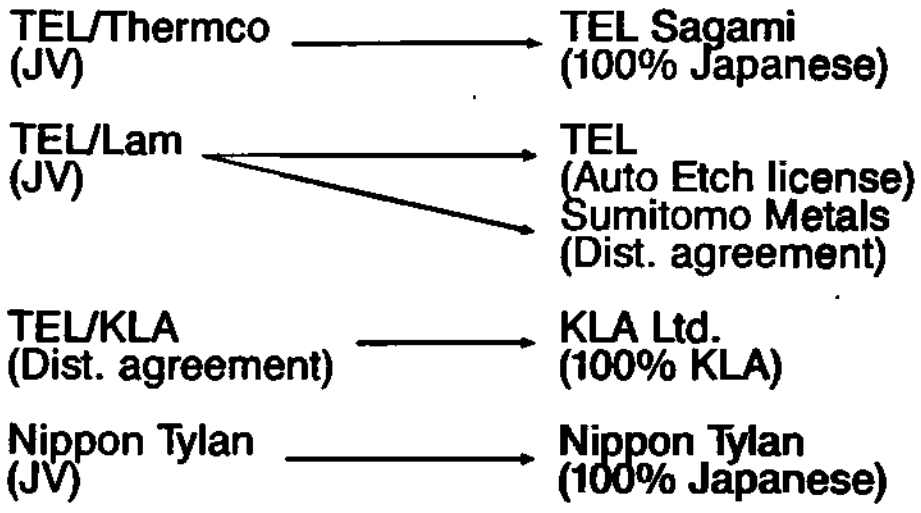
CHANGES IN JAPANESE ALLIANCES



Source: Dataquest

SUMMARY

- Structure of worldwide fab equipment industry is evolving.
- Previous leaders in U.S. fab equipment industry are losing momentum.
- Japanese equipment industry is maturing.
- The future? -- Only the excellent will survive.

Source: Dataquest

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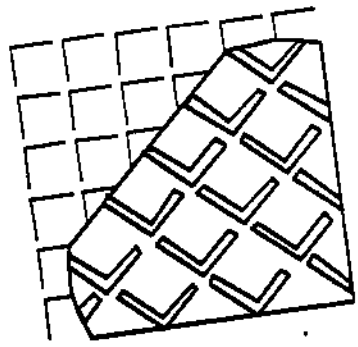
Our Rapidly Changing Industry:
Status 1988



SEMICONDUCTOR MATERIALS: PERSPECTIVE ON WAFERS

PEGGY MARIE WOOD, Ph.D.

Industry Analyst
Semiconductor Equipment and Materials Service
Dataquest Incorporated

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BACK TO THE ELEMENTS

A Look At The Periodic Table

II	III	IV	V	VI
	B	C	N	O
	Al	**Si**	P	S
Zn	Ga	Ge	As	Se
Cd	In	Sn	Sb	Te
Hg	Tl	Pb	Bi	Po

SILICON AND EPITAXIAL WAFERS

Agenda

- Merchant wafer supplier sales
- Wafer pricing pressures
- Acquisitions activity
- Outlook on epi

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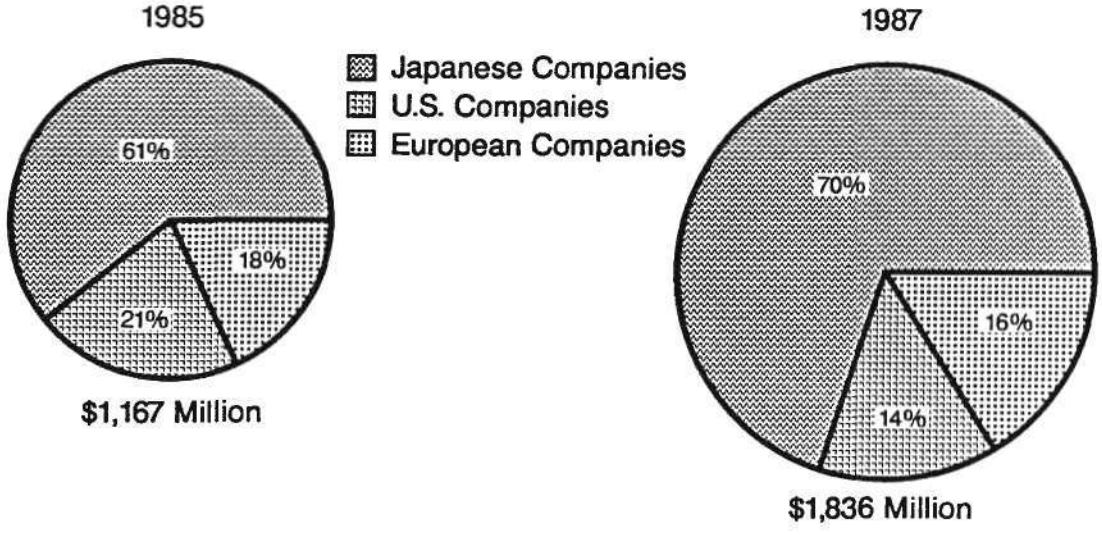
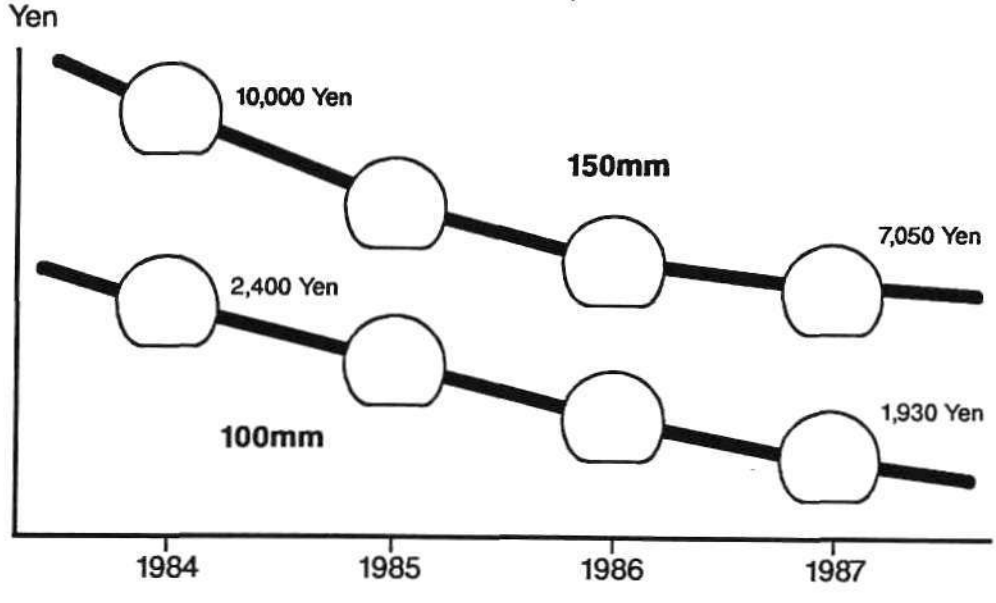
SILICON AND EPITAXIAL WAFER SUPPLIERS



Source: Dataquest

WAFER PRICING PRESSURES

A Look at Japan



Source: Dataquest

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ACQUISITIONS ACTIVITY

Kawasaki Steel	1984 →	NBK Corporation	CZ
Nippon Kokan K.K.	1985 →	Great Western Silicon	Poly
Mitsubishi Metal	1986 →	Siltec Corporation	CZ
Osaka Titanium	1986 →	U.S. Semiconductor	Epi
? ? ?	1988? →	Cincinnati Milacron	Epi

Source: Dataquest

OUTLOOK ON EPI

- Merchant epi wafer applications
  - United States
    - CMOS (memory, logic, ASICs)
    - Discrete (power devices, microwave)
  - Japan
    - Discrete devices
    - Bipolar ICs
    - CMOS ICs
  - No DRAMs yet
- Epi shortage in 1988?
  - What's driving increased epi demand?

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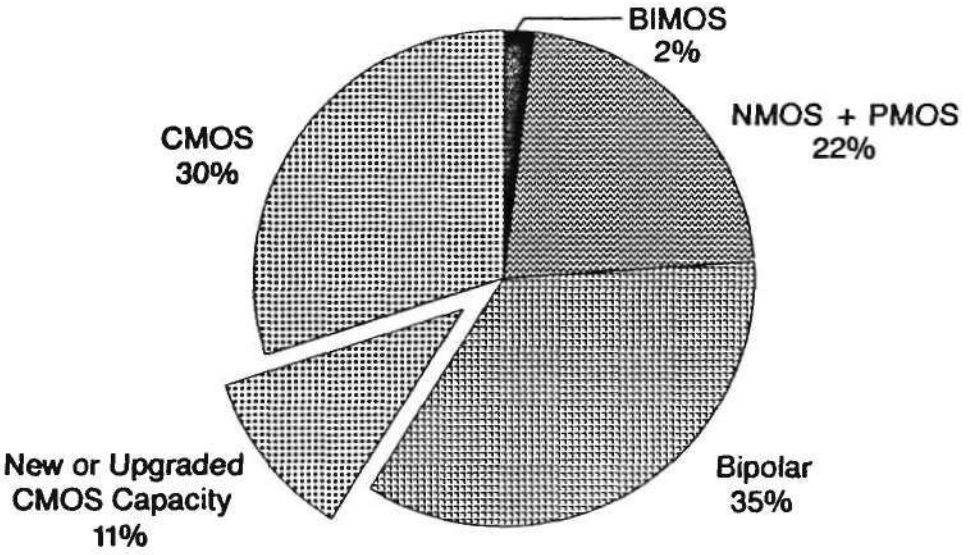
SQUARE INCH CAPACITY BY TECHNOLOGY

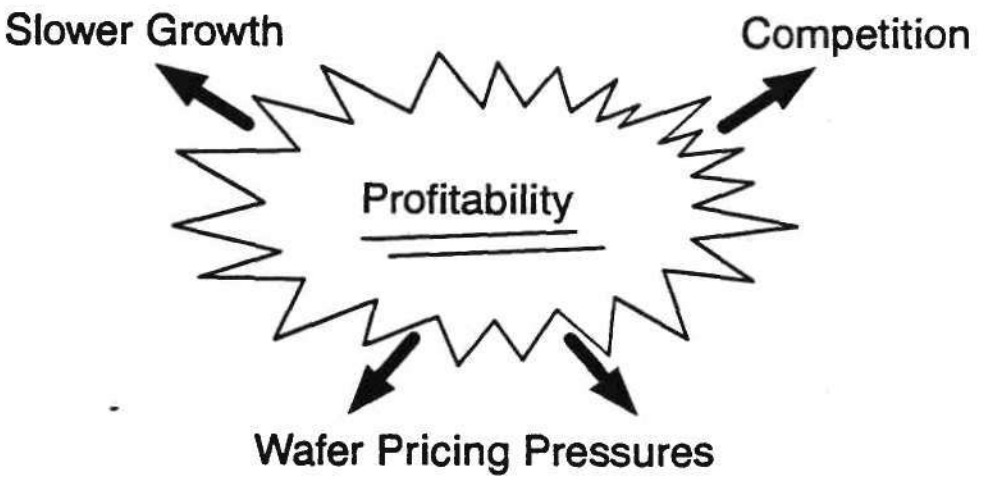
1987 North American Fab Data Base



Source: Dataquest

SILICON AND EPITAXIAL WAFER MARKETS

"It's Been Tough . . . It's Staying Tough"



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COMPOUND SEMICONDUCTOR MATERIALS

III-V, II-VI, IV-VI

II	III	IV	V	VI
	B	C	N	O
	Al	**Si**	**P**	**S**
Zn	**Ga**	**Ge**	**As**	**Se**
Cd	**In**	**Sn**	**Sb**	**Te**
Hg	Tl	**Pb**	Bi	Po

COMPOUND SEMICONDUCTORS

Agenda

- Devices and applications
- Materials: a potpourri of epitaxial layers
- Deposition technologies

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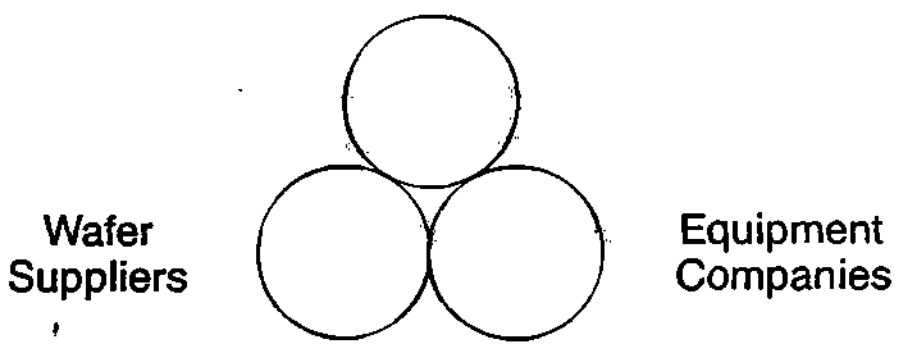
COMPOUND SEMICONDUCTORS

Activity on all Fronts



COMPOUND SEMICONDUCTORS

Devices

- GaAs ICs
  - Analog: oscillators, amplifiers, MMICs
  - Digital: SRAMs, ASICs, gate arrays
- Optoelectronic devices
  - LED lamps and displays
  - Lasers
  - Photodetectors (avalanche photodiodes)
  - Repeaters
  - Advanced optoelectronic devices (i.e., double heterojunction lasers, multiple quantum well lasers, superlattice structures)
- Other discrete devices
  - Power FETs, small signal transistors

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COMPOUND SEMICONDUCTORS

Device Applications

- Communications
  - Fiber optics, satellite communications, local area networks
- Electronic data processing
  - Supercomputers
- Instrumentation
  - High-speed test and measurement systems
- Military
  - Satellite communications, radar, night vision systems, electronic warfare
- Consumer
  - TV and VCR remote controls, CD players

COMPOUND SEMICONDUCTORS

Device Manufacturers: Who is Involved?

Japanese Companies	North American Companies	European Companies
Matsushita	Avantek	Philips
NEC	Gigabit Logic	Plessey III-V
Sharp	Hewlett-Packard	Siemens
Sony	Texas Instruments	Telefunken
Toshiba	TRW	Thomson CSF

Source: Dataquest

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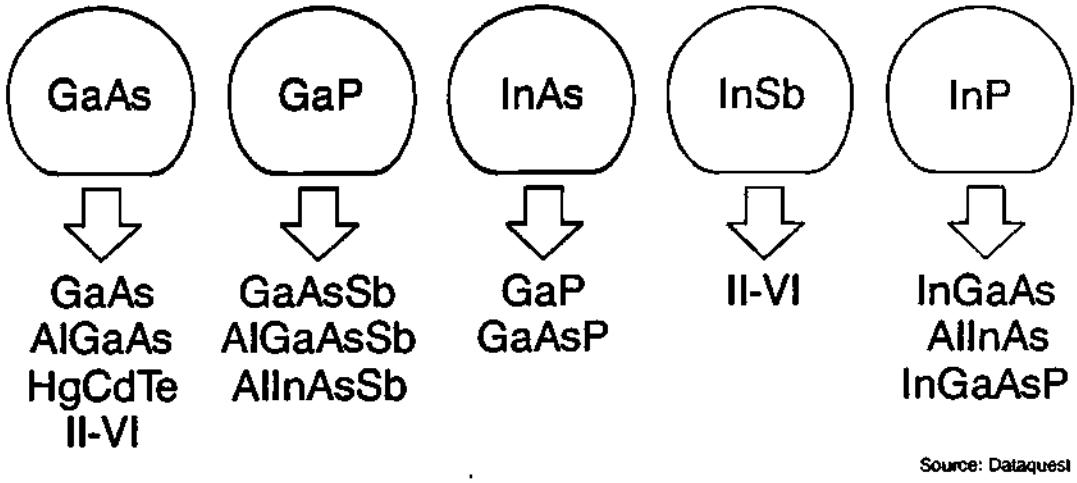
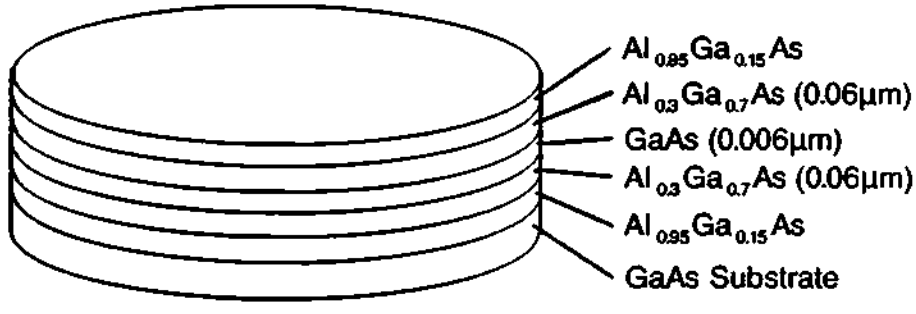
COMPOUND SEMICONDUCTORS
III-V SUBSTRATES AND EPITAXIAL LAYERS



Source: Dataquest

QUANTUM-WELL LASER STRUCTURE



Source: Dataquest

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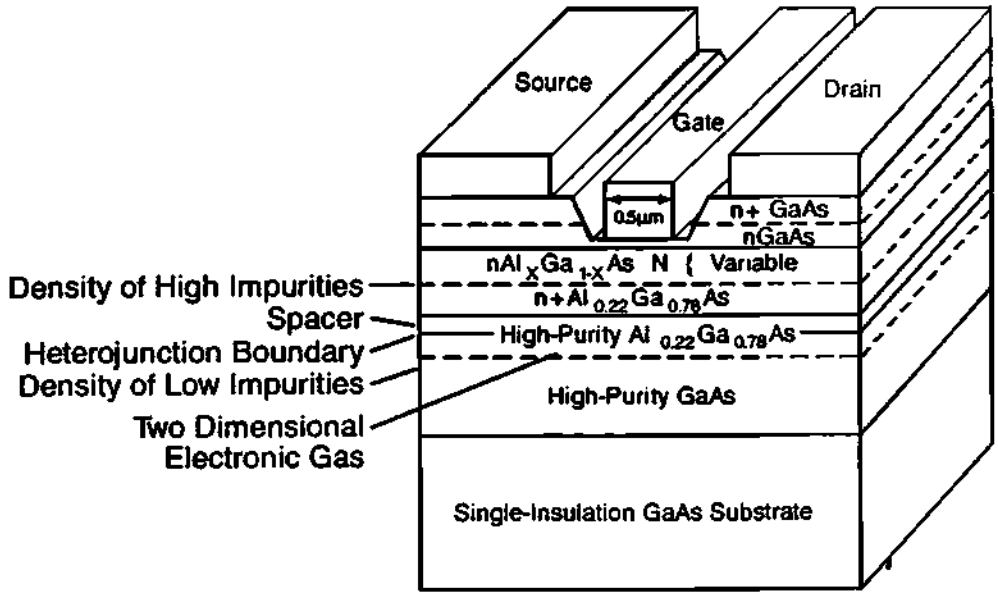
0.5-MICRON GATE HEMT



Source: Sanyo Electric

COMPOUND SEMICONDUCTORS

Wafer Suppliers: Who Is Involved?

- Approximately 40 companies
- North American companies (22)
  - Start-up companies, equipment manufacturers, chemical and mining concerns
- Japanese companies (11)
  - Cable and mining companies, silicon wafer suppliers
- European companies (7)
  - Silicon and materials suppliers, start-up companies

Source: Dataquest

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COMPOUND SEMICONDUCTORS

Epitaxial Deposition Technologies

MBE	MOCVD
- Ultrahigh vacuum deposition	- Low-pressure deposition
- Materials deposited: Compound SC materials, semiconductors, metals, superconductors (?)	- Materials deposited: Compound SC materials, superconductors (?)
- Throughput: 1-2 wafers/cycle, growth rates of 1-10 A/sec	- Throughput: Higher-throughput systems, growth rates of 1-300 A/sec
- Price range: $600,000-$1.1 million	- Price range: $200,000-$570,000

Source: Dataquest

COMPOUND SEMICONDUCTORS

Equipment Companies: Who Is Involved?

- North American companies
  - MOCVD: Crystal Specialties, Emcore, Spire
  - MBE: Perkin-Elmer, Varian
- Japanese companies
  - MOCVD: Nippon Sanso, TEL Sagami, Ulvac
  - MBE: Anelva, Ulvac
- European companies
  - MOCVD: Cambridge, EEV
  - MBE: ISA Riber, VG Instruments

Source: Dataquest

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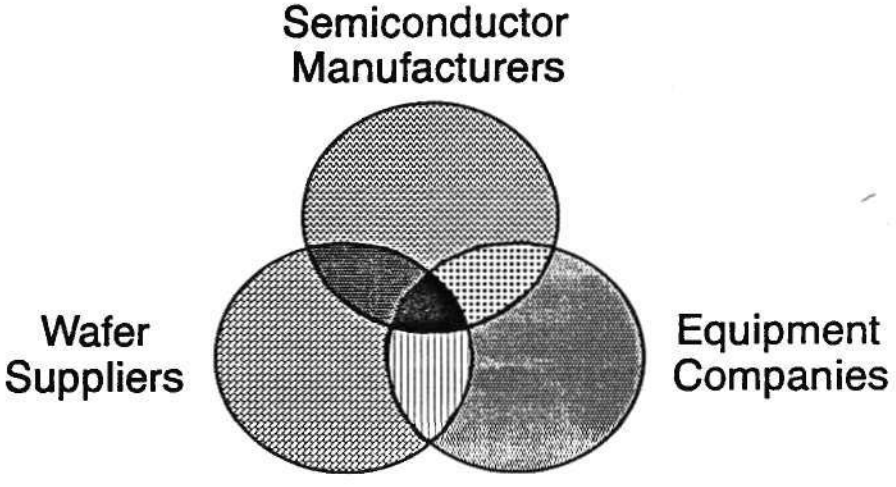
COMPOUND SEMICONDUCTORS

The Distinctions Are Not So Sharp



THE BEST OF BOTH WORLDS?

GaAs-on-Silicon

II	III	IV	V	VI
	B	C	N	O
	Al	**Si**	P	S
Zn	**Ga**	Ge	**As**	Se
Cd	In	Sn	Sb	Te
Hg	Tl	Pb	Bi	Po

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GaAs-ON-SILICON

- Advantages of silicon
  - Wafer size, cost, mechanical and thermal properties
- Advantages of gallium arsenide
  - Higher speed, radiation hardness, photonic properties
- Fruits of the marriage?
  - 1K SRAMs (Texas Instruments)
  - Room temperature, continuous-wave laser (University of Illinois, TI, Xerox)
  - Five-year program for development of GaAs-on-Si ICs and focal-plane arrays for radar applications (Ford Microelectronics)

Source: Dataquest

PUTTING IT ALL IN PERSPECTIVE

1987 World Markets at a Glance

	Silicon-Based	Compound SC Materials
Devices	$37.4 Billion	$2.4 Billion
Wafers	$1,836 Million	$200 Million +
Epitaxial Equipment	$53 Million	$115 Million

Source: Dataquest

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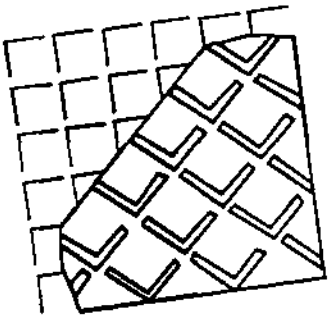
Our Rapidly Changing Industry:
Status 1988



COMPETITIVE TECHNOLOGY DEVELOPMENTS IN JAPAN

GENE NORRETT

Corporate Vice President
General Manager, Components Division
Dataquest Incorporated

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OVERVIEW - A DAY IN THE LIFE OF A. JOE AMERICA

- 6 a.m. - Home automation (HA)
- 7 a.m. - Car electronics
- 8 a.m. - Office automation (OA)
- 5 p.m. - Electronic shopping
- 7 p.m. - Home entertainment

Where there is a daily inconvenience, there is a market need.

INVENT THE FUTURE!

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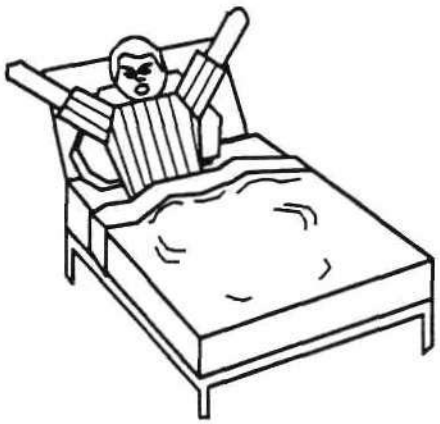
6 a.m. - Home Automation



- Wake up
- Shower
- Shave/apply makeup
- Breakfast
- Morning TV
- Home security and controls

HOME AUTOMATION IN THE 1990s

Problems	Needs	Devices Required
Get Kids Up	Stereo wake-up	MCU, DRAM, S/C lasers
Shower Too Hot/Cold	Preset temperature	Sensor, 4-bit MCU
Breakfast Rushed	Preset cooking	4-bit MCU, DRAM
Traffic Jams	Interactive TV/ traffic advisory	16-bit MCU
Forget Lights, Oven, Alarm and Other Items	House control panel at door	Voice-synthesis chips, audio RAM, 8-/16-bit MCUs, sensors

Source: Dataquest

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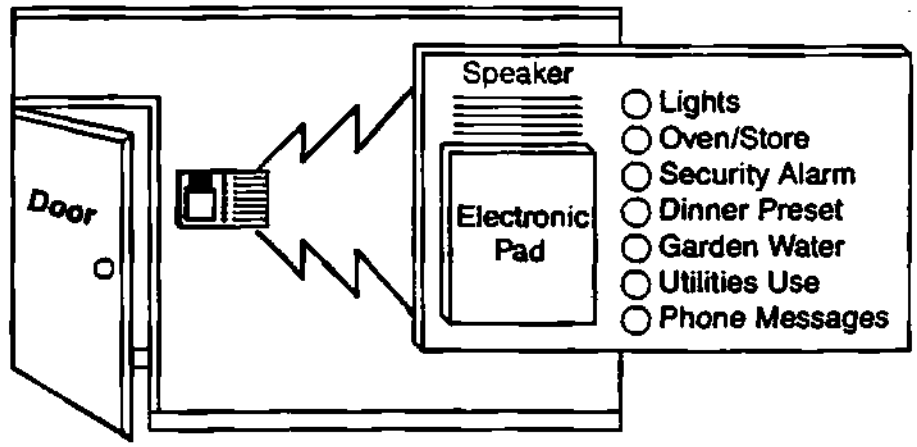
HOME CONTROL SYSTEM OF THE 1990s



Source: Dataquest

7 a.m. - Car Electronics

Problems	Needs	Devices Required
Traffic Jams	Navigation system	Modem ICs, sensors, 16-/32-bit RISC graphics chips, 4Mb/16Mb RAM and ROM
Business Calls	Built-in phone/ fax system	Modem ICs, 16-bit MPUs, 4Mb/16Mb memories

Source: Dataquest

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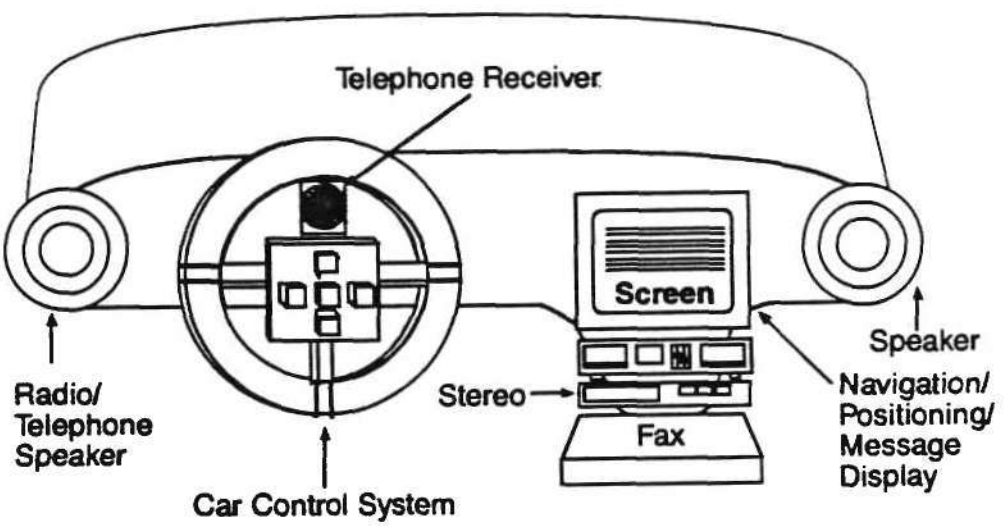
7 a.m. - Car Electronics

Problems	Needs	Devices Required
Reach for Dials	Built-in steering wheel control system	Voice recognition chips, 16-/32-bit MPUs
Maintenance (Tires, Repairs, Oil)	Maintenance advisory system	4Mb/16Mb ROMs and RAMs 4-bit MCUs
Locked Out	Voice door key	Voice recognition chips

Source: Dataquest

THE AUTOMOTIVE OFFICE OF THE 1990s



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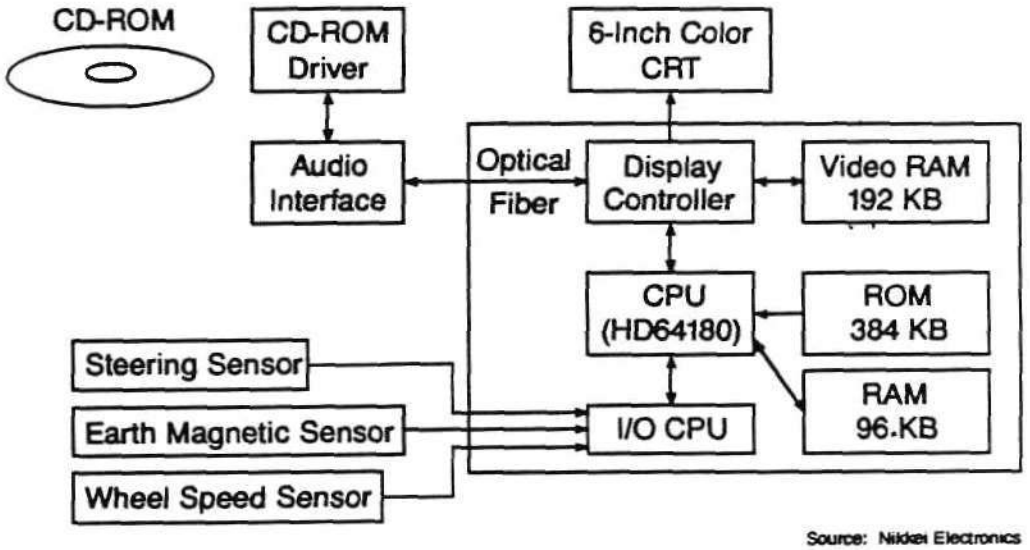
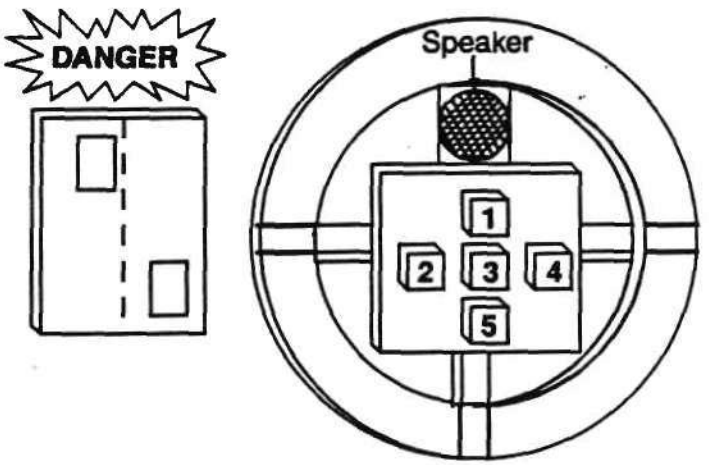
TOYOTA'S CD-ROM NAVIGATION SYSTEM



Source: Nikkei Electronics

STEERING WHEEL CONTROL SYSTEM



1 Headlights
2 Anticollision Radar System
3 Stereo System
4 Telephone
5 Navigation System

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8 a.m. - OFFICE AUTOMATION

Problems	Needs	Devices Required
Phone Tag	Office wrist phone	Modem ICs, DRAMs, MCUs
Copier and Fax Backed Up	Personal, plain paper fax/copier/printer	32-bit MPUs, DRAMs, ROMs, semiconductor lasers
Where Is Person?	Office locator system	Sensors, voice-synthesis ICs
Long Phone Calls	Phone stopwatch and cost calculator	4-bit MCUs, DRAMs
Fax or Phone Cheaper?	Fax/phone alternative cost calculator	MCUs, DRAMs, ROMs

Source: Dataquest

11 a.m. - OFFICE CHAOS

Possible Solutions:

- Memo-to-text/-graphics electronic tablet
- Transparency machine

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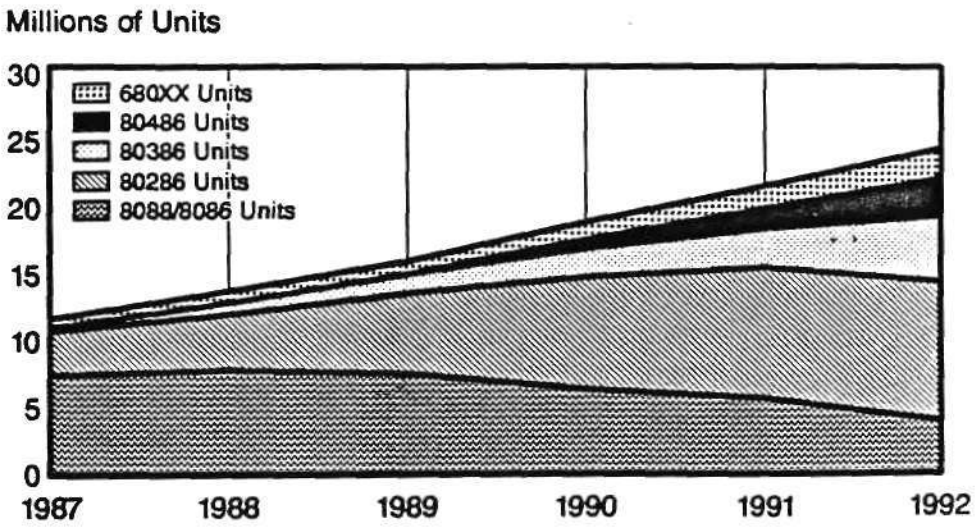
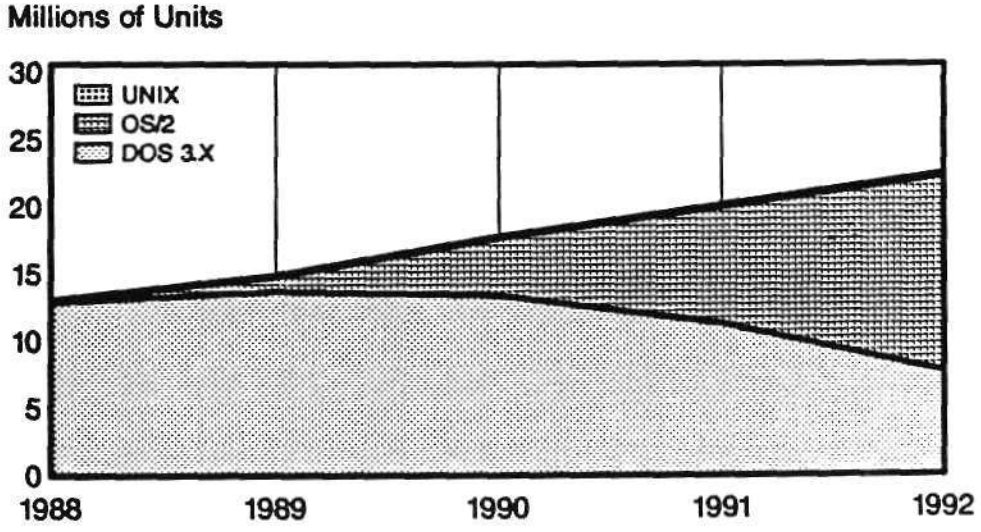
ESTIMATED PC SHIPMENTS

by Microprocessor Type



Source: Dataquest

ESTIMATED PERSONAL COMPUTER OPERATING SYSTEM SHIPMENTS



Source: Dataquest

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VIDEOPHONE PC OF THE 1990s

- 4-8 mips
- 4-8MB RAM
- Megapixel color displays - 8-10 inches
- 3.5-inch storage
- Built-in LAN
- Coprocessing
- 80MB hard disk

HOT NEW SEMICONDUCTORS FOR THE OFFICE

Emerging Systems	Semiconductors Needed
Laptop PC	Sea-of-gates ASICs, megabit memories (IC cards), specialized 32-bit MPUs, voice recognition chips
Videophone PC	CCD sensors, voice recognition chips, IC card readers
Personal fax/copier	Advanced telecom ICs, printer font ROM cartridges, megabit memory storage

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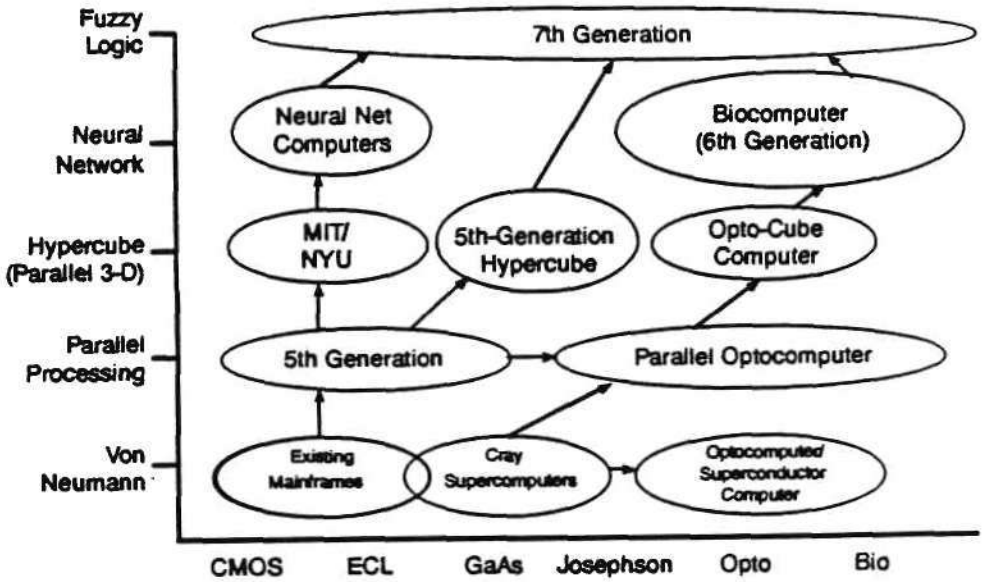
FUTURE COMPUTING TRENDS



Source: Dataquest

5 p.m. - ELECTRONIC COMPARISON SHOPPING

Item	Lucky's	Safeway	Alpha-Beta
Whole Wheat Bread	$1.39	$1.49	$1.25
1/2-Gallon Skim Milk	2.00	1.80	1.95
Boned Chicken	3.75	4.50	4.25
Raisin Bran Cereal	2.75	3.20	3.10
6-Pack Budweiser	3.50	4.20	3.99
Total	$13.39	$15.19	$14.54
Send Order	↑		

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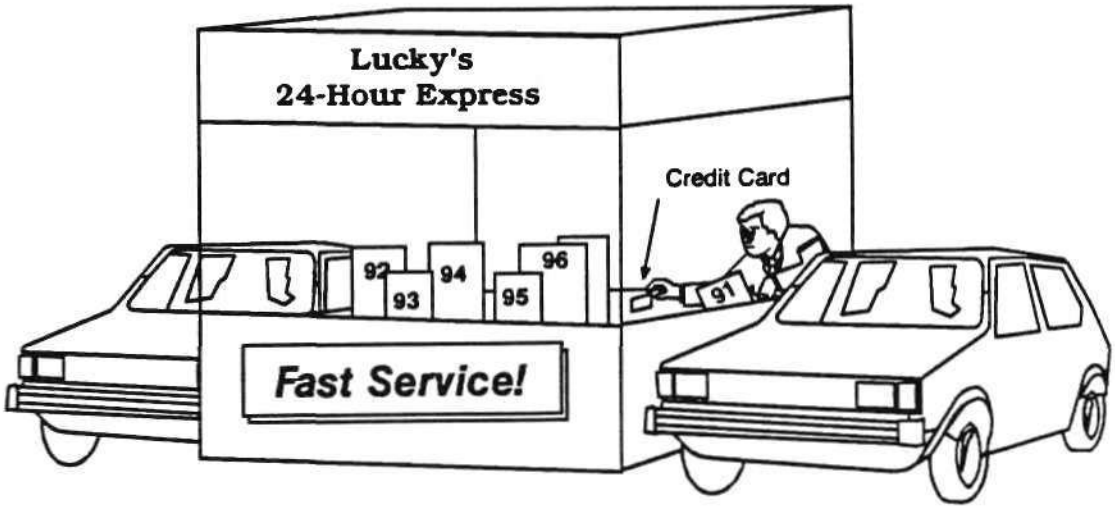
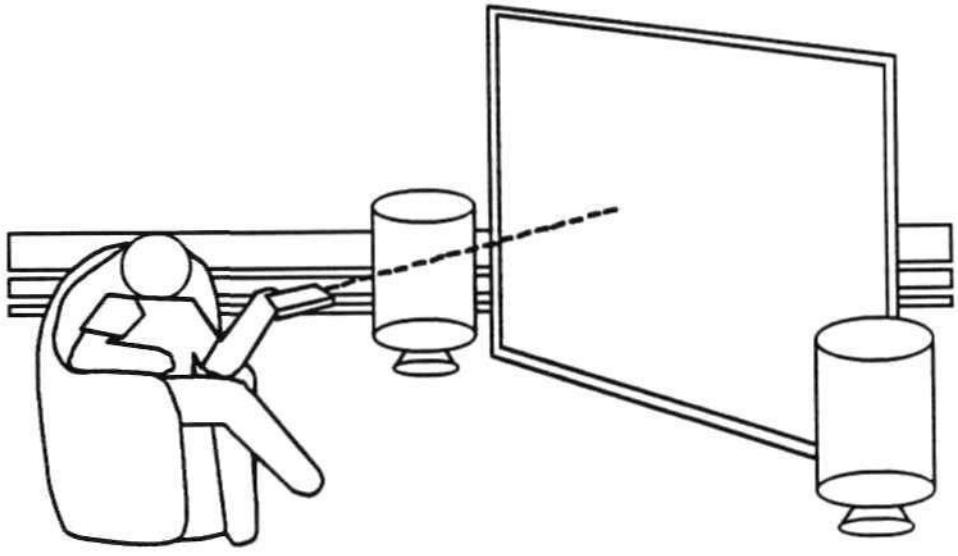
6 p.m. - SHOPPING PICKUP



7 p.m. - HOME ENTERTAINMENT



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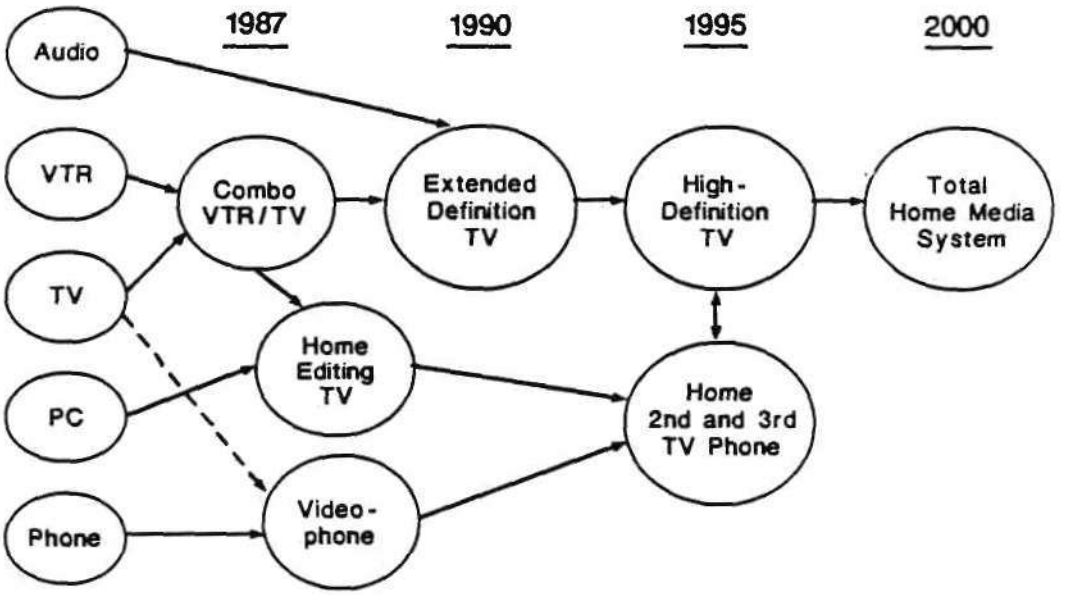
EMERGING HOME ELECTRONICS



HOT NEW HOME ELECTRONIC SEMICONDUCTORS

Emerging Systems	Semiconductors Needed
Large-Screen Combo VTR/TV	Video RAMs (4Mb/16Mb/64Mb) 32-bit video processors Sea-of-gates ASICs
Remote Control Handsets	Semiconductor lasers Voice recognition chips 32-bit controllers
Videophone Sets (Second or Third TVs)	Voice recognition chips Video RAMs CCD sensors Specialized 32-bit video processors

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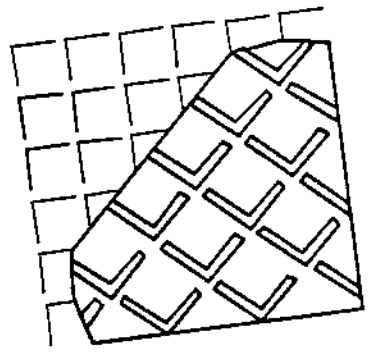
Our Rapidly Changing Industry:
Status 1988



COMPETITIVE STRUCTURE IN ASIA

TOM WANG

Director
Asia/Pacific Components Group
Dataquest Incorporated

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AGENDA

- Asian semiconductor industry outlook
- Semiconductor manufacturers in Asia
- Key issues in 1988
- Summary and conclusion

ASIAN SEMICONDUCTOR INDUSTRY OUTLOOK

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- Market growing drastically
- Competition increasing significantly
- Manufacturing moving offshore
- Business opportunities growing

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SEMICONDUCTOR CONSUMPTION

(Millions of U.S. Dollars)

	1985	1986	1987*
South Korea	$436	$624	$1,101
Taiwan	$496	$694	$1,171
Hong Kong	$334	$478	$ 806
Singapore	$271	$350	$ 590

* Estimated

Source: Dataquest

ESTIMATED SEMICONDUCTOR CONSUMPTION

(Billions of U.S. Dollars)

	1986	1987	1988	1992
ROW	$ 2.9	$ 4.9	$ 6.3	$11.8
Europe	$ 5.5	$ 6.8	$ 7.5	$11.9
Japan	$12.4	$14.5	$17.4	$27.5
United States	$10.2	$12.5	$14.2	$20.2

Source: Dataquest

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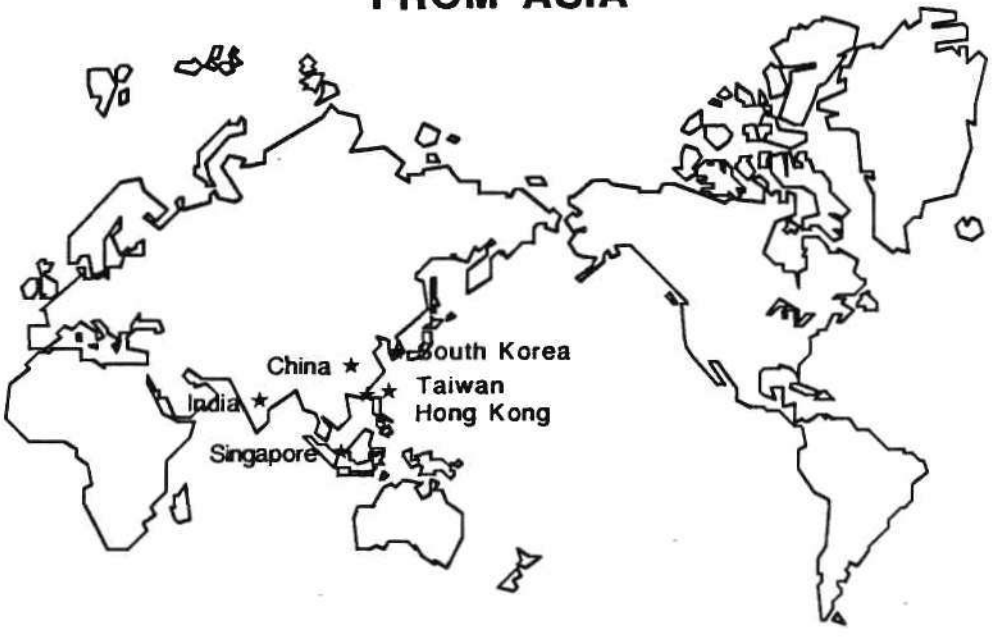
COMPETITION INCREASING SIGNIFICANTLY FROM ASIA



COMPETITION FROM THE 4 "Cs"

- Consumers
- Computers
- Communications
- Semi-Conductors

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SEMICONDUCTOR PRODUCTION

(Millions of U.S. Dollars)

Company	1986	1987*	Growth Rate
Samsung	$170	$317	86.5%
GoldStar	$ 48	$ 68	41.7%
KEC	$ 50	$ 78	56.0%
UMC	$ 68	$ 90	32.4%

* Estimated

Source: Dataquest

COMPETITION IN MEMORY CHIPS

	Samsung	GoldStar	Hyundai
1M DRAM			
Mass Production	2Q '88	3Q '88	4Q '88
Wafer Size	6"	6"	6"
Design Rule	1.2µm	1.2µm	1.2µm
Capacity (Wafer/Day)	100-600	600	300
4M DRAM			
Mass Production	3Q '89	3Q '89	3Q '89

Source: Dataquest

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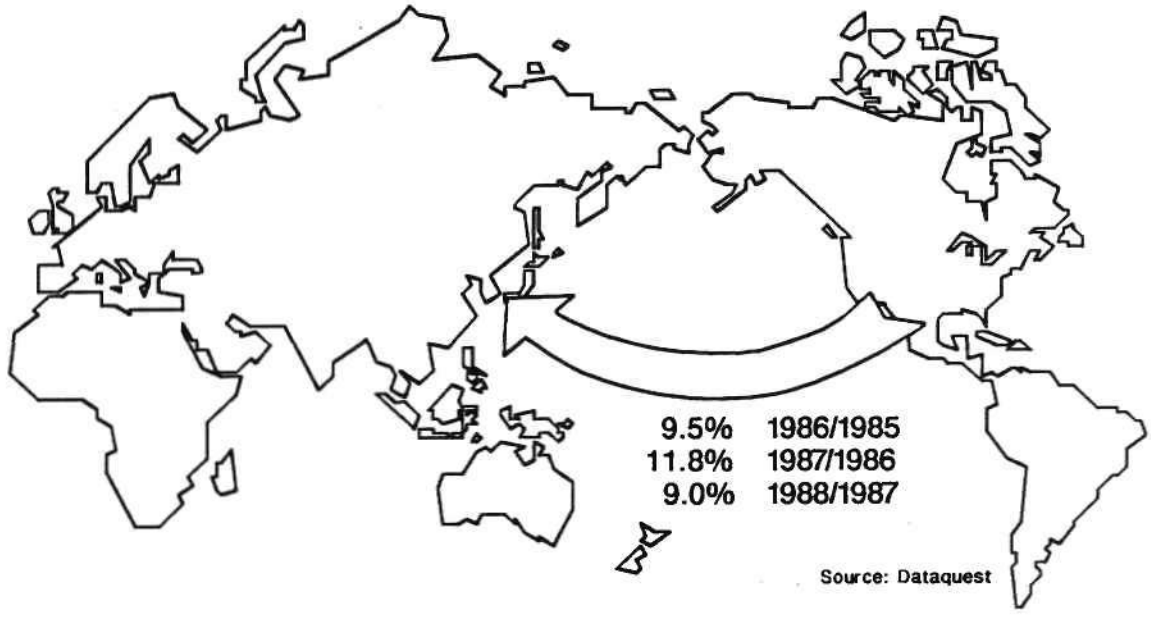
ESTIMATED PERCENT OF U.S. SEMICONDUCTOR CONSUMPTION MOVING OFFSHORE



MAIN REASONS FOR MOVING OFFSHORE

Before:

Low labor cost

Now:

Low labor cost + superior talent
+closeness to market

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FUNCTIONS OF OFFSHORE FACILITY

Before:
Assembly and testing

Now:
Design + fabrication +
assembly and testing

OPPORTUNITY

Economic Growth
Real GDP Growth Rates (%)

	1986	1987*	1988*
Taiwan	11.0	10.1	7.3
South Korea	12.4	11.1	8.0
Hong Kong	11.0	12.6	8.9
Singapore	1.9	6.9	5.5
China	8.0	9.7	9.1
Japan	2.4	2.5	3.0
United States	2.2	3.1	2.8
Europe	2.5	2.2	2.0

* Estimated

Source: Dataquest

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OPPORTUNITY

High-Technology Business Opportunities

- Semiconductor manufacturing
- Semiconductor equipment and materials manufacturing
- Systems manufacturing
- Financial opportunities

SEMICONDUCTOR MANUFACTURERS IN ASIA

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SEMICONDUCTOR MANUFACTURERS - SOUTH KOREA

- Samsung
- Goldstar
- Hyundai
- Daewoo
- KEC

SAMSUNG

Sales	$316 million	Sales Channels	Asia - agents Europe - agents U.S. - reps/dist'rs. Big OEMers - direct
Rank	22		
Products	256K DRAMs - 25% 64K DRAMs - 20% CMOS Logic - 25% Linear ICs - 10% Transistors - 20%	New Products	1M DRAMs 512K EPROMs 256K SRAMs CTV/VTR ICs Codec/Combo
Capacity (Wafers/year)	4" BIP - 360,000 5" MOS - 600,000 6" MOS - 200,000		

Source: Dataquest

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GOLDSTAR

Sales	$69 million	Sales Channels	Asia - agents
			Europe - agents
Products	TTL - 30%		U.S. - reps/dist'rs.
	Gate arrays - 20%		Big OEMers - direct
	74HC/HCT - 10%		
	Hybrids - 30%	New Products	1M DRAMs
	Linear ICs - 10%		256K DRAMs
			2Kx8 SRAMs
Capacity	4" BIP - 200,000		8Kx8 SRAMs
(Wafers/year)	5" MOS - 250,000		Fast TTLs

Source: Dataquest

HYUNDAI

Sales	$40 million	Sales Channels	Asia - agents
			Europe - agents
Products	256K DRAMs - 50%		U.S. - reps/dist'rs.
	16K SRAMs - 15%		Big OEMers - direct
	Mask ROMs - 15%		
	MPUs - 10%	New Products	1M DRAMs
	Others - 10%		
Capacity	5" MOS - 120,000		
(Wafers/year)	6" MOS - 480,000		

Source: Dataquest

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DAEWOO

Sales	$10 million	Sales Channels	Asia - agents Europe - agents
Products	Audio ICs - 50% Custom - 50%		U.S. - reps/dist'rs. Big OEMers - direct
Capacity (Wafers/year)	4" BIP - 90,000	New Products	ICs for PC ICs for telecom

Source: Dataquest

KEC

Sales	$78 million	Sales Channels	Domestic - direct International - through Toshiba
Products	Transistors - 70% Linear ICs - 30%	New Products	Linear ICs
Capacity (Wafers/year)	4" BIP - 200,000		

Source: Dataquest

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SEMICONDUCTOR MANUFACTURERS - TAIWAN

- UMC
- ERSO
- TSMC
- Rectron
- Fine
- Others

UNITED MICROELECTRONICS CORPORATION (UMC)

Sales	$90 million	Sales Channels	U.S. - reps./dist'rs.
Rank	50	New Products	PS/2 Model 30 Chip Set SCSI Chips Modem Chip Set Data Communication Chips
Products	Microcomponent & Memory ICs - 36.7% Consumer ICs - 26.3% Telephone ICs - 18.4% Custom ICs - 18.6%		
Capacity (Wafers/Year)	4" MOS - 480,000 6" MOS - 120,000 (Available Nov. 1988)		

Source: Dataquest

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ELECTRONICS RESEARCH AND SERVICE ORGANIZATION (ERSO)

Sales	$30 million
Products	PC Chip Set Consumer ICs Custom ICs Combo

Source: Dataquest

TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY (TSMC)

Product	Foundry
Capacity (Wafers/Year)	Fab I - 6" MOS - 120,000 Fab II - 6" CMOS - 360,000 (Available 1989)

Source: Dataquest

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SEMICONDUCTOR MANUFACTURERS - HONG KONG

- Hua Ko
- Elcap
- RCL

HUA KO

Products	Consumer ICs Custom ICs
Capacity (Wafers/Year)	4" MOS - 60,000

Source: Dataquest

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ELCAP

Products	EL6116 74HC/HCT Series Consumer ICs Custom ICs Gate Arrays (up to 3,000 gates) Packaging Service
Capacity (Wafers/Year)	4" CMOS - 60,000

Source: Dataquest

SEMICONDUCTOR MANUFACTURERS - SINGAPORE

- SGS-Thomson*
- HP
- Chartered

* Only SGS-Thomson is in production now

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SGS-THOMSON

Products	EPROMs Power Transistors Consumer ICs Microcomponent ICs
Capacity (Wafers/Year)	5" - 360,000

Source: Dataquest

CHARTERED SEMICONDUCTOR

6" wafer fab will be finished in early 1989.

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SEMICONDUCTOR MANUFACTURERS - CHINA

- Wuxi
- BETF
- Beijing Semiconductor Factories #3, 6, and 109
- Shanghai #5, 7, 14, and 19 Radio Components Factory
- Li shan
- Others

WUXI MICROELECTRONICS COMPLEX

Products

- Toshiba 5-chip set @ 5 million units/yr.
- Discrete semiconductor components (mostly for consumer electronics applications)
- 64K memories, 4-bit MCUs, and telecom devices in small quantities

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WUXI MICROELECTRONICS COMPLEX

Sales channels

- Not well developed, manufacturers almost entirely under exclusive agreement

Trends

- Capable of 3-micron technology
- Most production is of 4-inch wafers
- Future emphasis on telecom ICs, converters, and op amps

KEY ISSUES IN 1988

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KEY NEGATIVE ISSUES IN 1988

- Currency value appreciation
- Protectionism
- Competition from non-NICs
- U.S.-dependent industry

SUMMARY

- Asian semiconductor industry's worldwide influence will grow
- Asia will be worldwide leader in semiconductor consumption growth
- South Korea will be a significant DRAM producer
- Taiwan will become a major ASIC design center

Source: Dataquest

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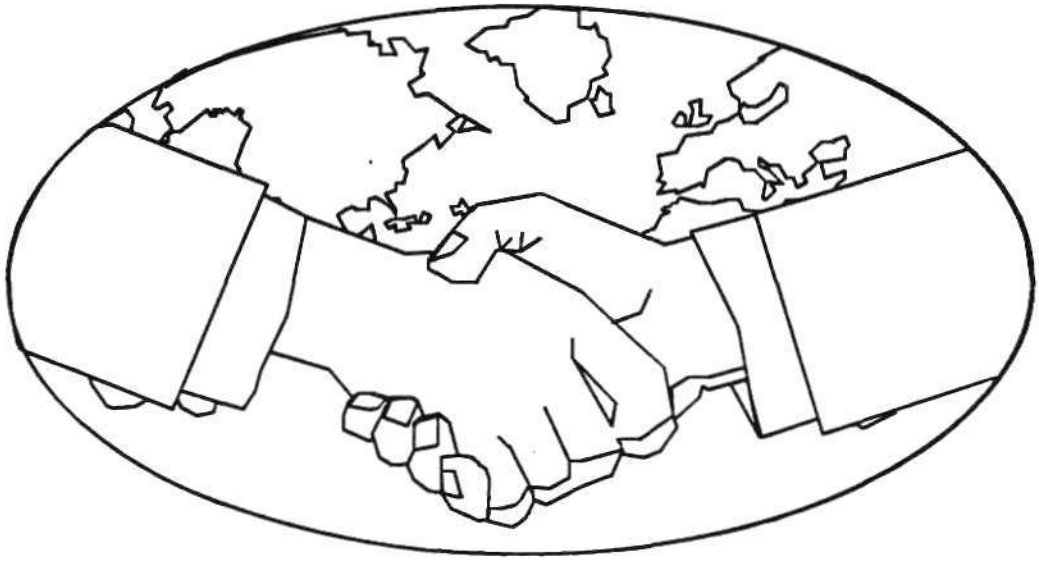
CONCLUSION



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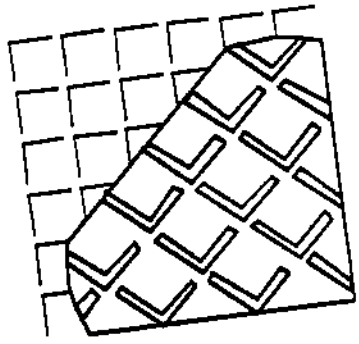
Status 1988



EUROPEAN COMPETITIVE ANALYSIS

BIPIN PARMAR

Senior Industry Analyst
European Components Group
Dataquest UK Limited

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WORLDWIDE SEMICONDUCTOR PRODUCERS' SHARES

(Billions of Dollars and Percentages)

	1986		1987		Growth
Japan	$14.0	48%	$17.8	49%	27.2%
United States	11.6	40	13.9	39	22.4%
Europe	3.4	11	4.0	11	17.6%
ROW	0.4	1	0.6	1	50.0%
Total	$29.4	100%	$36.3	100%	24.5%

Source: Dataquest

IMPACT OF SEMICONDUCTOR MERGERS

European Market Rankings

1986	1987	Company	Highest Position
6 and 5	2	SGS-Thomson	Semi. - 2
7 and 16	6	National-FSC	Bipolar Logic - 2
11 and 21	9	AMD-MMI	Bipolar Memory - 1
15 and 19	13	Plessey-Ferranti	Bipolar GA - 2

- Major impact on bipolar position, not on MOS
- 1988 is year of consolidating manufacturing
- 1989 and '90 - new investments in emerging processes

Source: Dataquest

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FUTURE TRENDS -- EUROPEAN ELECTRONICS INDUSTRY

- Europe will become a unified market after 1992
- Restrictive trade barriers will disappear
- Size of combined market will increase GNP by 5%
- Size of population will be 330 million
- New European standards will emerge in consumer electronics, telecommunications, and computers
- Scale of economy will drive down costs
- Europe will be more competitive in its own market

Source: Dataquest

FUTURE TRENDS -- EUROPEAN ELECTRONICS INDUSTRY

- Europe will have state-of-the-art processing capability
  - Espirit, Eureka, Megaproject
- European community will ensure:
  - Multinationals source components locally
  - Collaborative R&D on all fronts
  - Maintaining strong manufacturing base
- Europe
  - Still strong in consumer electronics and automotive
  - Telecommunications will get stronger
  - Stability in military market

Source: Dataquest

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EUROPEAN SEMICONDUCTORS MARKET SHARE

(Billions of U.S. Dollars and Percentages)

	1986		1987		Growth
Japan	$0.66	12.0%	$0.85	13.3%	28.8%
U.S.	2.53	45.9	2.75	43.2	8.7%
Europe	2.32	42.0	2.70	42.7	16.4%
ROW	0.02	0.1	0.05	0.8	150.0%
Total	$5.53	100.0%	$6.35	100.0%	14.8%

Source: Dataquest

EUROPEAN COMPONENTS GROUP

European Market Share Estimates, Millions of U.S. Dollars

ASICs

	1987	% Market Share
STM	$ 75.5	11.3%
ITT	73.0	10.9%
Siemens	66.0	9.8%
AMD-MMI	44.0	6.6%
LSI Logic	40.0	6.0%
Mietec	32.0	4.8%
National-Fairchild	32.0	4.8%
Ferranti	28.0	4.2%
AMS	27.0	4.0%
Motorola	24.5	3.7%
Texas Instruments	24.0	3.6%
Others	205.1	30.3%
Total Market	$671.1	

Source: Dataquest

EUROPEAN COMPONENTS GROUP

European Market Share Estimates, Millions of U.S. Dollars
Bipolar ASICs

	1987	% Market Share
Programmable Logic (Total)	$65	
AMD-MMI	43	66%
National-Fairchild	9	14%
Philips	8	12%
Texas Instruments	5	8%
Gate Array (Total)	$76	
Siemens	29	38%
Ferranti	22	29%
National-Fairchild	6	8%
Motorola	5	7%
Fujitsu	4	5%
Plessey	4	5%
Others	6	8%

(Continued)

EUROPEAN COMPONENTS GROUP

European Market Share Estimates, Millions of U.S. Dollars
Bipolar ASICs

	1987	% Market Share
Full Custom (Total)	$47	
Telefunken	16	34%
Siemens	13	28%
Texas Instruments	6	13%
Rifa	4	9%
National-Fairchild	3	6%
Others	5	10%

Source: Dataquest

EUROPEAN COMPONENTS GROUP

European Market Share Estimates, Millions of U.S. Dollars

	1986	1987	Growth 1986-1987	% Market Share 1987
MOS – $2,647				
Intel	201	283	41%	10.7%
Philips	225	258	1%	9.7%
NEC	199	225	13%	8.5%
STM	216	214	(1%)	8.1%
TI	155	184	19%	7.0%
MOS Memory – $811				
Intel	106	106	0	13.1%
NEC	89	105	19%	12.9%
Hitachi	115	103	(10%)	12.7%
TI	116	102	(12%)	12.6%
Toshiba	56	85	52%	10.5%

Source: Dataquest

EUROPEAN COMPONENTS GROUP

European Market Share Estimates, Millions of U.S. Dollars

	1986	1987	Growth 1986-1987	% Market Share 1987
MOS Micro – $783				
Intel	100	162	63%	20.7%
NEC	70	94	33%	12.0%
STM	58	74	28%	9.5%
Motorola	59	73	24%	9.3%
Philips	50	55	10%	7.0%
MOS Logic – $1,053				
Philips	198	199	1%	18.9%
STM	98	90	(8%)	8.5%
ITT	58	89	53%	8.5%
Motorola	60	71	18%	6.7%
National-Fairchild	47	64	36%	6.1%

Source: Dataquest

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EUROPEAN COMPONENTS GROUP

European Market Share Estimates, Millions of U.S. Dollars
MOS

	1987	% Market Share
Programmable Logic	$ 10	
Altera	4	40%
Cypress	2	20%
Xilinx	2	20%
Intel	1	10%
AMD-MMI	1	10%
Gate Array	$133	
LSI Logic	36	27%
Plessey	17	13%
National-Fairchild	14	10%
STM	11	8%
Fujitsu	10	8%
Toshiba	10	8%
Others	35	26%

Source: Dataquest

EUROPEAN COMPONENTS GROUP

European Market Share Estimates, Millions of U.S. Dollars
MOS

	1987	% Market Share
CBIC	$ 66	
VLSI Technology	16	24%
AMS	13	20%
Mietec	5	8%
ES2	5	8%
Texas Instruments	4	6%
Others	23	34%
Full Custom	$275	
ITT	73	27%
STM	61	22%
Mietec	27	10%
ASEA-88	23	8%
Siemens	21	8%
Others	70	25%

Source: Dataquest

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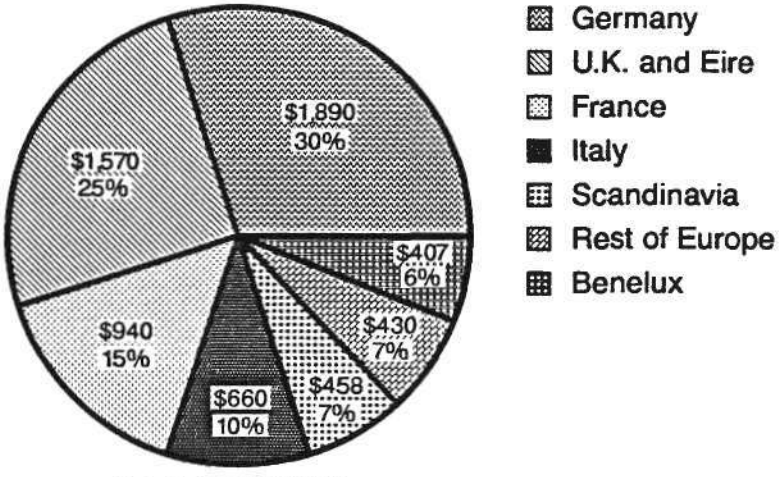
1987 EUROPEAN SEMICONDUCTOR MARKET BY REGION

(Millions of U.S. Dollars)

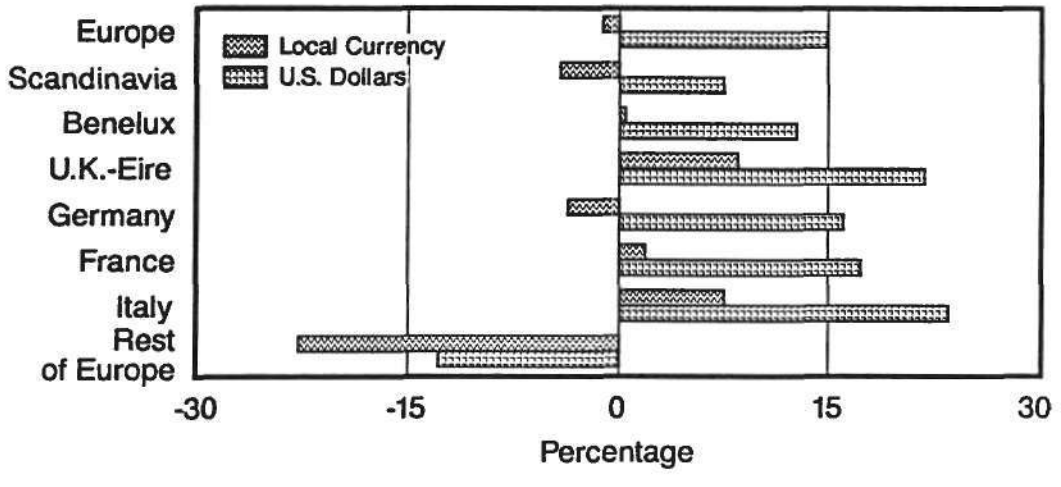


Total: $6,355 Million

Source: Dataquest

EUROPEAN SEMICONDUCTOR GROWTH BY REGION, IN PERCENTAGES

1987 vs. 1986



Source: Dataquest

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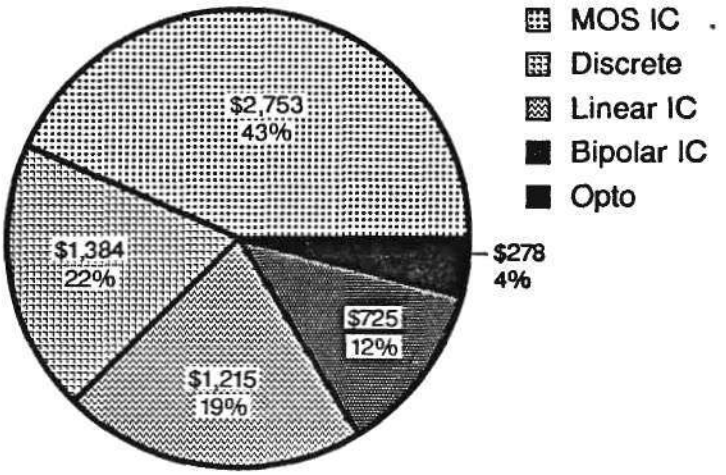
1987 EUROPEAN SEMICONDUCTOR MARKET BY PRODUCTS

(Millions of U.S. Dollars)

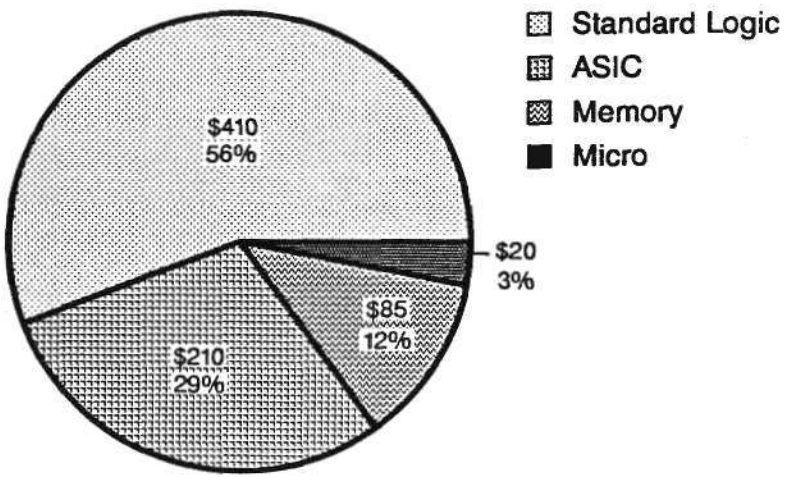


Total: $6,355 Million

Source: Dataquest

1987 EUROPEAN BIPOLAR MARKET BY PRODUCTS

(Millions of U.S. Dollars)



Total: $725 Million

Source: Dataquest

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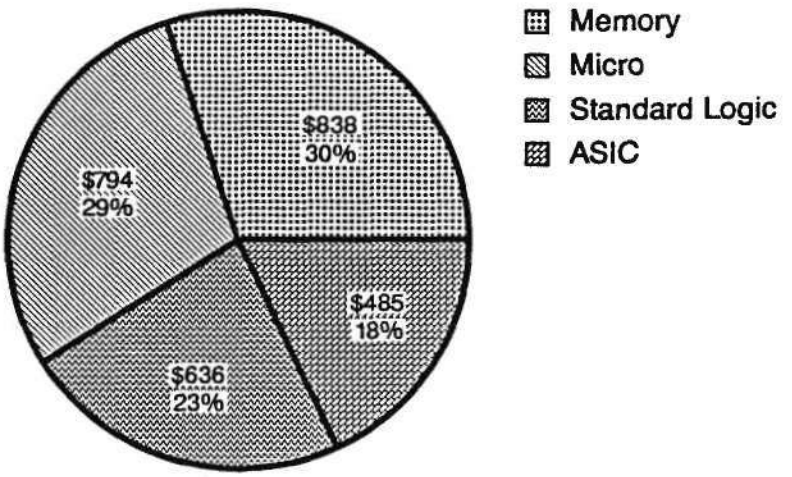
1987 EUROPEAN MOS MARKET BY PRODUCTS

(Millions of U.S. Dollars)



Total: $2,753 Million

Source: Dataquest

Dataquest Europe

SEMICONDUCTOR MARKET FORECAST 1987-1993

April 1988

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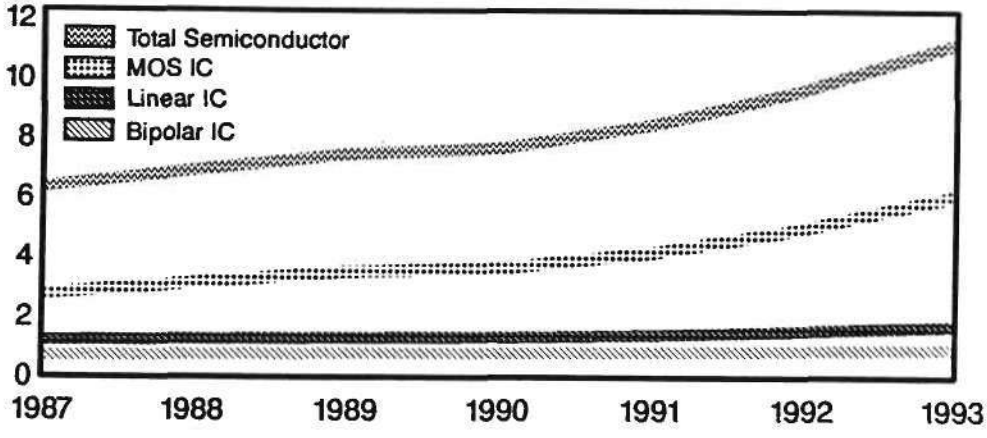
BIPOLAR, MOS, LINEAR IC EUROPEAN MARKET FORECAST

1987-1993

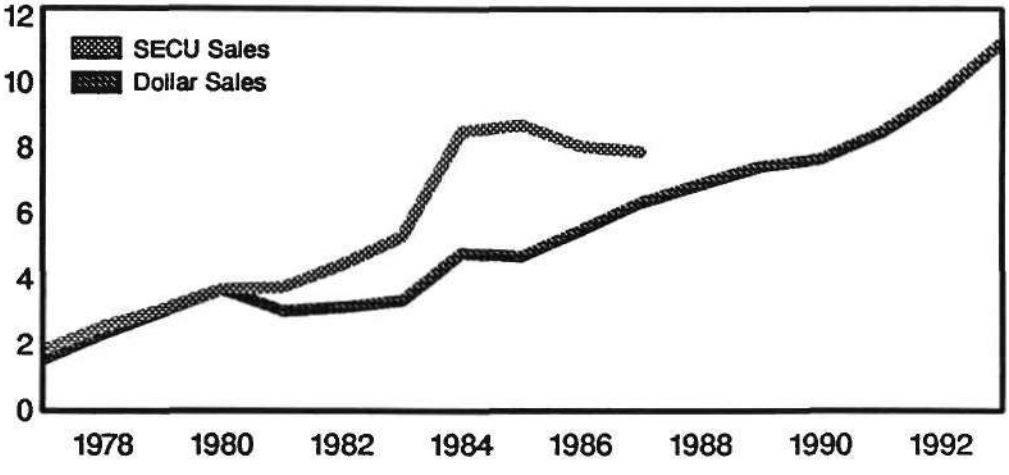
Billions of U.S. Dollars



Source: Dataquest

ESTIMATED EUROPEAN SEMICONDUCTOR SALES IN DOLLARS AND SECUs*/100

Billions



*SECUs = Semiconductor ECUs

Source: Dataquest

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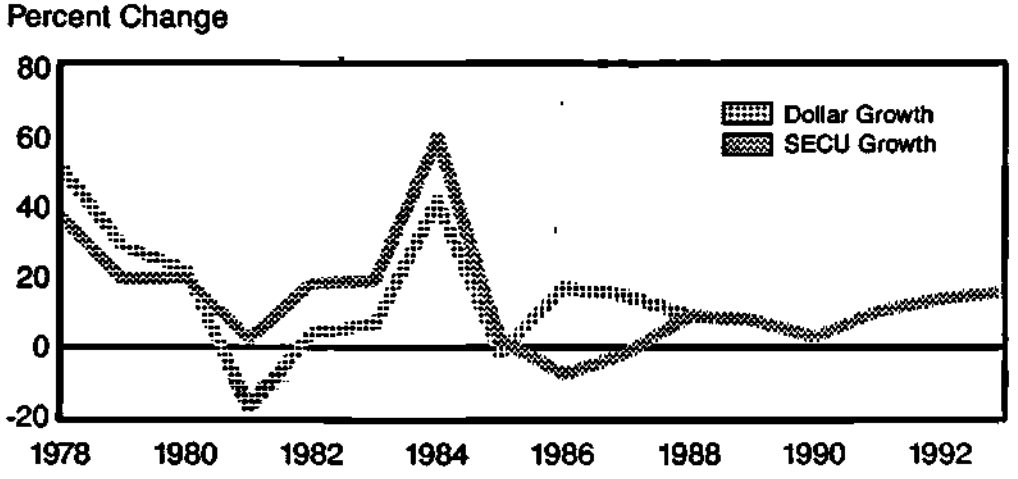
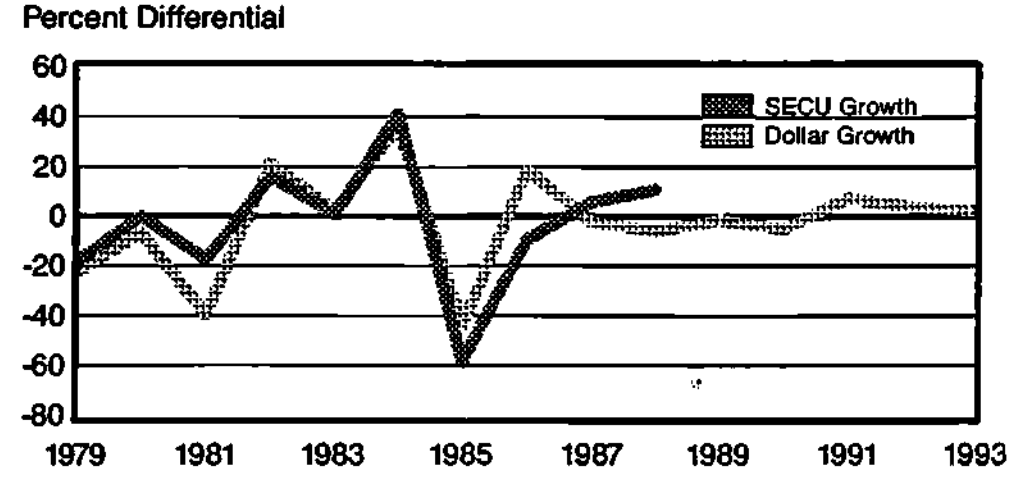
ESTIMATED EUROPEAN SEMICONDUCTOR SALES GROWTH IN DOLLARS AND SECUs*



*SECUs = Semiconductor ECUs

Source: Dataquest

ESTIMATED EUROPEAN SEMICONDUCTOR SALES GROWTH DIFFERENTIAL IN DOLLARS AND SECUs*



*SECUs = Semiconductor ECUs

Source: Dataquest

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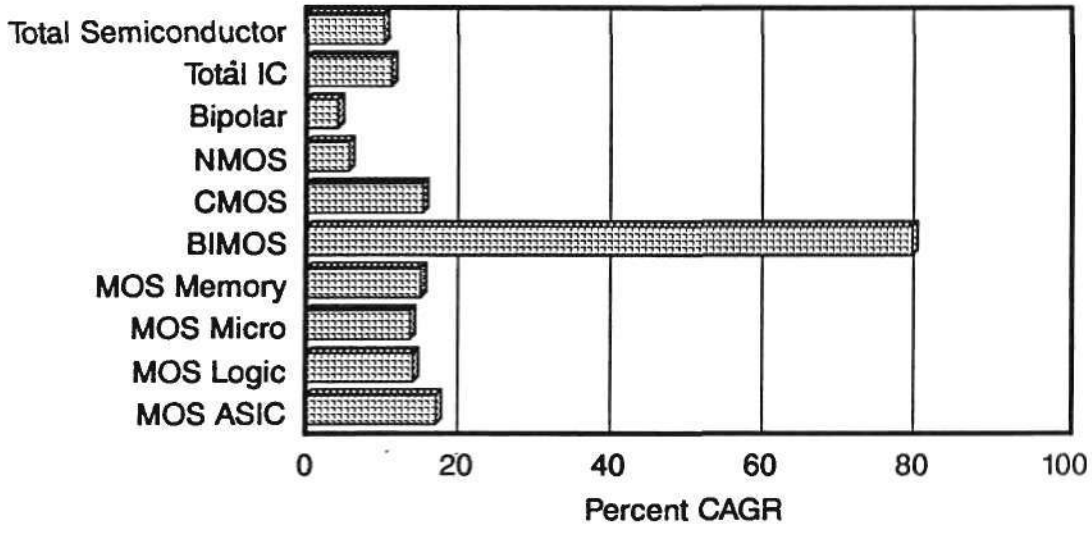
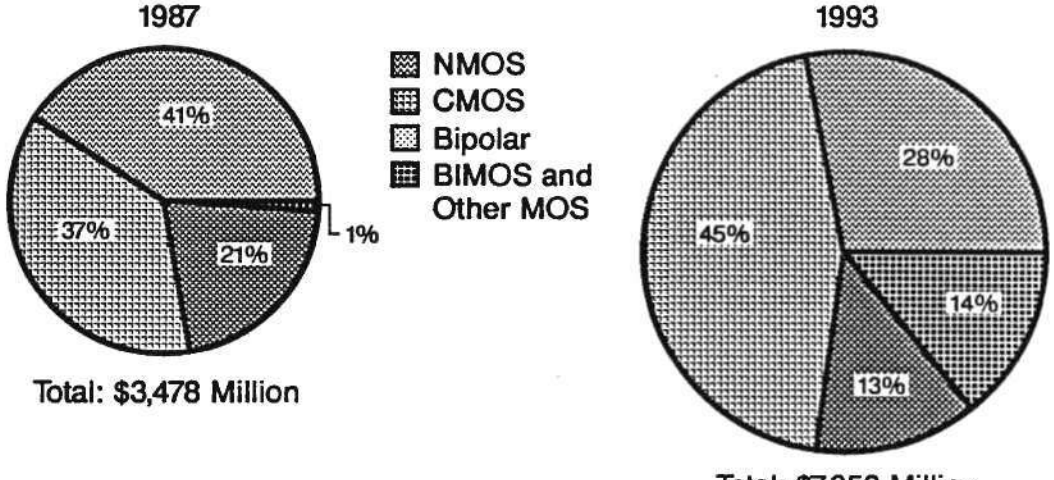
ESTIMATED EUROPEAN SEMICONDUCTOR MARKET

Product CAGR, 1987-1993



ESTIMATED EUROPEAN SEMICONDUCTOR MARKET

MOS and Bipolar Technology Growth
(Millions of U.S. Dollars)



Total: $3,478 Million

Total: $7,053 Million

Source: Dataquest

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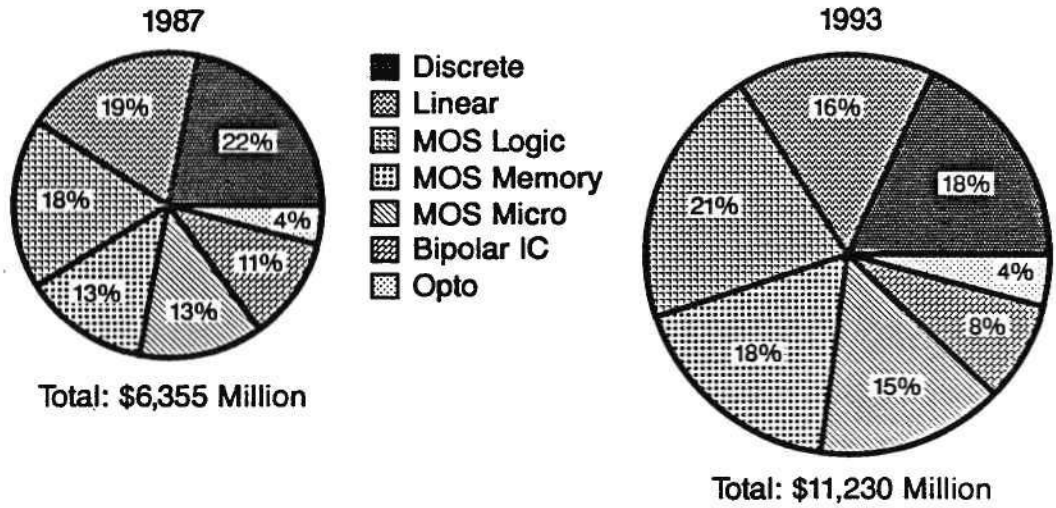
ESTIMATED EUROPEAN SEMICONDUCTOR MARKET

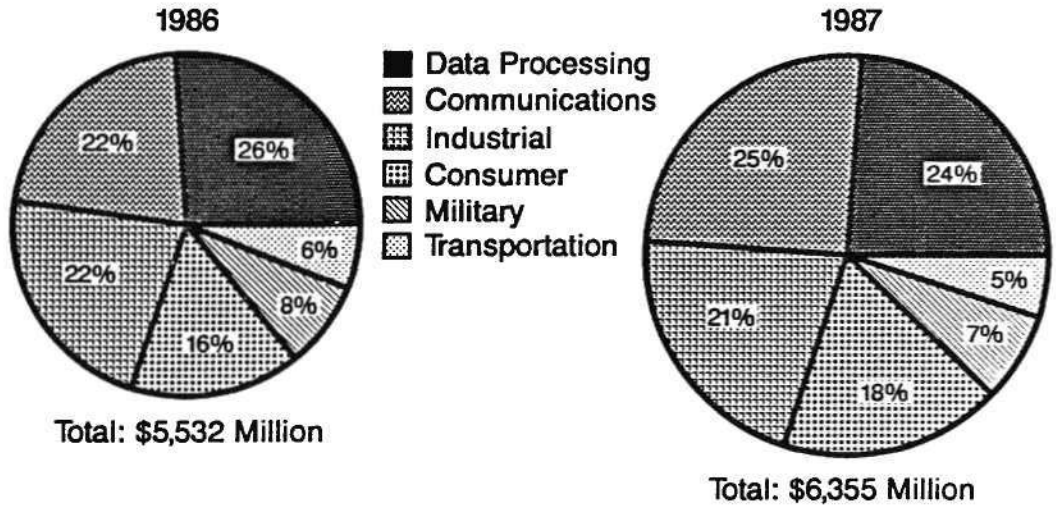
Product Growth
(Millions of U.S. Dollars)



Source: Dataquest

ESTIMATED EUROPEAN SEMICONDUCTOR MARKET

By End Use Segment
(Millions of U.S. Dollars)



Source: Dataquest

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