1995

SEMICON/West Seminar

San Francisco Marriott
San Francisco, California
July 13, 1995

Dataquest

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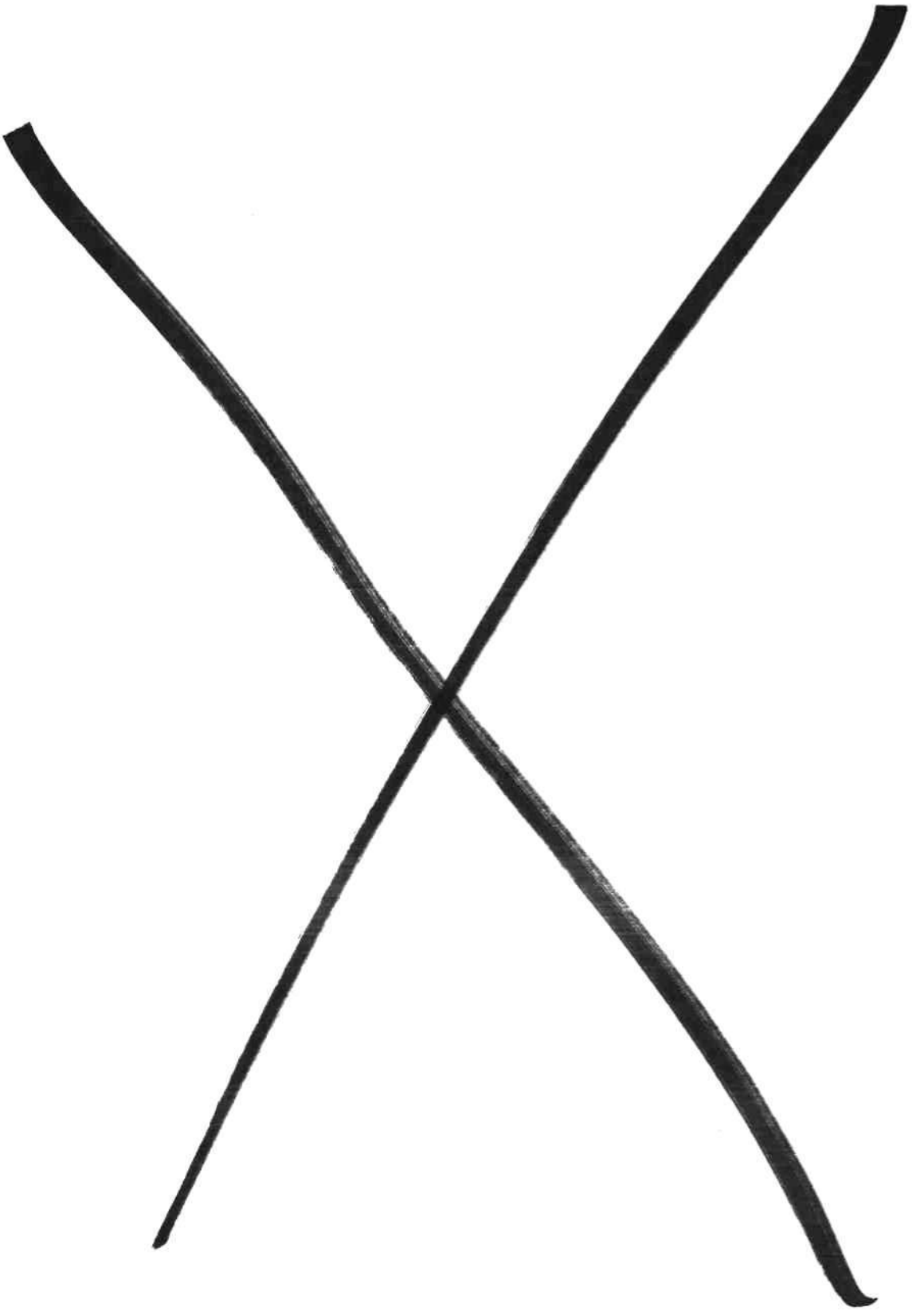


14th Annual SEMICON/West Seminar
July 13, 1995
San Francisco Marriott
San Francisco, California

7:30-8:00 a.m. **Registration and Continental Breakfast** — **Foyer**

8:00 a.m. **Wafer Fab Equipment Forecast: Are We Ready to Call the Silicon Cycle Dead?** — **Golden Gate C1 and C2**
Clark J. Fuhs
Senior Industry Analyst
Dataquest Incorporated

8:40 am **Do Profits Trickle Down the Semiconductor "Food Chain"?** — **Golden Gate C1 and C2**
Näder Pakdaman
Senior Industry Analyst
Dataquest Incorporated

9:15 a.m. **It's 1995—Do You Know What Your Customer's Customer Is Going to Do?** — **Golden Gate C1 and C2**
Dale Ford
Senior Industry Analyst
Dataquest Incorporated

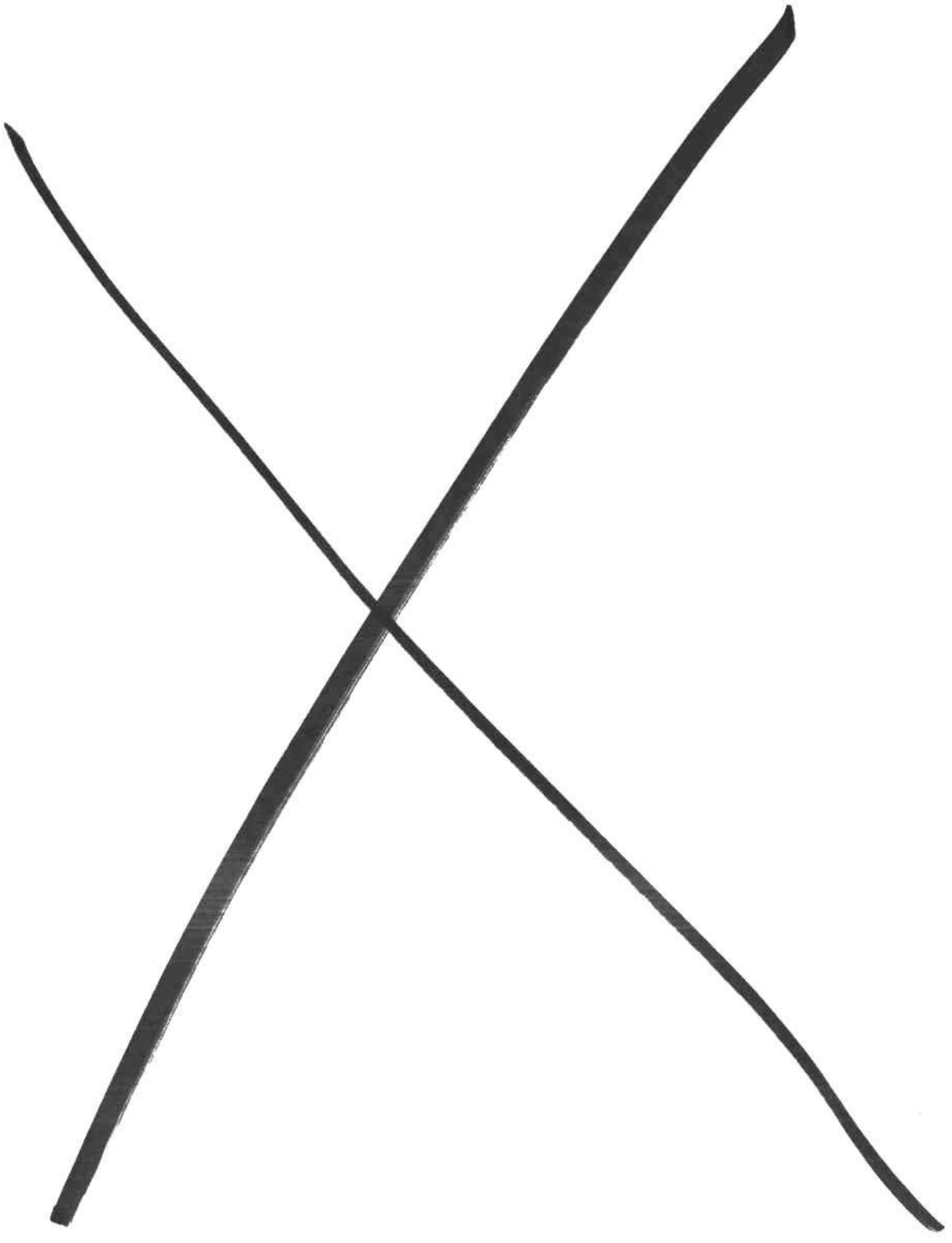
9:50 a.m. **Networking Break**

10:10 a.m. **LCD Industry Outlook—Toward the Year 2000** — **Golden Gate C1 and C2**
Dr. Yasumoto Shimizu
Senior Industry Analyst
Dataquest Incorporated Japan

10:45 a.m. **Semiconductor Fabs: Bigger, Fewer, and Better** — **Golden Gate C1 and C2**
Calvin Chang, Ph.D.
Industry Analyst
Dataquest Incorporated

11:20 a.m. **Flexible Manufacturing Fab Design** — **Golden Gate C1 and C2**
Jorge E. Carbó
Director, Marketing and Sales
SubMicron Technology

12:00 p.m. **Seminar Concludes**



Conference Evaluation

Thank you for attending SEMICON/West 1995. Your thoughts and comments regarding this event are an important part of our process to continually improve the value provided through our conference program. Please help us by taking a few moments to complete this questionnaire.

this section optional

Name: _____ Title: _____

Company Name: _____ Tel: _____

Nature of company's primary activity: _____

Where did you originally hear about this seminar?

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

How important were the following reasons for attending this conference?

Please circle your rating:	not very important				very important
To hear and talk to Dataquest analysts	1	2	3	4	5
To learn more about Dataquest Semiconductor services and reports	1	2	3	4	5
To network with seminar attendees	1	2	3	4	5

Additional reasons:

_____

_____

_____

	not very satisfied				very satisfied
How satisfied are you overall that the conference met these objectives:	1	2	3	4	5

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

_____

_____

_____

Conference Evaluation

Please evaluate the sessions you attended by circling your rating:	1 = Low 5 = High	1 = Poor 5 = Excellent	1 = Poor 5 = Excellent	
	Interest Level	**Presentation**	**Content**	**did not attend**
Wafer Fab Equipment Forecast: Are We Ready to Call the Silicon Cycle Dead? Clark J. Fuhs, Dataquest	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Do Profits Trickle Down the Semiconductor "Food Chain"? Näder Pakdaman, Dataquest	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
It's 1995 — Do You Know What Your Customer's Customer Is Going to Do? Dale Ford, Dataquest	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
LCD Industry Outlook—Toward the Year 2000 Dr. Yasumoto Shimizu, Dataquest Japan	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Semiconductor Fabs: Bigger, Fewer, and Better Calvin Chang, Ph.D., Dataquest	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○
Flexible Manufacturing Fab Design Jorge E. Carbó, SubMicron Technology	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	○

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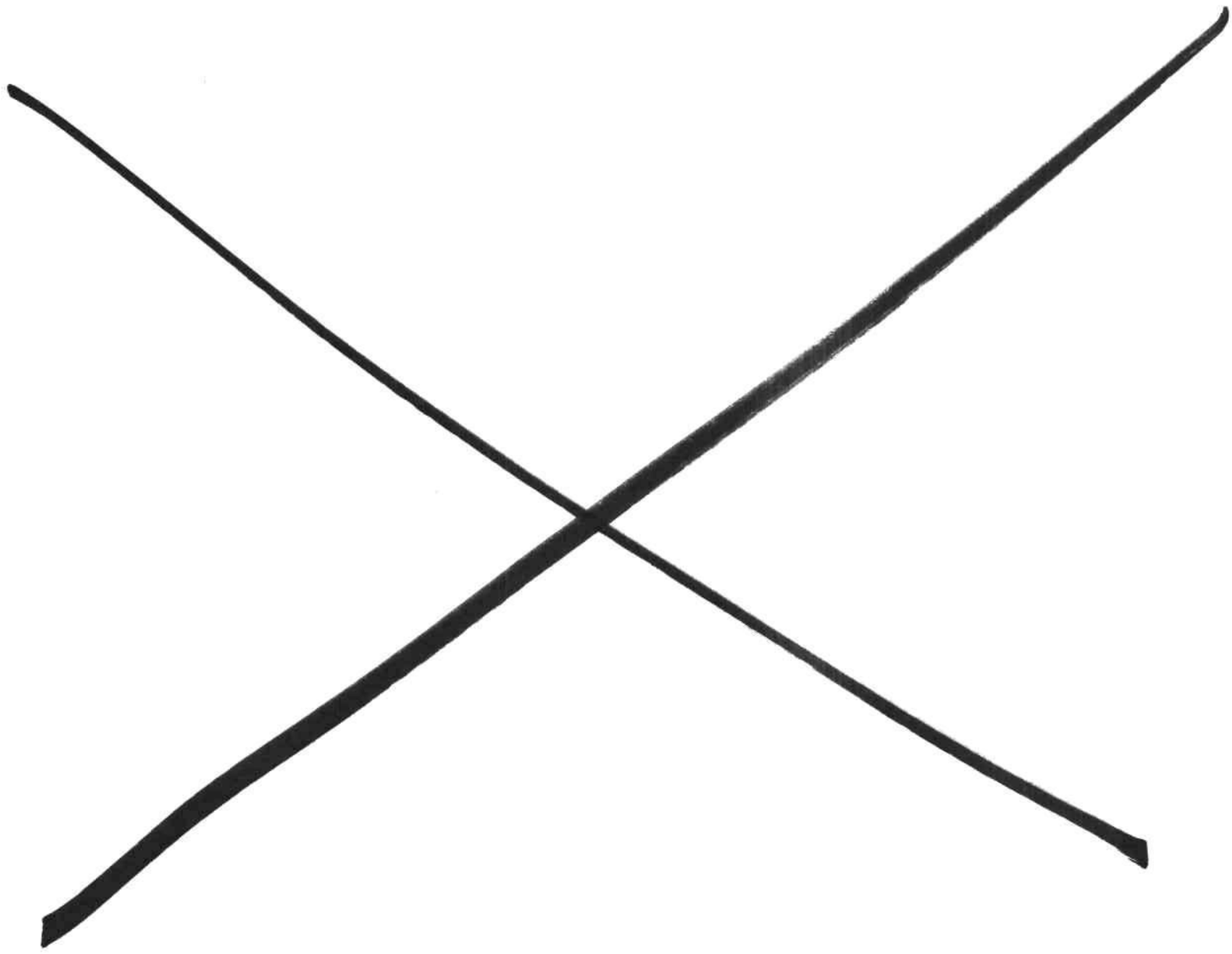
Which Dataquest service group(s) are of interest to you? Please check.

- ○ Computers and Peripherals
- ○ Consulting
- ○ Document Management
- ○ IT Services
- ○ Online, Multimedia and Software
- ○ Semiconductors
- ○ Telecommunications



Attendees

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Ralph Waggitt
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ABN-AMRO Bank
Inga C. Lapsins
Corporate Banking Officer
Robin Yim
Vice President
Robert Hartinger

Applied Materials Inc.
Randy Bane
Manager Global Marketing
Waley Chang
Industry Analyst
Sesh Ramaswami
Product Manager
Deborah Robinson
Market Analyst

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Indu Gupta
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Erik Stone
Manager

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John Cromwell III
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Assistant Credit Manager
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Industry Analyst
Dale Ford
Industry Analyst
Clark J. Fuhs
Senior Industry Analyst
Joseph Grenier
Vice President, Semiconductor Device and Applications Group
Gene Norrett
Vice President and Group Director, Semiconductors Worldwide
Näder Pakdaman
Senior Industry Analyst
Dr. Yasumoto Shimizu
Senior Industry Analyst

Eaton Corporation
Ian Morris

Edwards High Vacuum International
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Vice President Sales

E.I. DuPont Company
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Semiconductor Industry Manager

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Gary Vannice
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Craig Sue
IC Production

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LAM Research
Krista Bitel
Buyer Planner

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Ken Dalle-Molle
Market Research Analyst
Bill Groves
Public Relations

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Marty Hammond
Brad Mattson
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Tim McCarthy
Vice President, Manufacturing

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Jon D. Tompkins
President/Chief Executive Officer

Tencor/Prometrix
Gary Bultman
Vice President, Marketing

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Lee Smith
Vice President, Marketing

Tribotech
Bud Cain
Consultant

Ultratech Stepper
Joe Nava
Vice President

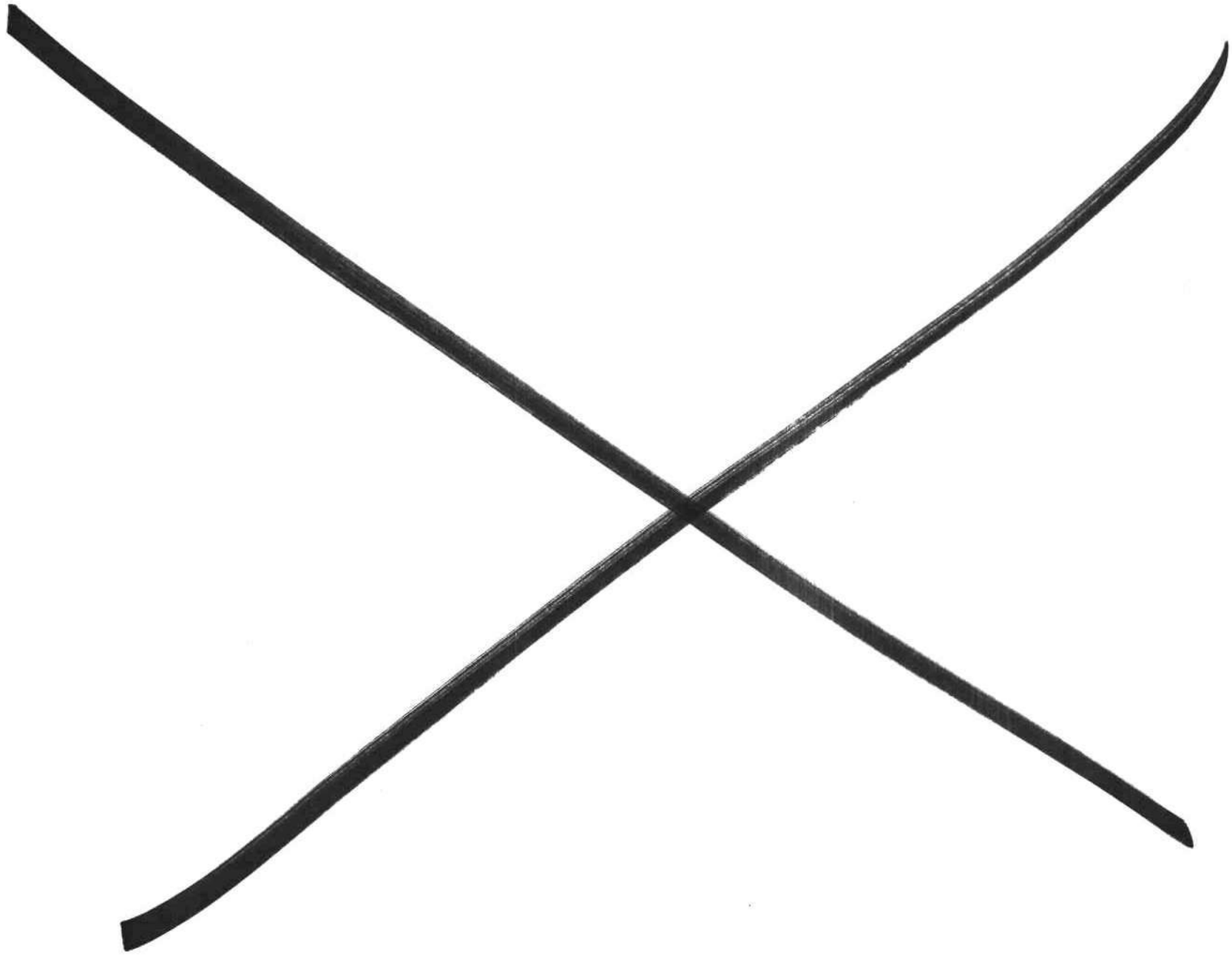
Unit Instruments
David Sheriff
Director, Marketing

USL Capital
Colleen Lusian
Director, Equipment Risk

Varian Associates
Fred Wong
Vice President and General Manager

Western Digital
Douglas Blacke
Director

Other attendees:
Tom Mancino



Wafer Fab Equipment Forecast: Are We Ready to Call the Silicon Cycle Dead?

Clark J. Fuhs

Senior Industry Analyst
Semiconductor Equipment, Manufacturing, and Materials Service
Semiconductors Group
Dataquest Incorporated

Mr. Fuhs is a Senior Industry Analyst for Dataquest's Semiconductor Equipment, Manufacturing, and Materials service in the Semiconductors group. He is responsible for research and analysis of semiconductor materials and trends in IC manufacturing techniques along with forecasting capital spending and the wafer fab equipment market.

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

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

Presentation Overview

- What is the "Silicon Cycle"?
- Forecast and trends
  - Semiconductor production
  - Capital spending
  - Wafer fab equipment
- Understanding the cyclicality drivers
- Tools for timing
- Conclusions

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What Is the Silicon Cycle?

- "Every five years" theory has no real basis
- Past cycles had symptom of inventory buildup
- Causes?
  - Electronic equipment slows (tied to economy)
  - PC unit shipments slow or decline
  - DRAM business cycle happens
- Past slowdowns had two to three events occur together

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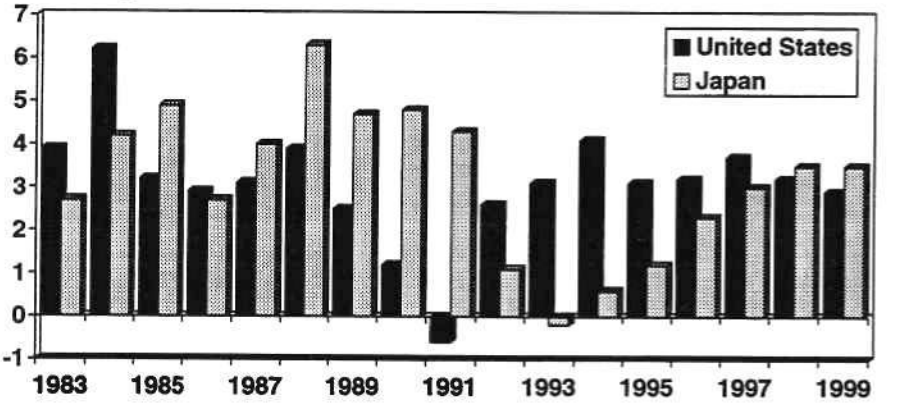
The World Economy: United States and Japan No Longer Synchronous



Forecast Source: Dun & Bradstreet Corporation

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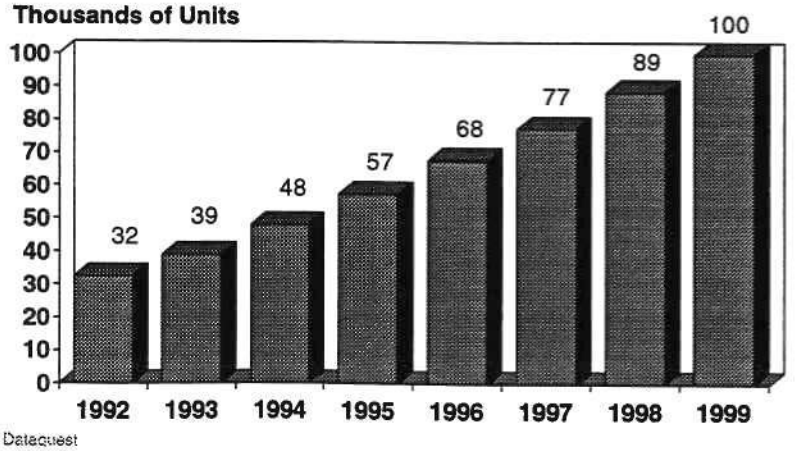
PC Unit Forecast



Source: Dataquest

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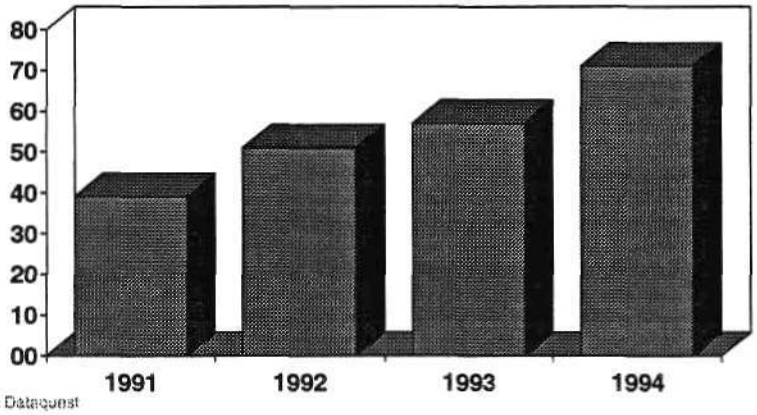
Network Interface Card Penetration: An Indicator of a Future Driver?

Market Penetration for North American PC Units



Source: Dataquest

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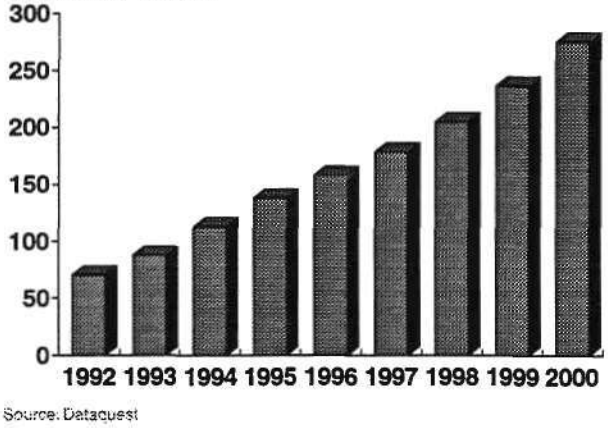
Worldwide Semiconductor Production Forecast

Billions of Dollars



- Electronic equipment
  1994: $690 billion
  2000: $1,044 billion
- Semiconductor
  1994: $113 billion
  2000: $275 billion
- Wafer fab equipment
  1994: $10.8 billion
  2000: $29.7 billion

Source: Dataquest

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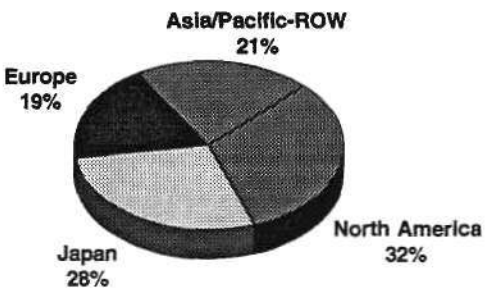
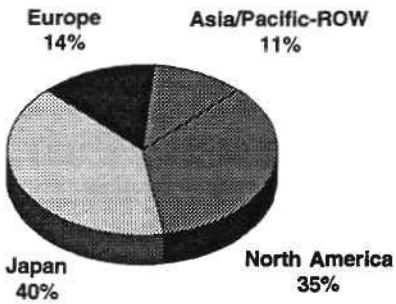
1994 Regional Semiconductor Consumption and Production

Semiconductor Consumption



Semiconductor Production



Source: Dataquest

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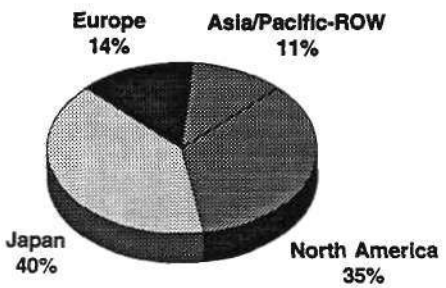
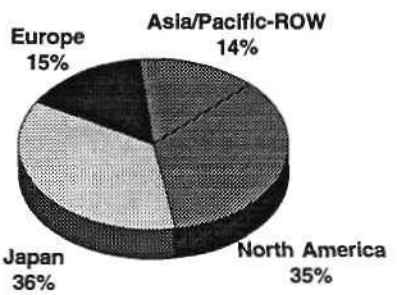
Regional Semiconductor Production Trend Forecast

1994 Production: $112.6 Billion



2000 Production: $274.9 Billion



Source: Dataquest

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1995 Capital Spending Overview

- Worldwide growth of 60 percent from 1994 to 1995
  - $21.8 billion to $34.8 billion
- Asia/Pacific leading the way
- European companies
  - Investing heavily in flourishing economy
  - PC boom in full swing
- North American and Japanese investment sustained
- Smaller semiconductor companies participating in every region
- IBM and Siemens are back

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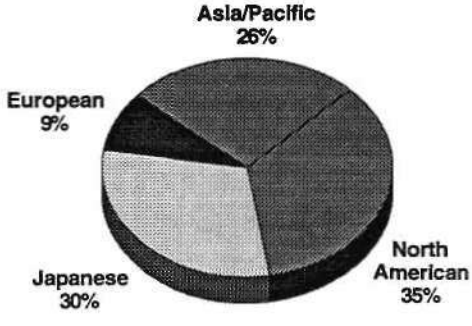
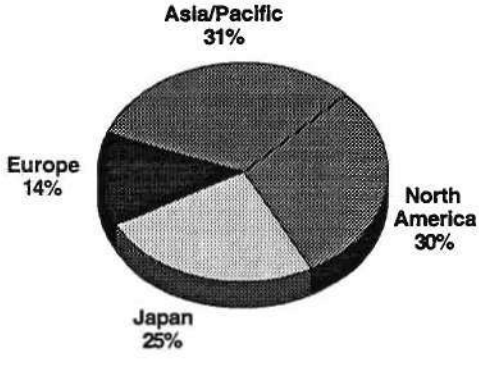
1995 Capital Spending

By Base of Company



By Region of Spending



Source: Dataquest

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1995 Capital Spending Drivers

- DRAMs, DRAMs, and DRAMs
  - Big three Korean spending up 124 percent
  - Incremental Japanese spending on 16Mb DRAM
  - Three new Taiwanese players (nearly $1 billion in 1995)
- Foundry capacity: Evolution of dedicated contract manufacturing
- Asian foundry spending nearly doubles to $1.6 billion
- Micro/logic/ASIC demand and telecom spurring North American and European regional investment
- Overall company profitability in industry

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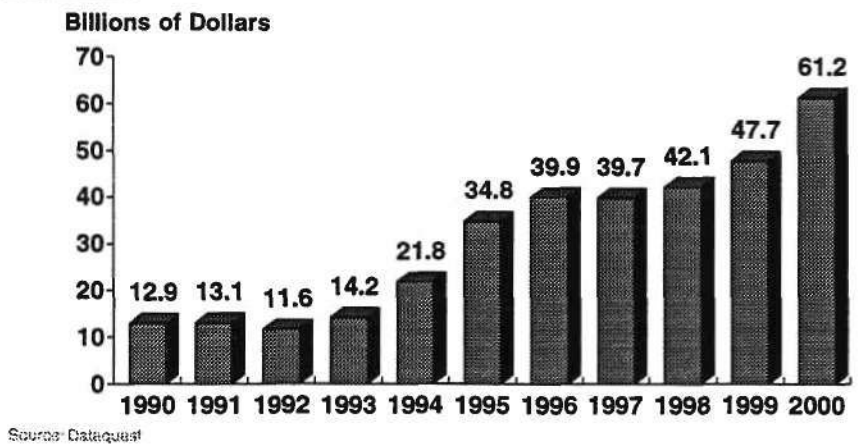
Capital Spending Forecast



Source: Dataquest

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Asia/Pacific: Capital Spending Trends

- Investment patterns "huge"
- By end of 1996: lots of 16Mb DRAM capacity
- Foundry capacity spending
  - More than doubled to about $900 million in 1994
  - Concentrated on "brick and mortar"
  - 1995 and 1996 will see more equipment spending
  - Spending should continue to grow into 1997
- A new fab model is emerging: TSMC, Chartered, SubMicron Technology, ASMC-Shanghai
- Asia/Pacific foundries should gain market share

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Top 10 Capital Spenders in 1995

1995 Rank	1994 Rank		Projected 1995 Spending ($M)	Change
1	1	Intel	3,538	46
2	2	Motorola	2,250	37
3	9	LG Semicon	2,125	166
4	4	Samsung	1,975	98
5	3	NEC	1,644	47
6	11	Hyundai	1,500	114
7	5	Fujitsu	1,420	44
8	6	Hitachi	1,358	40
9	7	Toshiba	1,229	32
10	16	Siemens AG	1,060	159

Source: Dataquest

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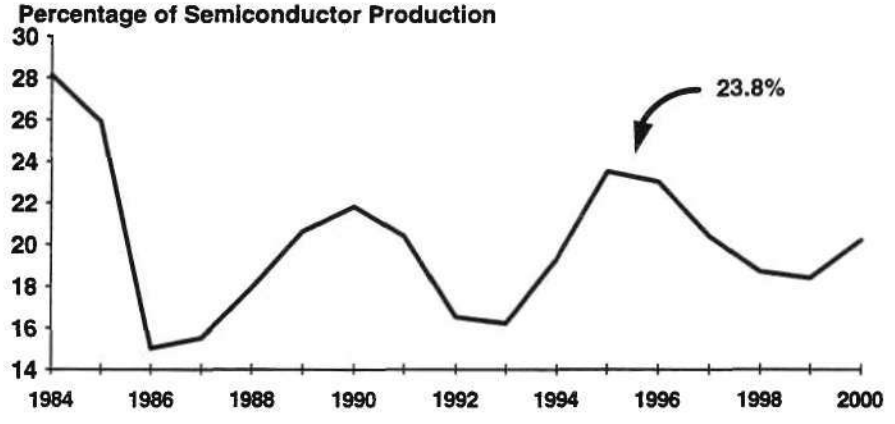
Capital Spending as a Percentage of Semiconductor Production



Source: Dataquest

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A Look at the Previous Wafer Fab Equipment Forecasts: What Changed?

	1/95 (%)	4/95 (%)	7/95 (%)
1995	16	31	52
1996	-7	9	21
1997	3	-5	-5

- 16Mb DRAM transition not occurring
- DRAM pricing still firm/rising
- PC and semiconductor forecasts raised
- Forecasting methods sharpened

Source: Dataquest 9500100

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Wafer Fab Equipment Forecast

- 1994 was a peak (?) growth year—up 56%
- Bookings and backlog momentum
  - Continued boom for 1995, up 52%
  - Extending into good growth for 1996
- Two "pause" years in 1997 and 1998
  - DRAM capacity absorption
  - 1997 is the slowest-growth semiconductor year
  - DRAM pricing to resume and "catch up" on its normal price-per-bit decline
- Resumption of accelerated growth by 1999

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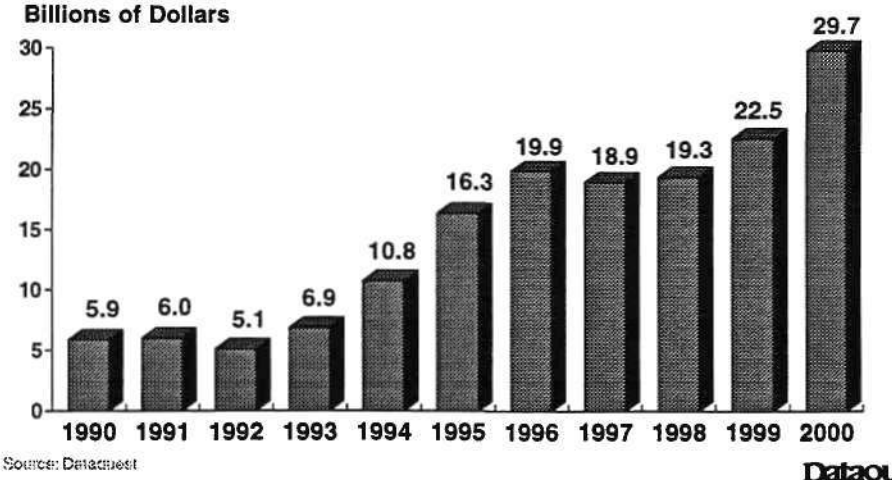
Worldwide Wafer Fab Equipment Forecast



Source: Dataquest

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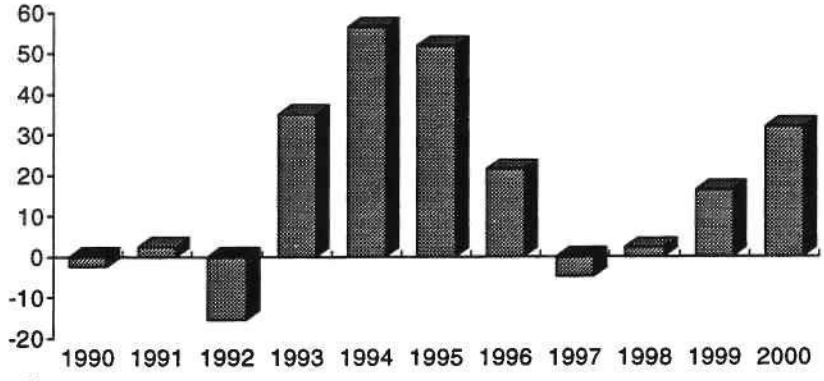
Wafer Fab Equipment: Year-to-Year Percentage Changes



Source: Dataquest
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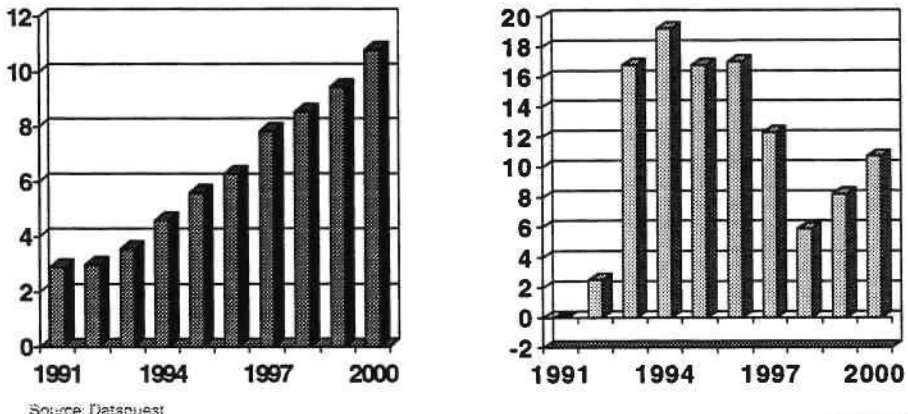
Silicon Market Forecast



Source: Dataquest
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Dataquest Conclusions

- Strong market 1993-1996 driven by DRAM and foundry
- Capital investment has caught up to demand, but ... initial 16Mb mismatch extending DRAM shortage
- Investments should stabilize in 1997-1998
- Equipment segments supplying multilevel logic should fare best in slowdown
- Asia/Pacific will continue as the high-growth region
- Foundry manufacturing strategies/models will gain momentum
- Prospects for industry strong: 16 to 18% CAGR

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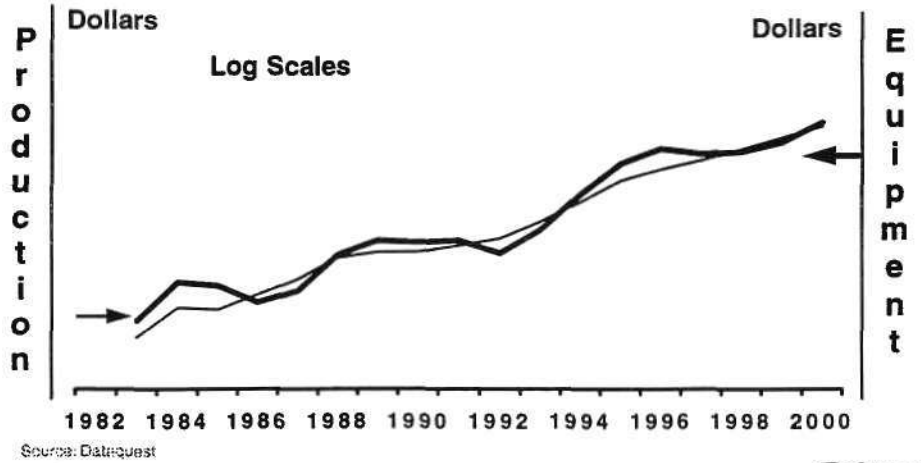
Trends: Equipment Spending and Revenue Overlaid



Source: Dataquest

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Understanding and Predicting the Cycle

- Caused by the DRAM "business" cycle
- Search for the mechanism to develop the timing tools
- Timing tools
  - Net Cumulative Investment (NCI) model
  - DRAM pricing statistic
  - Wafer fab equipment booking indicator
- What are they telling us?

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Net Cumulative Overinvestment versus Underinvestment: Methodology

- Objective: Quantify degree of capacity constraint/excess—1 to 2 years in advance
- Long-term growth rates for semiconductors and wafer fab equipment are correlated
- Net cumulative investment equals zero over time
- Industry cycles through over- and underinvestment
- Model developed correlating historical information
- Model dependent on changing growth rates of the underlying semiconductor industry

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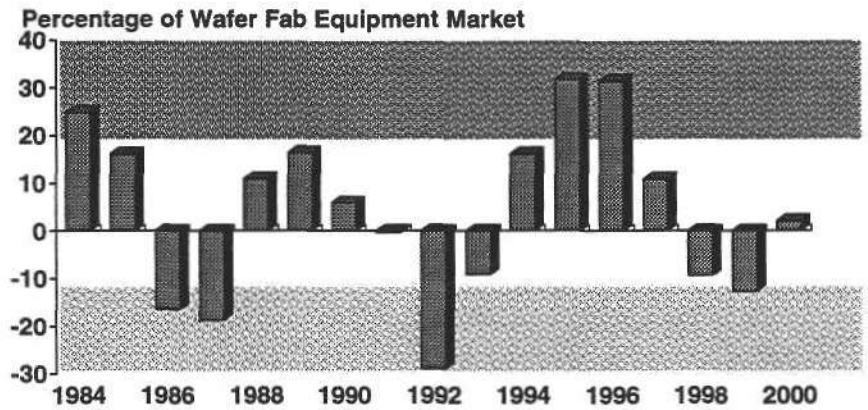
Net Cumulative Investment as a Percentage of Equipment Market



Source: Dataquest

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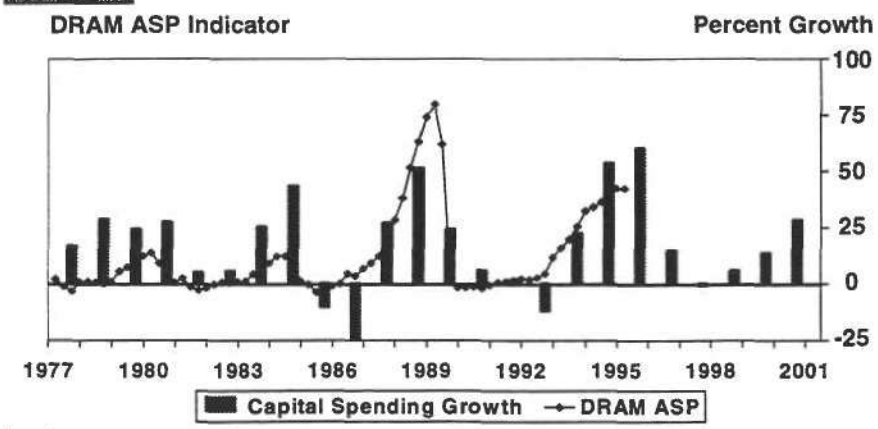
Capital Spending and DRAM Pricing Correlation



Note: Year tick marks signify start of year, so capital spending bar slightly preceding tick mark refers to prior year performance.

Source: Dataquest

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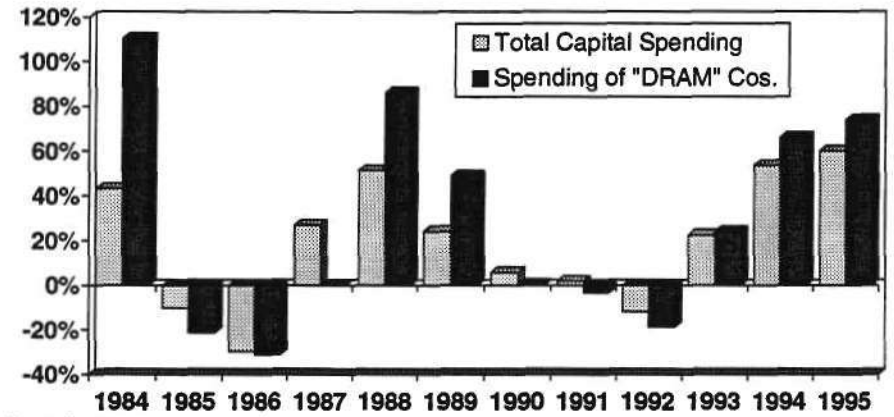
"DRAM" Capital Spending Compared to Total



Source: Dataquest

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What's Going On Here?

- Slowdown triggered by a unit density transition
  - Example: Buyers order 4Mb DRAMs instead of 1Mb
  - This is NOT a technology shift!
- As market pulls next generation ...
  - Prices and demand for old chip decline
  - Capacity is converted from old to new density
- Capacity conversions create large silicon efficiency
  - Bits per square inch can triple by line conversion
  - Demand handled by conversion in preference to spending new capital monies

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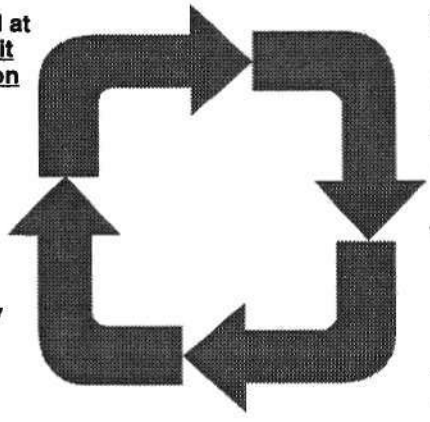
DRAMs and the Equipment Cycle



Capacity constrained at a specific density: Bit demand drives silicon demand

Setting up transition to next density, but still constrained at older generation: Bit demand drives silicon demand

Conversions done. Shrinks, yield, and productivity enhancements delay spending: Bit demand results in small increase in silicon demand

Transitioning to next bit density: Bit demand met by conversion of capacity: Little increase in silicon demand

9503783

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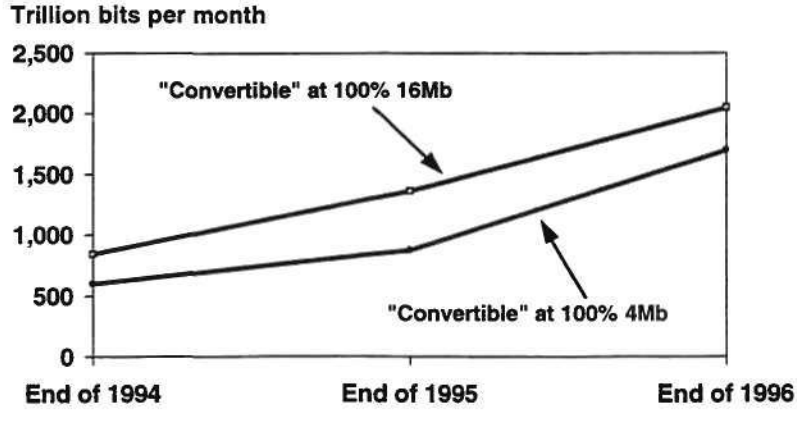
Monthly Bit Capacity "Window" for 4Mb and 16Mb DRAMs



Source: Dataquest

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Dataquest Conclusions

- Worldwide economic recession not on horizon
- PC unit shipments should continue to grow 16% CAGR
- Silicon cycle is not quite dead
  - Narrowing scope to DRAM business cycle
  - Magnitude of cycles should diminish over time
- Watch for clear signs of transition to 16Mb
  - 1x16 configuration reaching 60 to 65% yields
  - DRAM price index falls

9503785

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Acknowledgments

- Calvin Chang
- Mike Glennon—DQ UK
- Dan Heyler—DQ Hong Kong
- Ben Lee—DQ Taiwan
- Mario Morales
- Näder Pakdaman
- Beth Sargent
- George Shiffler
- Yoshihiro Shimada—DQ Japan
- Yasumoto Shimizu—DQ Japan
- J. H. Son—DQ Korea

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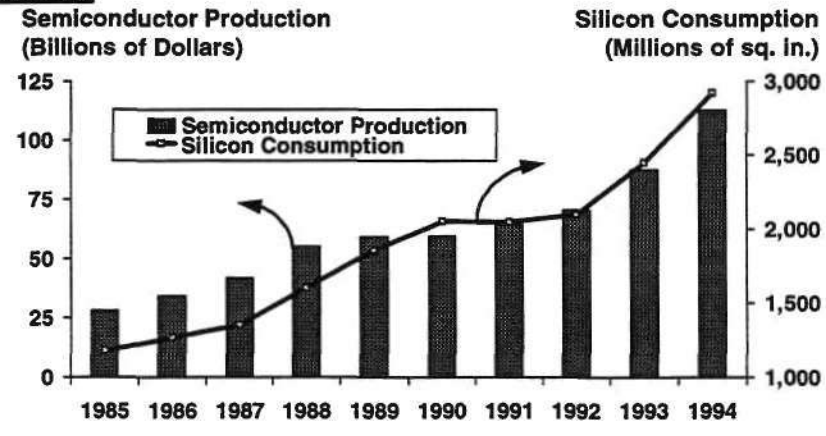
Production and Silicon Consumption Growth Rates



Source: Dataquest

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Annual Forecast Themes 1995-2000

	1995	1996	1997	1998	1999	2000
Logic Units Growth	Solid	Solid	Moderate	Moderate	Moderate	Solid
Investment in Logic Capacity	Solid	Solid	Moderate	Moderate	Moderate	Solid
Memory Unit Growth	Solid	Weak	Moderate	Moderate	Solid	Strong
Investment in Memory Capacity	Strong	Moderate	Weak	Weak	Moderate	Strong
Primary Production Technology (Microns)	0.35-0.6	0.35-0.5	0.35-0.5	0.3-0.5	0.25-0.4	0.25-0.4
Front-End Equipment versus Facilities Capital	Facilities	Equipment	Facilities	Balanced	Balanced	Equipment

Source: Dataquest

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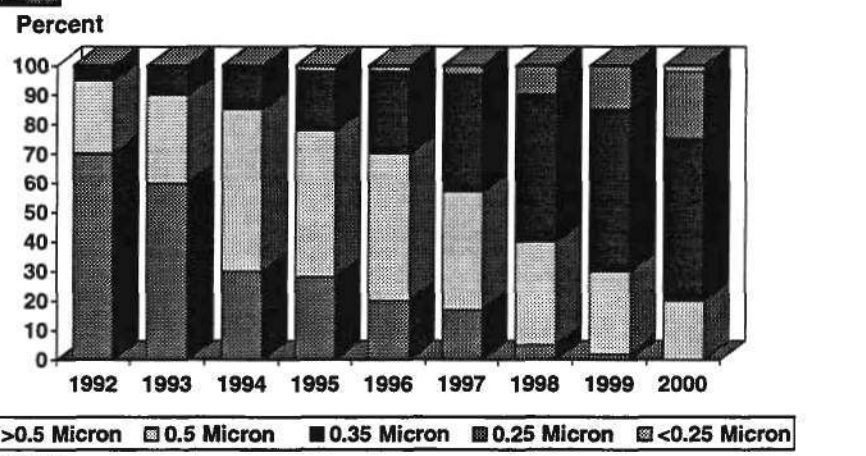
Allocation of Equipment by Linewidth Driven by Volume Production



Source: Dataquest

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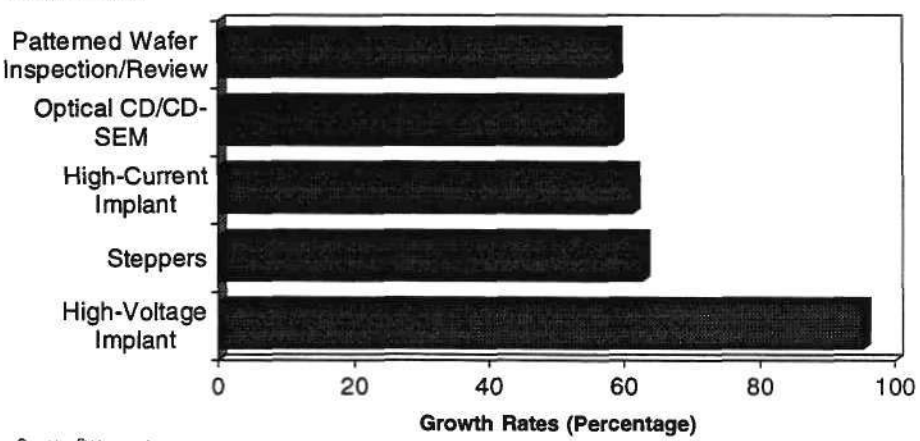
Fastest-Growing Equipment Segments in 1995



Source: Dataquest

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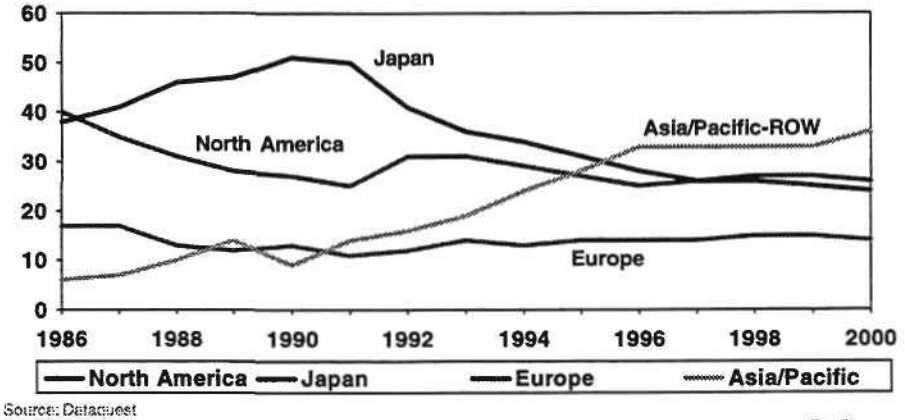
Forecast Wafer Fab Equipment Market Split by Region



Source: Dataquest

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Wafer Fab Equipment Forecast: Summary

	1995	1996	1997
Wafer Fab Equipment ($M)	16,340	19,854	18,888
Growth (%)	52	22	-5
Regional Growth (%)			
North America	41	14	-2
Japan	37	9	-10
Europe	69	17	-2
Asia/Pacific-ROW	79	44	-5

Source: Dataquest

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Notes:

Do Profits Trickle Down the Semiconductor "Food Chain"?

Näder Pakdaman

Senior Industry Analyst
Semiconductor Equipment, Manufacturing, and Materials Service
Semiconductor Group
Dataquest Incorporated

Mr. Pakdaman is a Senior Industry Analyst for Dataquest's Semiconductor Equipment, Manufacturing, and Materials service in the Semiconductor group. He is responsible for research and analysis of semiconductor equipment and trends in IC manufacturing techniques with a specific focus on the lithography segment.

Prior to joining Dataquest, Mr. Pakdaman was at IBM T.J. Watson Research Center and IBM East Fishkill. His responsibilities included fast optoelectronic testing and qualification of advanced optical lithography systems.

Mr. Pakdaman has B.S. degrees in mathematics and physics and an M.S. degree in electrical engineering from Purdue University. He was a doctoral candidate at Columbia University in applied physics prior to joining Dataquest.

Agenda

- Introduction
  - PCs' impact on the semiconductor "food chain"
- Scope of the study
- Financial definitions
- Financial comparisons
- Conclusions

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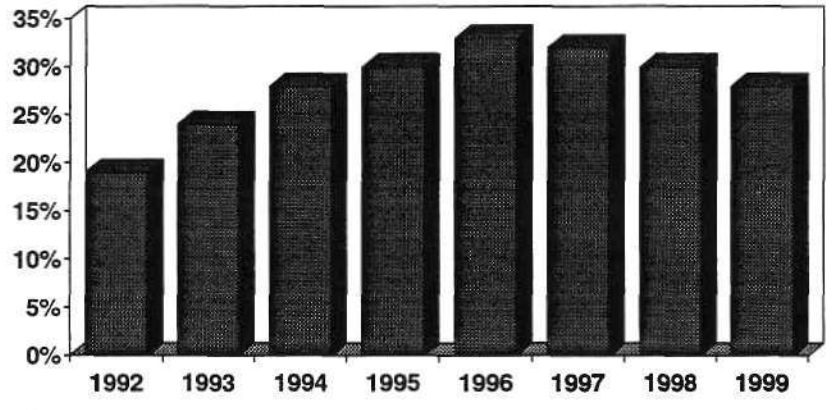
PC Semiconductor/Total Semiconductor (Revenue)



Source: Dataquest

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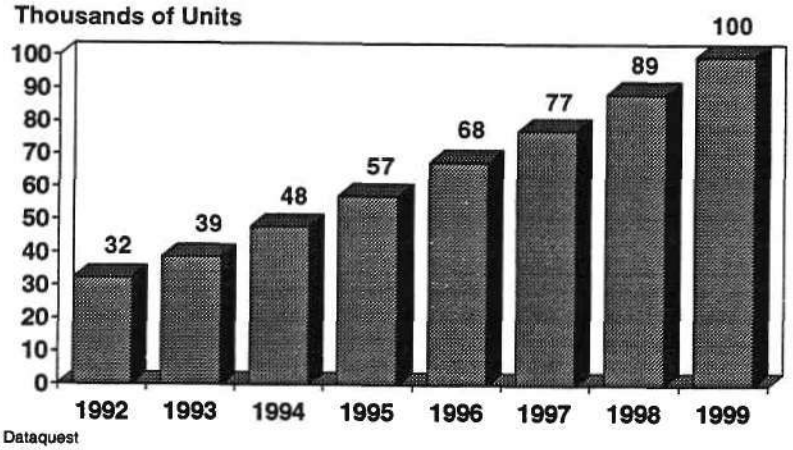
PC Unit Forecast



Source: Dataquest
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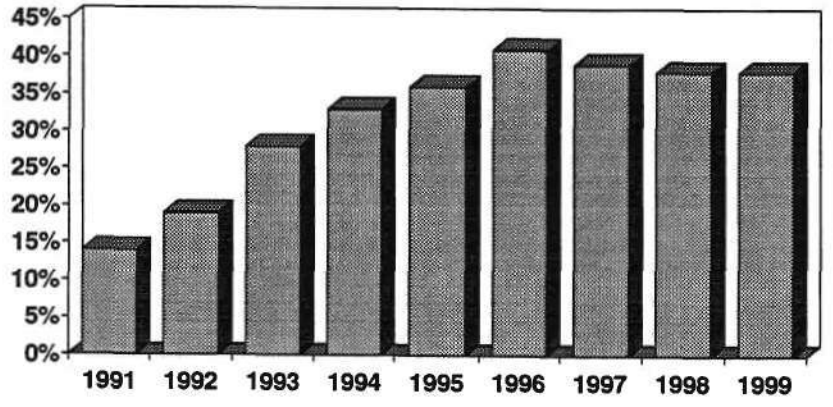
Semiconductor Content per PC (Revenue)



Source: Dataquest
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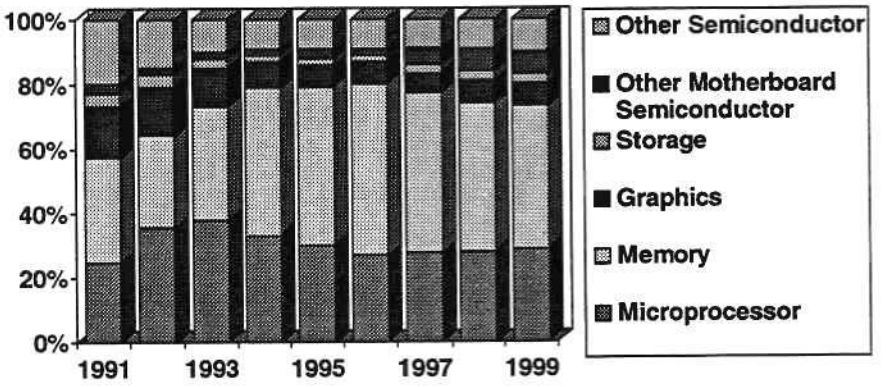
Distribution of Semiconductors in PCs (Revenue)



Source: Dataquest
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Scope of the Study

- Focus on PC industry
- Primarily "pure players"
- Source: company annual reports
- U.S. publicly traded companies
- Nine-year period (1986-1994)
  - Equipment (1988-1994): five players, (1986-1987): four players
  - Materials suppliers (1986-1987): one player, (1988-1989): two players, and (1990-1994): four players
  - PC and semiconductor manufacturing (1986-1994): five players each

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Scope of the Study

- Four groups of companies:
  - PC suppliers (Advanced Logic Research, AST Research, Compaq, Dell, Gateway 2000)
  - Semiconductor manufacturers (AMD, IDT, Intel, Micron, VLSI Technology)
  - Equipment suppliers (Applied Materials, FSI International, KLA Instruments, Silicon Valley Group, Ultratech Stepper)
  - Materials suppliers (Align-Rite International, Kyocera, MEMC Electronic Materials, Photronics)

Consolidated Statement of Operations

- Net sales
  - Cost of goods (COG)
    - Gross profit = net sales - COG
  - Research and development (R&D)
  - Selling, general, and administrative (SG&A)
    - Operating expense = gross profit - (R&D + SG&A)
  - Tax
  - Other expenses (income) = extraordinary expenses (income) - depreciation and amortization + ...
- Net income = net sales - COG - R&D - SG&A - tax - other

Cash Flow from Operating Activities (Example)

Net Income

- – Depreciation and amortization
- – Loss (gain) on sale of property, plant, and equipment
- – Deferred income tax
- – Changes in operating assets and liabilities (that is, inventories, other assets, accounts
- – Payable and receivable, etc.)
- = Cash flows from operating activities

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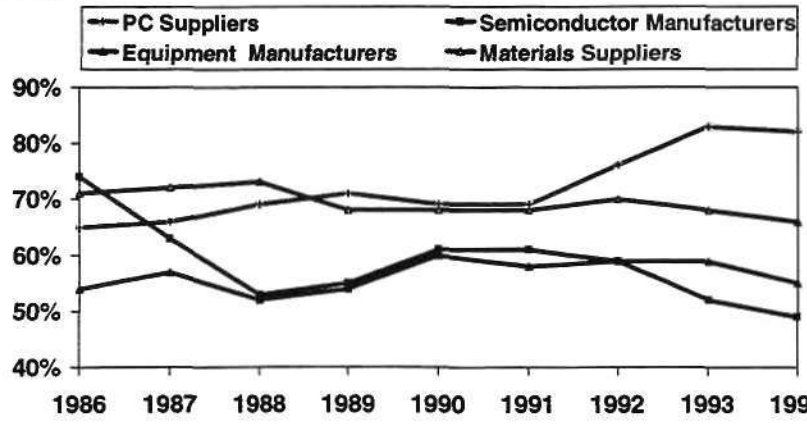
Cost of Goods/Net Sales



Source: Annual Reports, Dataquest

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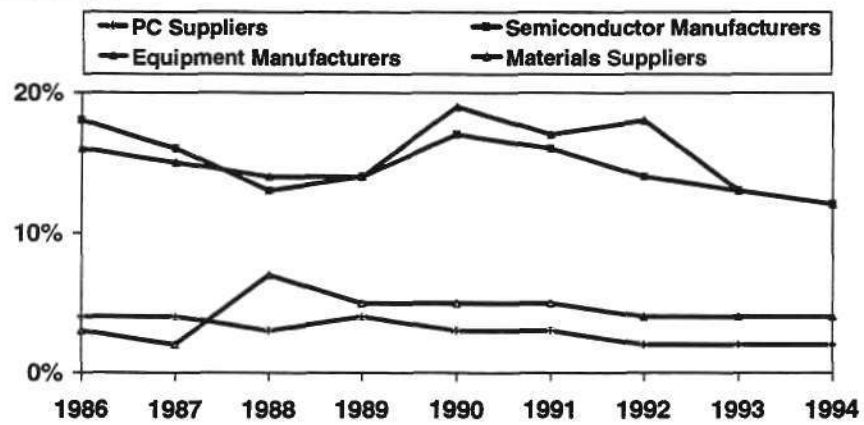
Do Profits Trickle Down the Semiconductor "Food Chain"?

R&D/Net Sales



Source: Annual Reports, Dataquest
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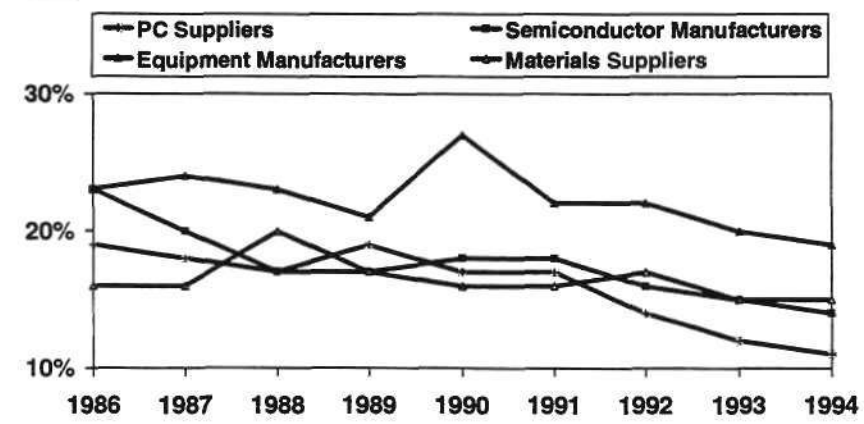
SG&A/Net Sales



Source: Annual Reports, Dataquest
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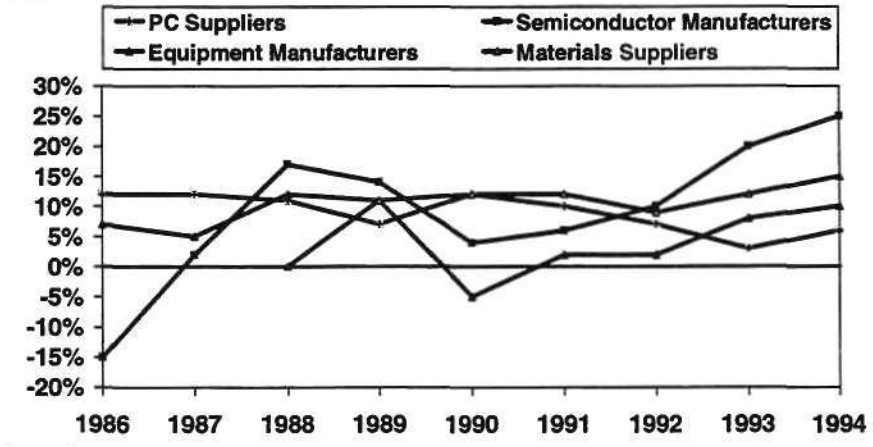
Operating Income/Net Sales



Source: Annual Reports, Dataquest
9503831

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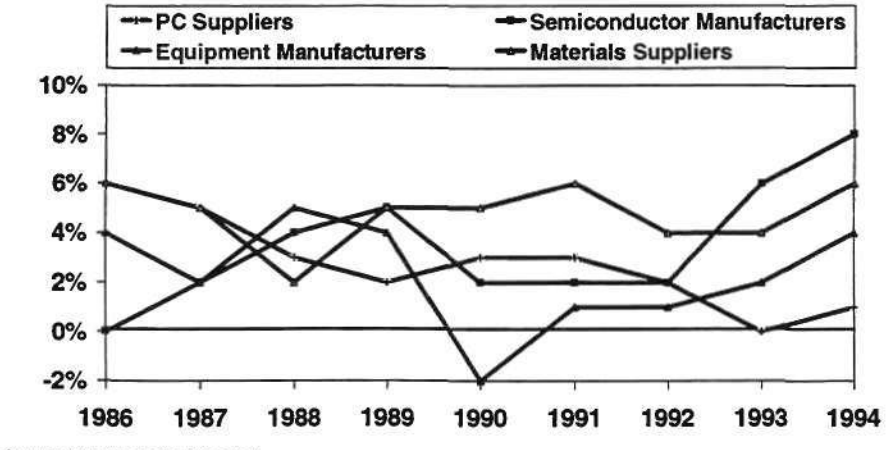
Taxes/Net Sales



Source: Annual Reports, Dataquest
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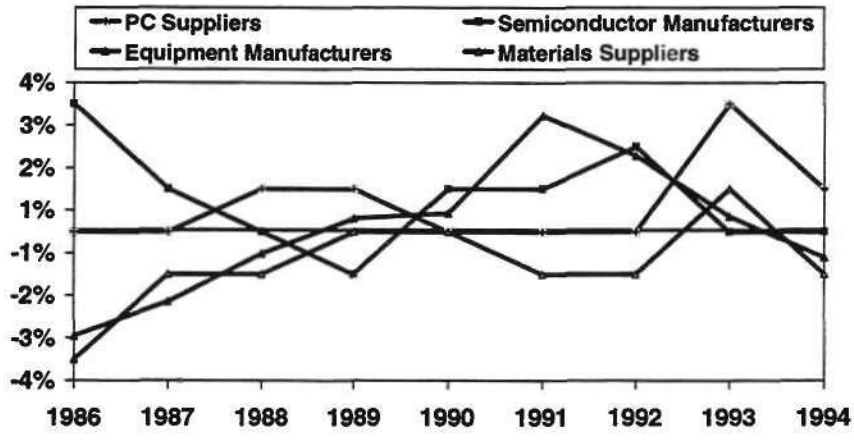
Other Expense (Income)/Net Sales



Source: Annual Reports, Dataquest
9503833

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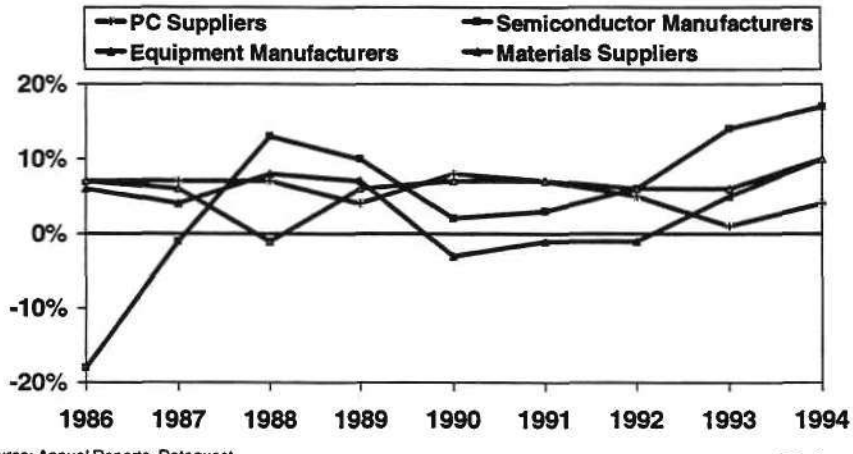
Net Income/Net Sales



Source: Annual Reports, Dataquest
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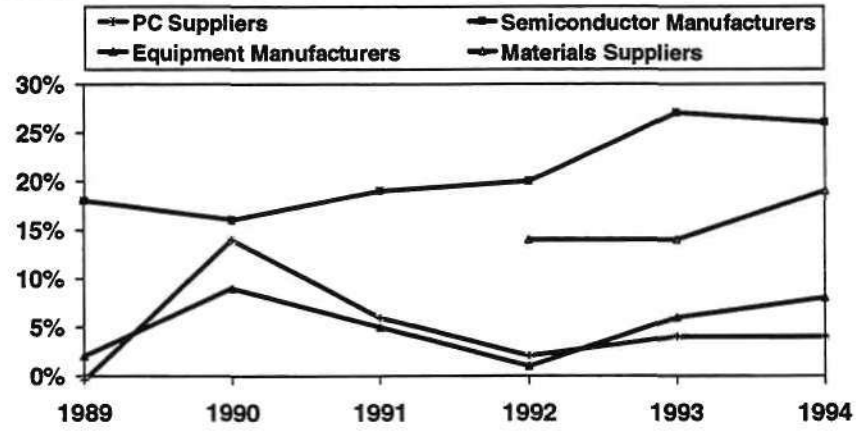
Cash Flow (Operating)/Net Sales



Source: Annual Reports, Dataquest
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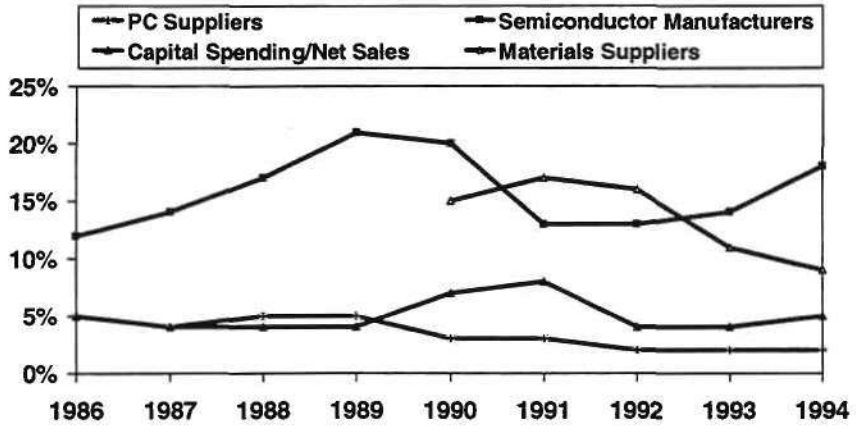
Capital Spending/Net Sales
(Purchase of Property, Plant, and Equipment)



Source: Annual Reports, Dataquest
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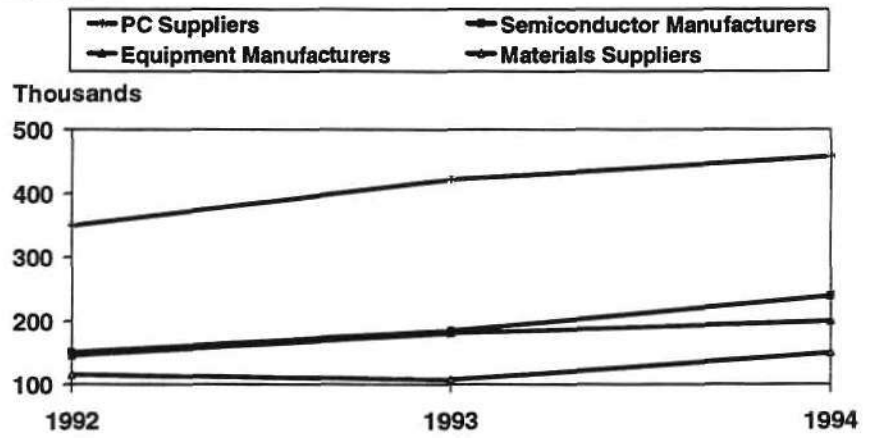
Net Sales/Employee



Source: Annual Reports, Dataquest
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Conclusions

- Do profits trickle down the "food chain"?
  - YES!! *The risks are balanced by the rewards*
- On the cost side:
  - COG: commodity vs. value added
  - R&D: commodity vs. value added
  - SG&A: equipment vs. the rest
- On the income side:
  - Value-added product lines are more volatile
  - Gaps between the commodity and the value-added players, caused by investment

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Insights for the Future

- How to increase the margins:
  - PC suppliers: Invest for the motherboard
  - Semiconductor manufacturers: Keep on Moore's Law
  - Equipment suppliers: Justify ASPs with productivity
  - Materials suppliers: Ownership in productivity (OPC, fast photoresist, EPI ...)

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Notes:

It's 1995—Do You Know What Your Customer's Customer Is Going to Do?

Dale L. Ford

Senior Industry Analyst
Semiconductor Applications Markets Worldwide
Semiconductor Group
Dataquest Incorporated

Mr. Ford is responsible for conducting market research and analysis for the Semiconductor Applications Markets Worldwide service at Dataquest. In addition, he manages the competitive analysis research on personal computer systems ranging from servers to palmtop devices. His work also includes contributions on client-specific consulting projects.

Mr. Ford is a specialist on the end use or application of semiconductors. His scope of analysis includes both economic and technical trends regarding the semiconductor content of electronic equipment.

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

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

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

Agenda

- Worldwide and regional production forecast
- Multimedia PCs
- Consumer products
  - Set-top boxes
  - Video-CD and DVD
- High-speed communications
- Wireless communications
- Conclusion

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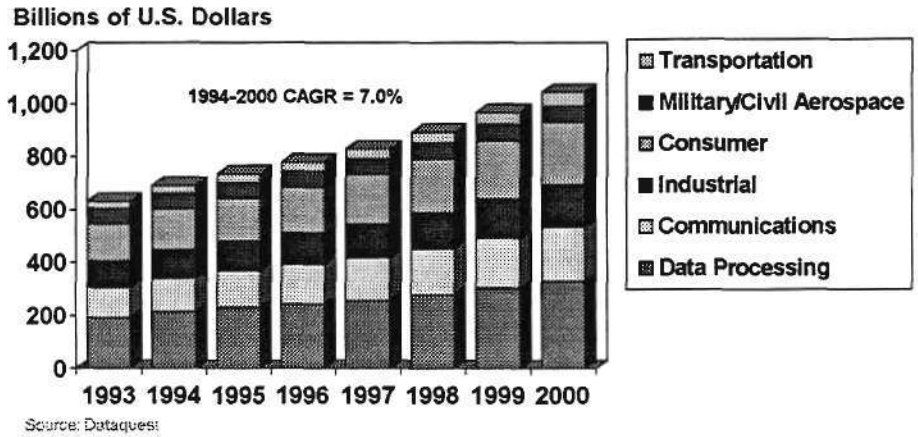
Worldwide Electronic Equipment Production: On Target for $1 Trillion by 2000



Source: Dataquest

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Opportunity Drivers

- "At home" work and education
- Digital era
- Cross-industry migration
- Emerging economies build and consume
- "Green" awareness
- Regulation

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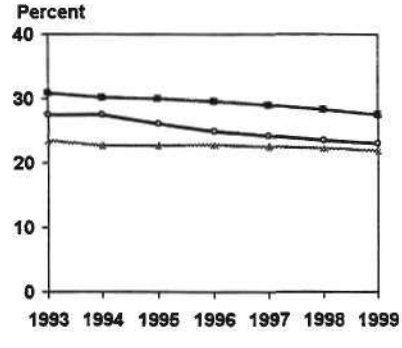
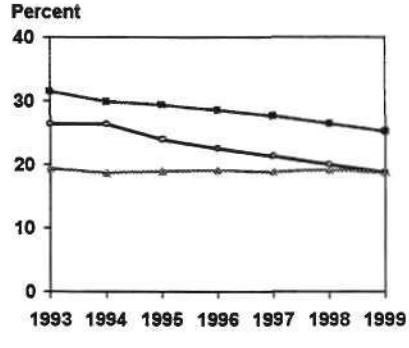
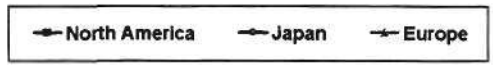
Dramatic Production Shift to the Asia/Pacific Region

Regional Share of Electronic Equipment Production Revenue



Regional Share of Data Processing Equipment Production





Source: Dataquest

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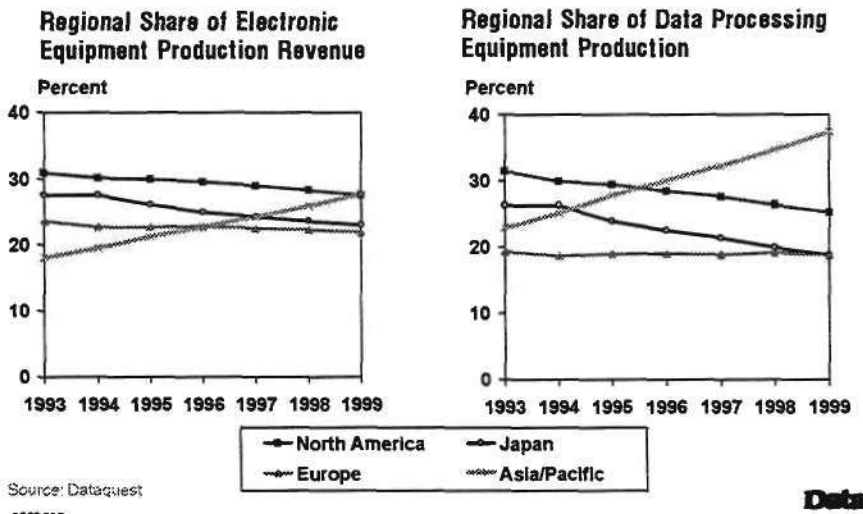
Dramatic Production Shift to the Asia/Pacific Region



Source: Dataquest
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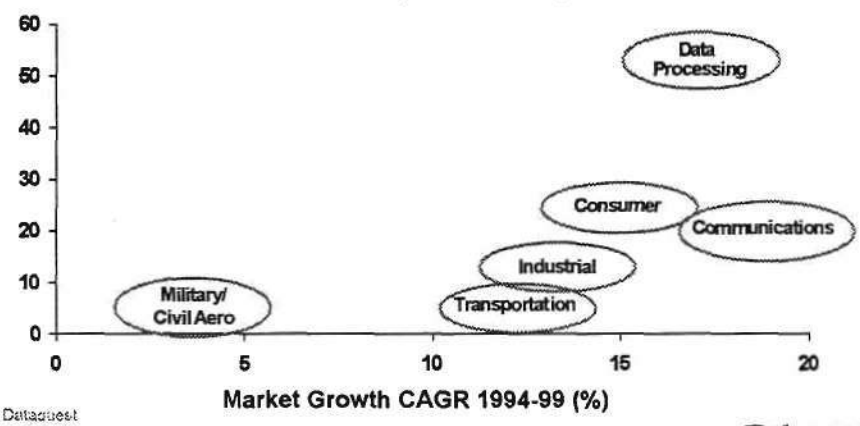
Data Processing and Communications Drive Chip Market from $110 Billion in 1994 to $273 Billion by 2000



Source: Dataquest
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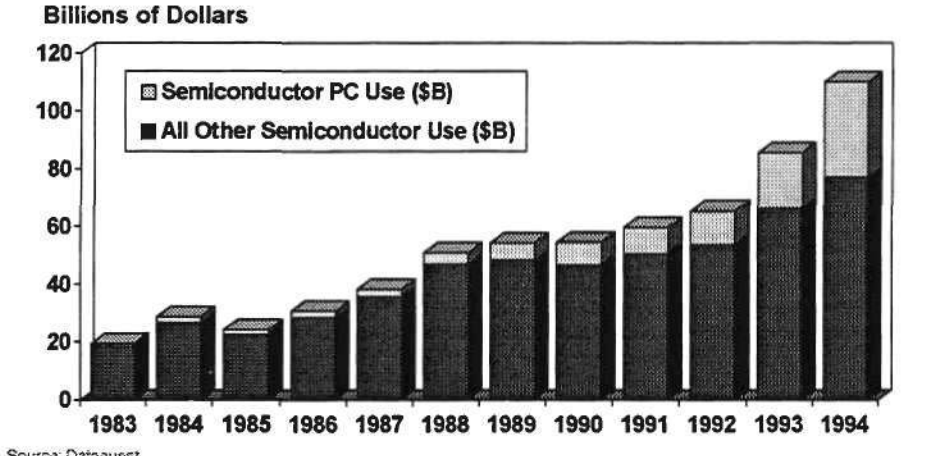
PCs and ICs: Who's Zoomin' Who?!



Source: Dataquest

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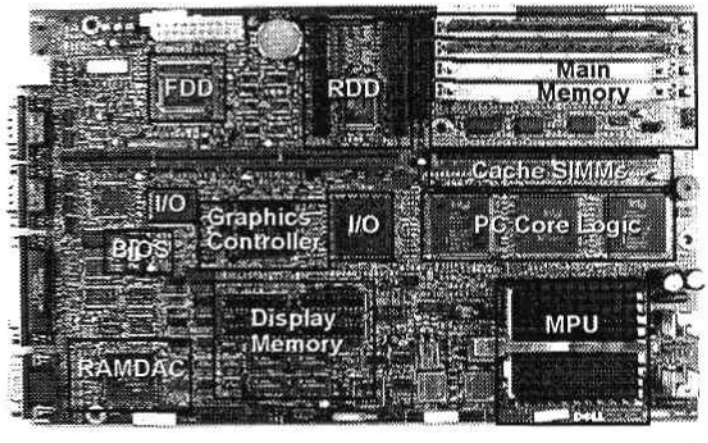
The Motherboard: Home of One-Third of the Semiconductor Market



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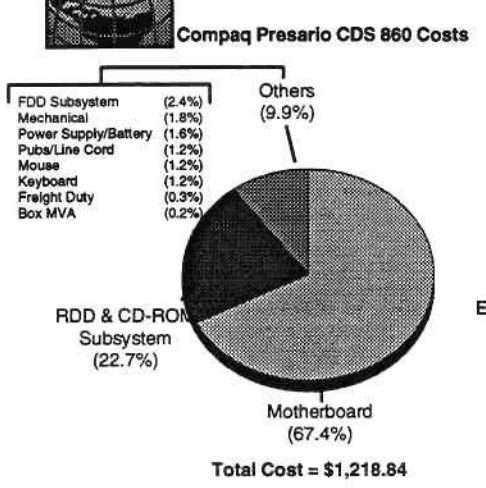
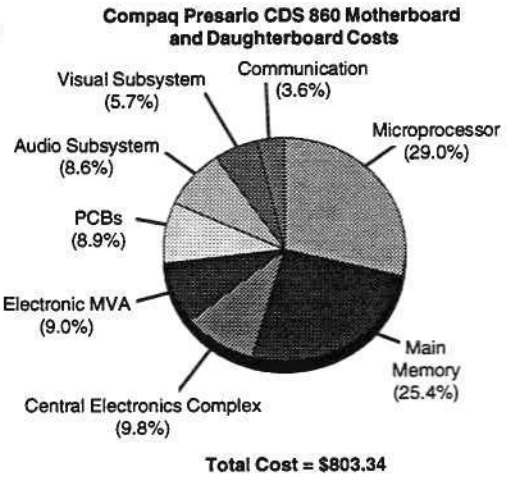
In a Cost-Competitive World, Chips Capture the Value in Multimedia PCs





Source: Dataquest
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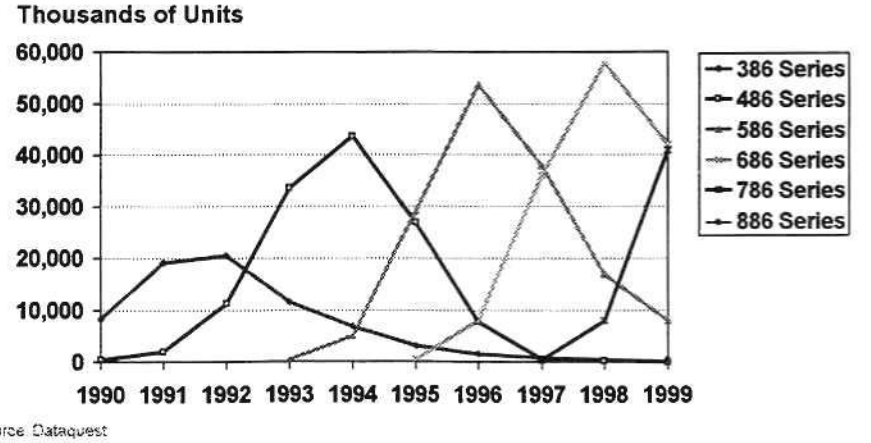
PC Processor Life Cycles: A New Generation Every Two Years



Source: Dataquest
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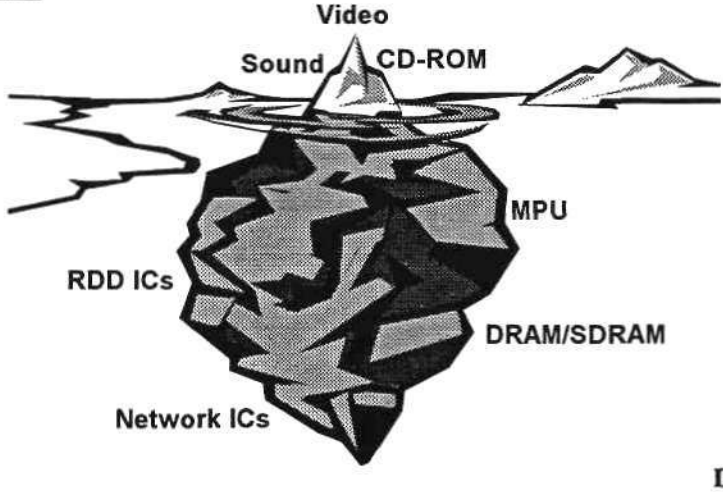
The Impact of Multimedia Is Not Always Highly Visible



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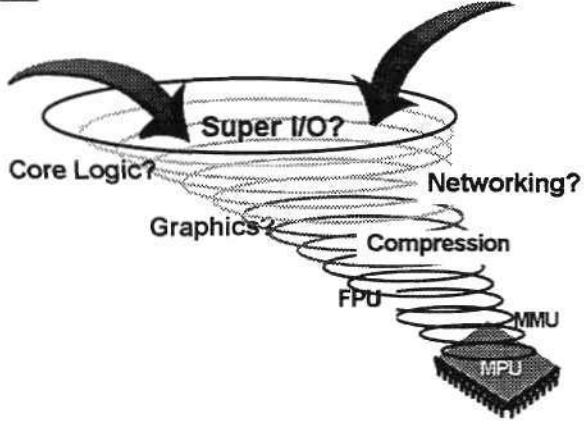
The MPU—Black Hole of the PC



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It's 1995—Do You Know What Your Customer's Customer Is Going to Do?

PC of theYear 2000

	Mainstream	Leading Edge
CPU	P7, 200 MHz	P8, 400 MHz
RAM	32MB, synchronous	64MB, synchronous
Storage	4GB, CD-ROM, IDE/SCSI	8GB, CD-ROM, IDE/SCSI/Fiber Channel
Multimedia	1.5M-pixel, accelerated video, 3-D wave table sound	2M-pixel, accelerated video, 3-D wave guide sound
Bus	PCI/PCMCIA	PCI/Cardbus
Communications	USB, 100-Mbps LAN, V.34 modem	USB, ATM (155 Mbps), modem/digital

Source: Dataquest

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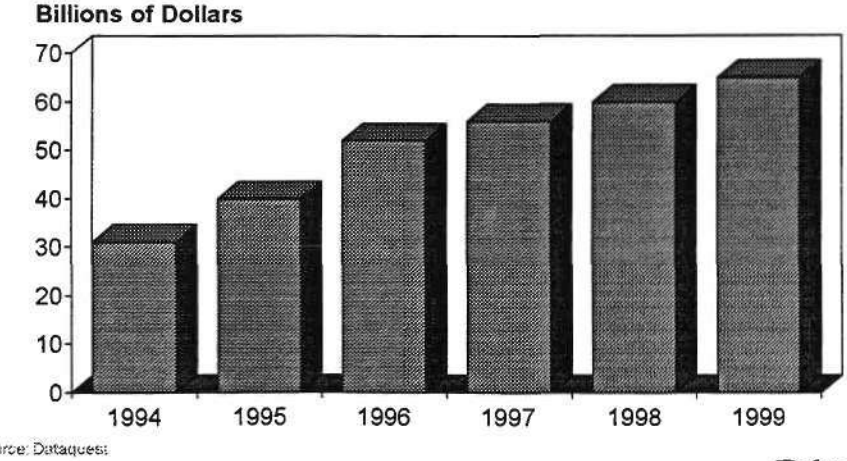
Personal Computer Semiconductor Revenue Forecast (Preliminary)



Source: Dataquest

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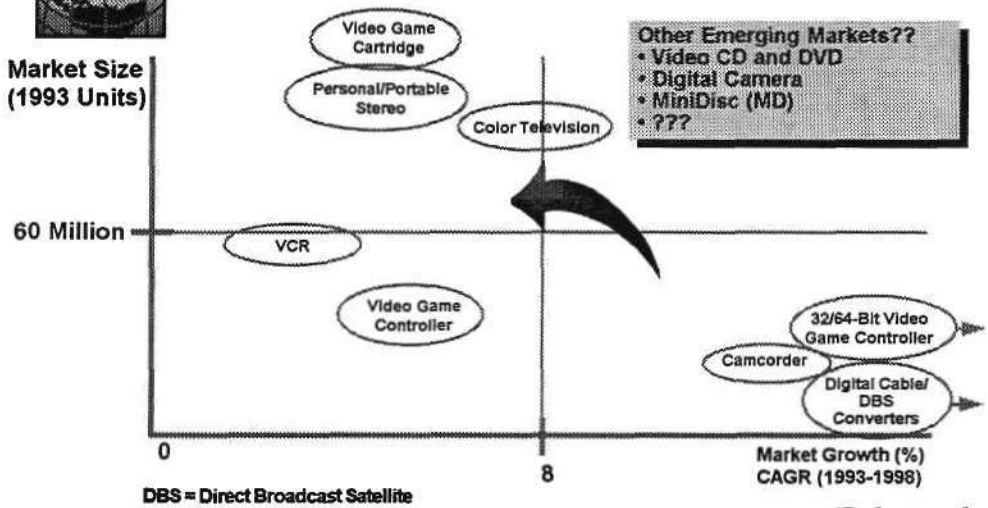
It's 1995—Do You Know What Your Customer's Customer Is Going to Do?

A Wave of Interactive, Digital Technologies Is Rolling into the Home



DBS = Direct Broadcast Satellite

Source: Dataquest

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Digital Set-Top Boxes—DBS Sales Soar while Cable Systems Struggle

- U.S. trials are under way
- Consumer desires are uncertain
- Timetables have slipped
- DirecTV DBS systems rolling out
- Video server and set-top box economies aren't ready for prime time
- Competing architectures emerging
  - OpenTV
  - Magic Carpet
  - Others

9503603

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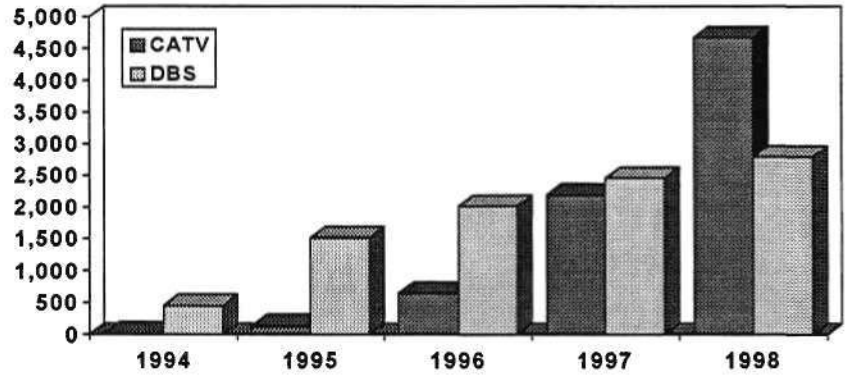
Digital Cable Set-Top Box Market (Worldwide)



Source: Dataquest
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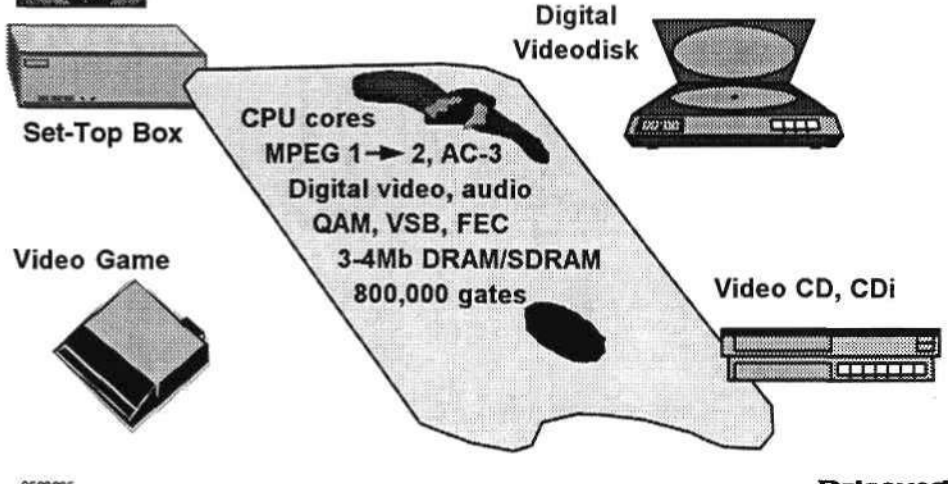
Interactive Consumer Chips



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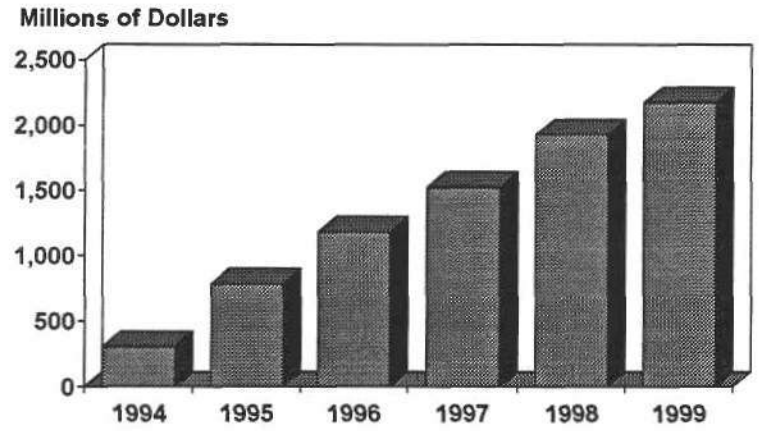
Next-Generation Interactive System Chip Demand



Source: Dataquest
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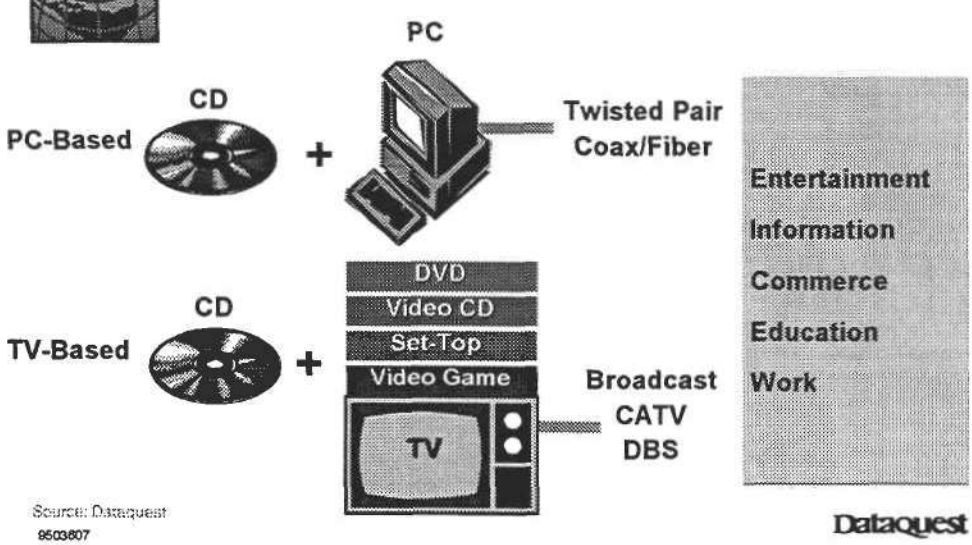
The Battle for the Home



Source: Dataquest
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Digital and Interactive Consumer: Is It a Computer or TV or ????

- Digitization: The evolution of current products and the revolution of new products
- Fighting for the home market: PCs, DBS, CATV, interactive games, CD-Video, Digital VCR, ...
- Set-top boxes: Great potential, many hurdles to get there
- Interactive games: Computing power of workstation
- Digital videodisk (DVD): Dualing standards between Toshiba/Time Warner and Sony/Philips
- New digital audio: MiniDisc pushes ahead, software support critical
- Compression, integrated video and audio, demodulation

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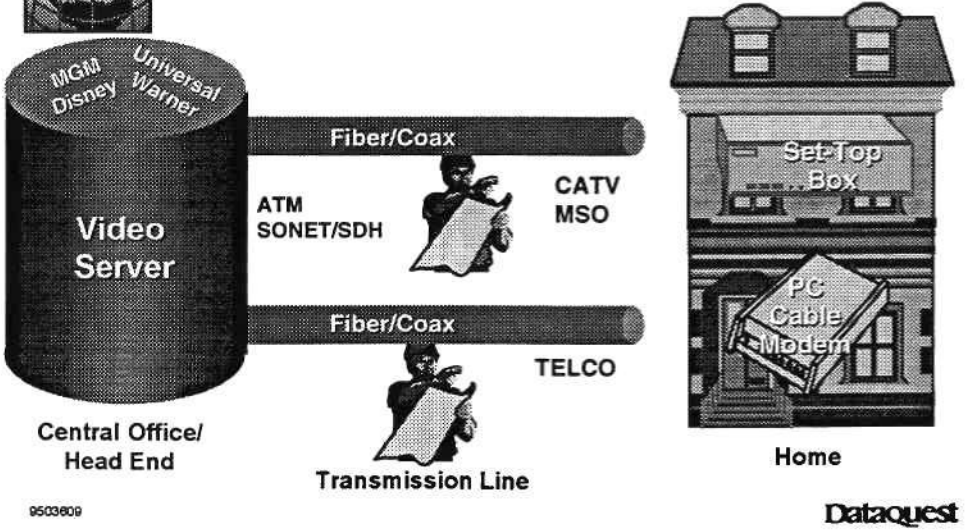
Public Networks: The Race Is On



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Speed Drivers

- LAN/WAN
  - Not just e-mail anymore
  - Server mania, groupware, multimedia
- Public infrastructure
  - Flat revenue
  - Grass is greener
- Home
  - Online mania
  - Work-at-home
  - Where the grass grows

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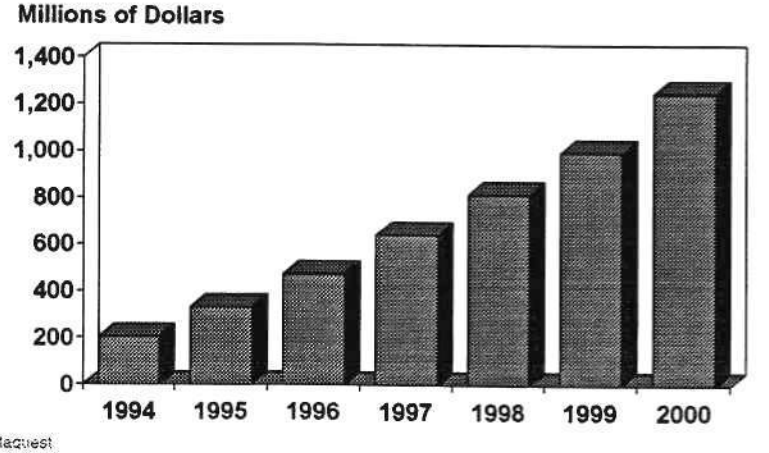
High-Speed Wired Communications Chip Market



Source: Dataquest

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Drivers of Wanderlust Communications

- Two-thirds of the world has never placed a phone call
- Quicker infrastructure deployment
- <1% of total minutes of phone use is wireless today
- One person, one number
- Digital/PCS—competition in earnest

9503612

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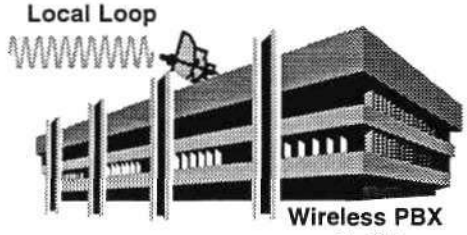
Emerging Wireless Communications Opportunities

Digital Cordless
900 MHz
DECT
PHP



Local Loop

Wireless PBX
DECT
Wireless LAN
RF
IR

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

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Narrowband PCS: New Protocols and Hardware

- The next generation of subscriber devices
  - Two-way pagers → Motorola's Tango
  - Two-way "mobile answering machines"
  - PCMCIA add-in transceivers
  - Integrated devices using chipset transceivers
  -
- Manufacturers
  - Motorola: The dominant player
  - GlenAyre/wireless access: Licensed players
  - NEC: "synthesized protocol"

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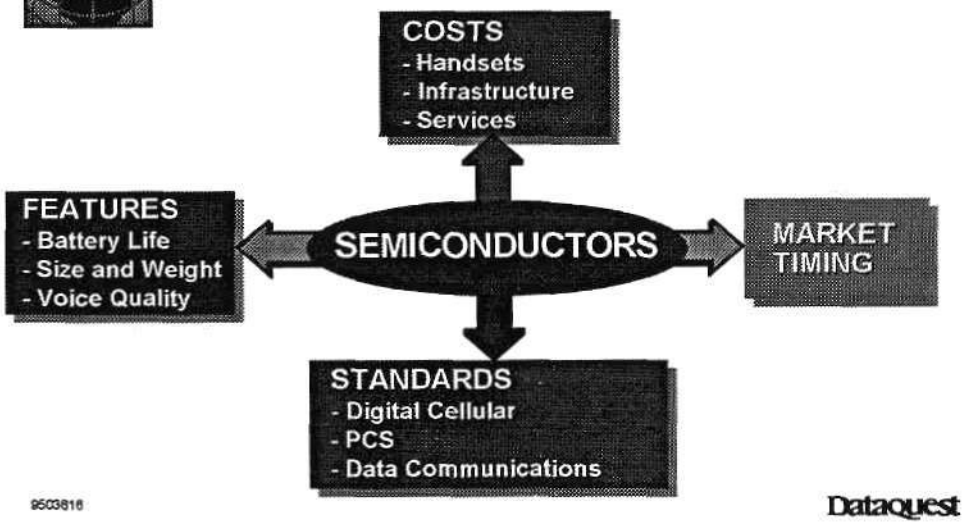
Digital Cellular and Broadband PCS: Next-Generation Terminals

- Subscriber terminals
  - Voice-centric devices (for example, IBM/BellSouth Simon)
  - Data-centric devices (for example , Sony MagicLink, Motorola Envoy, and Marco)
  - PCMCIA add-in transceivers
  - Dual-mode phones moving to dual-band
    - The DCS 1900 challenge
- Critical features: Talk- and standby-time, signal transmission, size and weight
- Key technologies: Antennas, batteries, and ...

SEMICONDUCTORS

9503615

The Central Role of Semiconductors in the Wireless World



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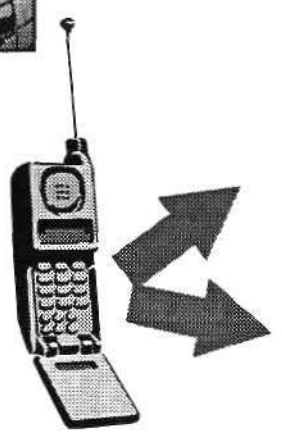
Typical Chip Opportunities



RF/IF

Discrete/passive integration
GaAs versus silicon
Single-chip IF

Baseband

One- to two-chip standard implementation (DSP-based)
MCU
Flash memory
E^2 memory
SRAM
Modem input (data)

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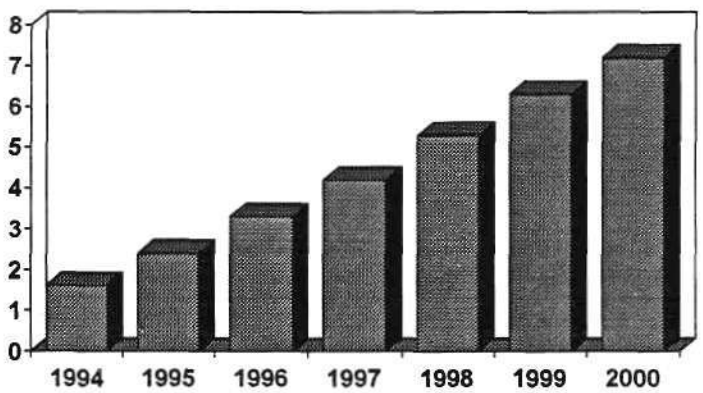
Cellular and Broadband PCS Chip Market



Source: Dataquest

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Dataquest Conclusions

- Numerous markets driving growth of semiconductor industry
  - PC dominance
  - Digital consumer
  - High-speed and mobile communications
- Emerging economies play critical role in production and consumption

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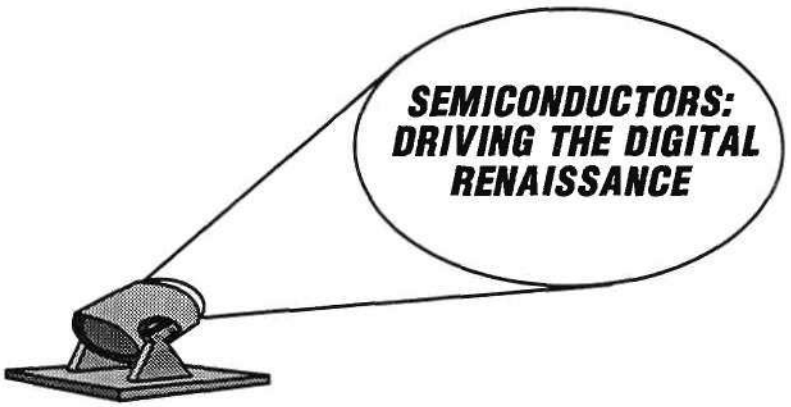
It's 1995—Do You Know What Your Customer's Customer Is Going to Do?

Semiconductor Manufacturers: Creating and Capturing Increasing Value



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Notes:

LCD Industry Outlook—Toward the Year 2000

Dr. Yasumoto Shimizu

Senior Industry Analyst
Dataquest Japan

Dr. Shimizu is a Senior Industry Analyst in the Japanese Semiconductor Group at Dataquest Japan. His responsibilities include research and analysis of the LCD industry with respect to LCD manufacturing, panel production and applications, and semiconductor fab equipment, manufacturing, and semiconductor materials.

Before joining Dataquest, Dr. Shimizu worked for Balzers Japan Corporation, where he was manager of application and technology of hard film coatings. Prior to that, he was in the Electronic Imaging Devices Research Laboratory for Fuji Xerox Co. Ltd. as a Senior Engineer of Research and Development of the imaging sensor.

He received a doctorate in engineering in thin film and solid surface physics from Shizuoka University and master's and bachelor's degrees in engineering in applied chemistry from Yamanashi University.

Agenda

- LCD industry status
- LCD market forecast
- Market trend
- Standardization
- LCD manufacturing
- Conclusion

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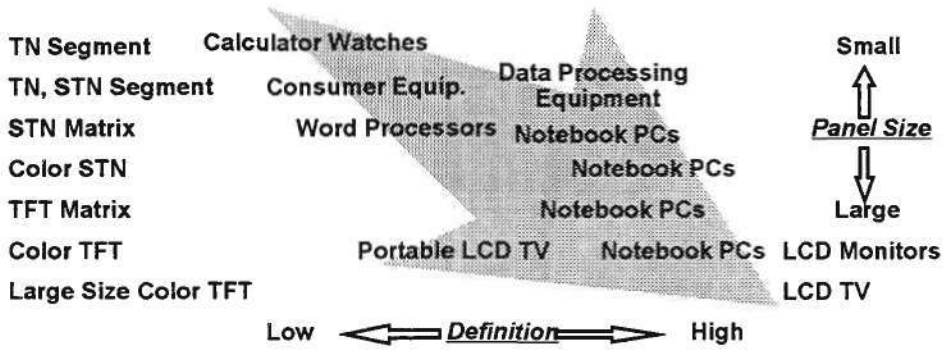
LCD Industry Status
Expanding LCD Application



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LCD Industry Status

1994 LCD Industry Review

- Second-generation glass substrate installed
- Ramp-up of volume production lines
- Color filter and TFT LCD lines proliferated
- STN color LCD achieved high color display quality
- LCD performance is up
  - Low power consumption, wide viewing angle range, contrast ratio, etc.
- 10-inch color LCD demand increasing
  - LCD probed to be successor to CRT

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LCD Industry Status

LCD Market Changes with Demand for Color

- Color filter needed
- Three times the pixel cells ...
  - Increasing density, decreasing yield
  - Three times the number of driver IC channels/panel
- More expensive than monochrome
- Strong demand for color
- Rapid growth of LCD market

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LCD Industry Status
Manufacturers of Active Color LCDs

- Sharp
- Display Technology Inc.
- NEC
- Toshiba
- Hosiden
- Hitachi
- Epson
- Casio
- Fujitsu
- Advanced Display Inc.
- Matsushita
- Sanyo
- Samsung
- LG Electronics
- Hyundai
- Others

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LCD Industry Status
Manufacturers of Passive Color LCDs

- Sharp
- Tottori Sanyo
- Toshiba
- Hitachi
- Epson
- Optrex
- Kyocera
- Matsushita
- Citizen
- Canon
- Stanley
- Others

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LCD Industry Status

Manufacturers of Color Filters

- Toppan Printing
- Dainippon Printing
- Toray
- Shinto Print
- Micro Engineering
- Toyo Sigyo Printing
- Mitsumura Printing
- Sasatoku Printing
- Tottori Sanyo
- Kyocera
- Internal Production
- Others

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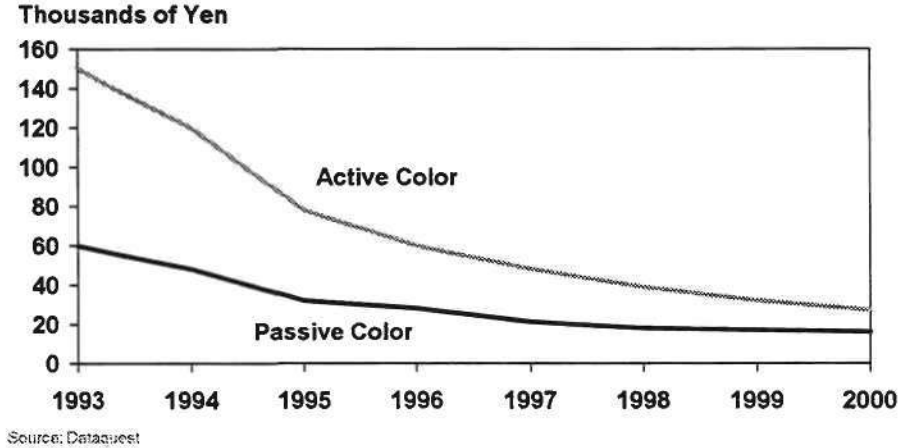
LCD Market Forecast

10.4-Inch VGA LCD Price Trend



Source: Dataquest

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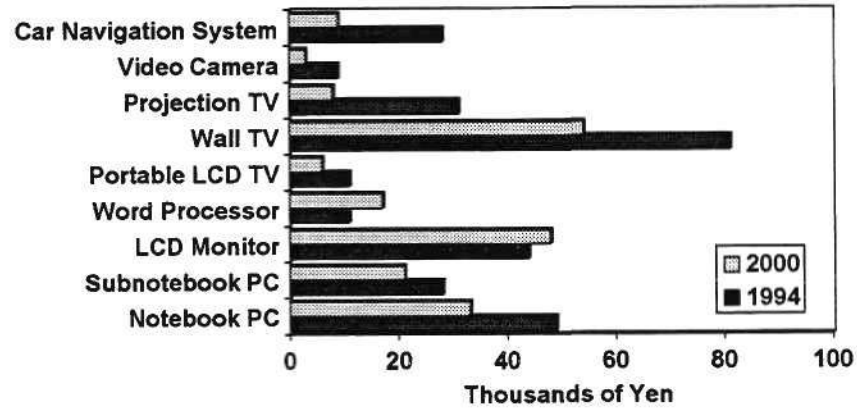
LCD Market Forecast
LCD Average Price Forecast for Major Applications



Source: Dataquest
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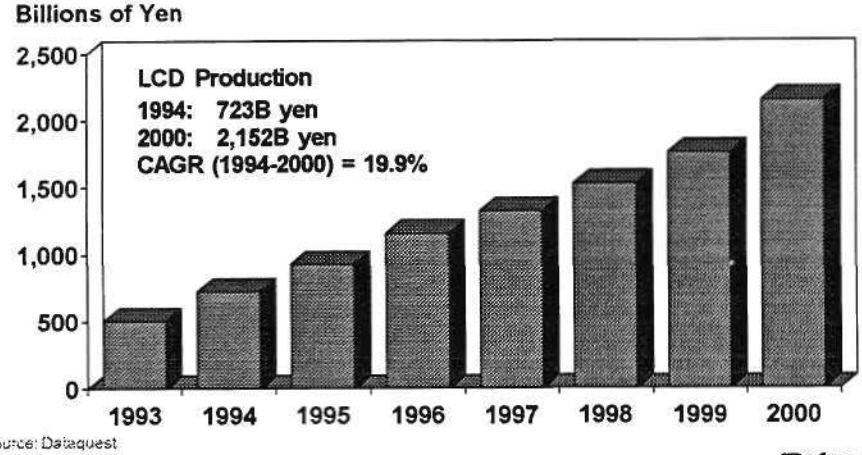
LCD Market Forecast
LCD Production Forecast



Source: Dataquest
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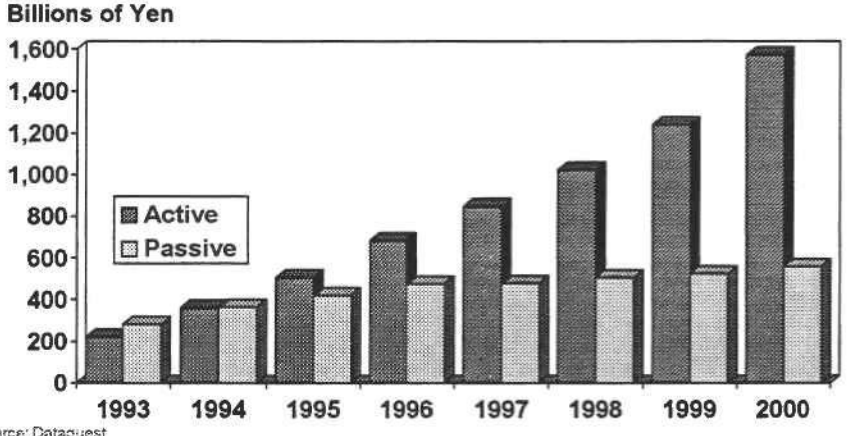
LCD Market Forecast

LCD Production Forecast: Active to Dominate Passive



Source: Dataquest
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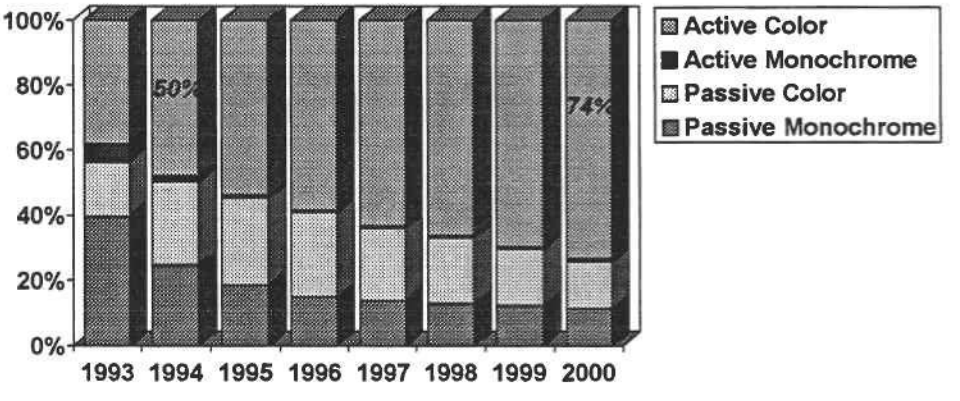
LCD Market Forecast

LCD Production Contribution by Type (Yen Basis)



Source: Dataquest
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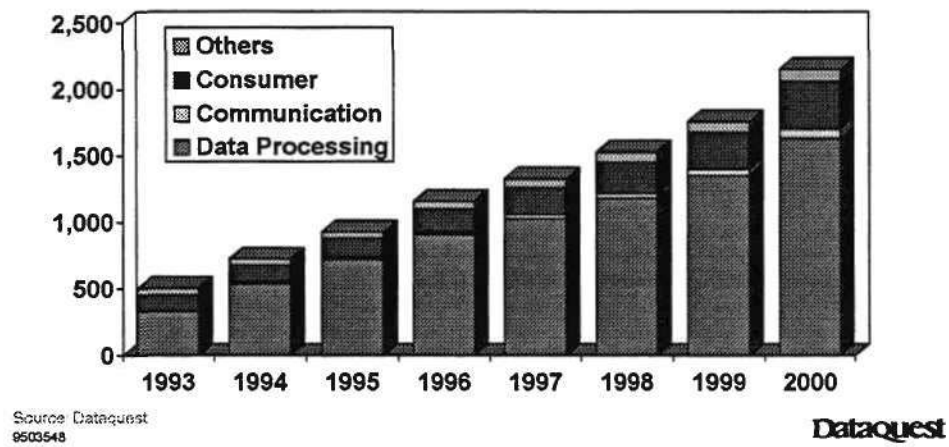
LCD Market Forecast
LCD Market by Application



Source: Dataquest
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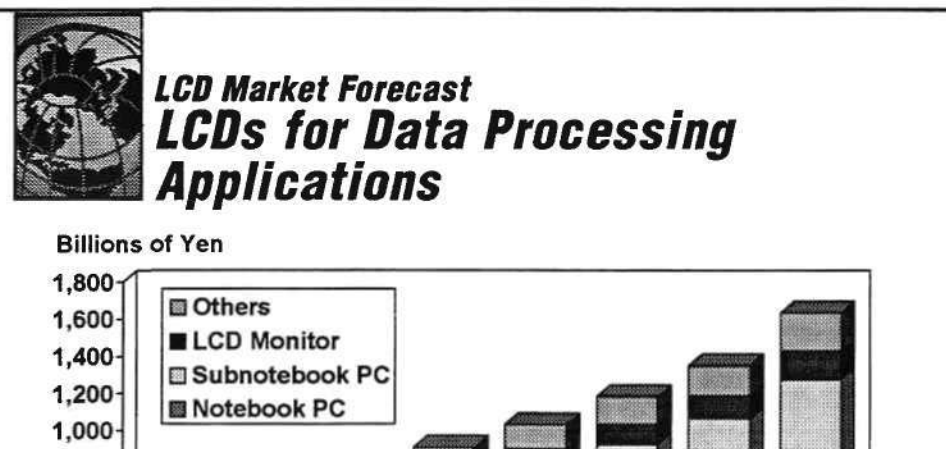
LCD Market Forecast
LCDs for Data Processing Applications



Source: Dataquest
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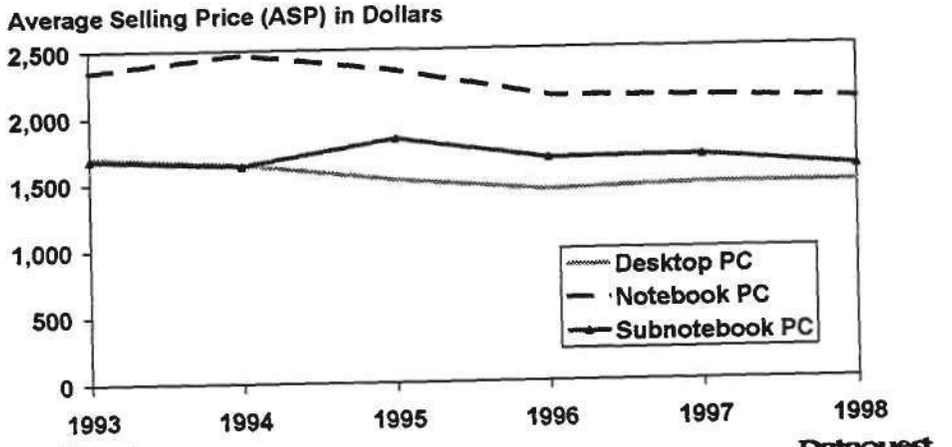
Market Trend

Personal Computer ASP Trends



Source: Dataquest
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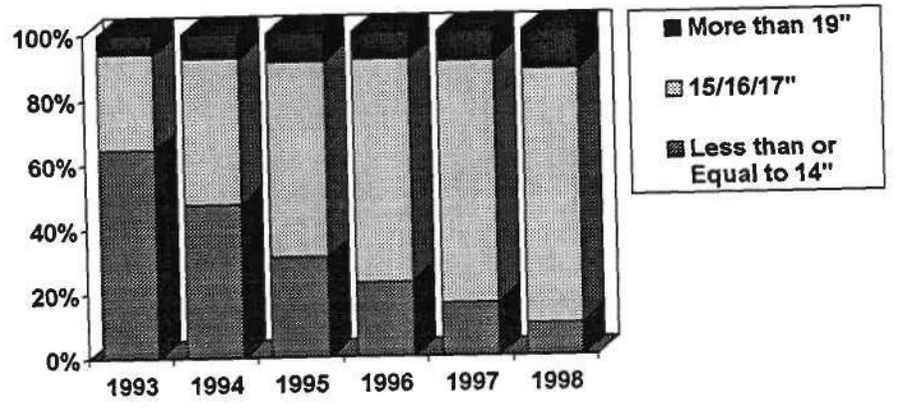
Market Trend

CRT Monitor Market by Size (Unit Basis)



Source: Dataquest
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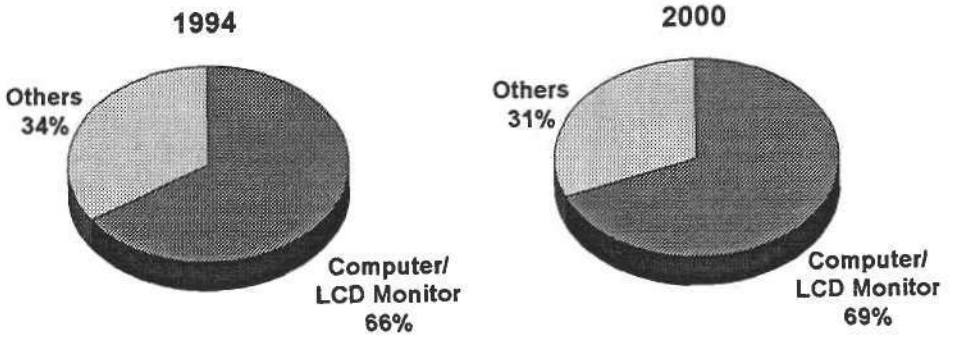
Market Trend

LCDs for Computers/Monitors



Source: Dataquest
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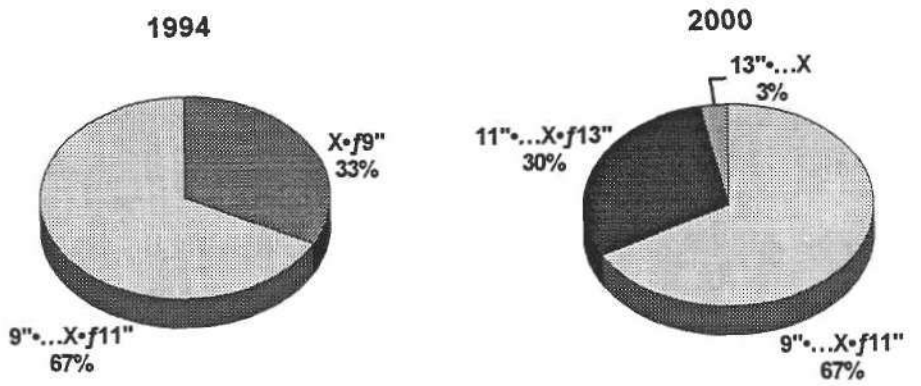
Market Trend

LCDs for Computers/Monitors by Size (Unit Basis)



Source: Dataquest
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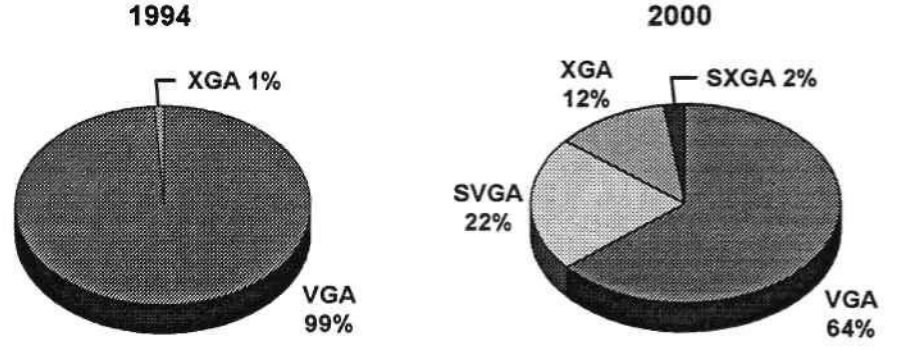
Market Trend

LCD Display Format Trends in the Computers/Monitors Market (Unit Basis)



Source: Dataquest

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Market Trend

Long-Term Market Trend

- Notebook PC
  - Dominant format is VGA or SVGA
    - Notebook PC ASP is $2.5K
    - Market penetration constrained by LCD cost
- Subnotebook PC
  - VGA is best
  - 9.5 inches becomes mainstream
- Other markets
  - Market expansion is slower
  - Large LCD (over 13 inches) is niche market
  - STN color LCDs create new market

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Market Trend

Short-Term Market Trend

- STN LCD
  - Major manufacturers switching production to color LCD
  - Strong color demand continues
- Color filter
  - STN filter supply will remain tight
  - Tight TFT filter supply to be relieved
- TFT color LCD
  - If TFT prices decline, TFT will take share away from STN
  - If prices remain firm, portable PC demand will decelerate

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Standardization

Why Standardization?

- Glass substrate size strategy
- Efficient capital spending
- Manufacturing equipment availability
- LCD prices lower

.... But problems/issues exist today

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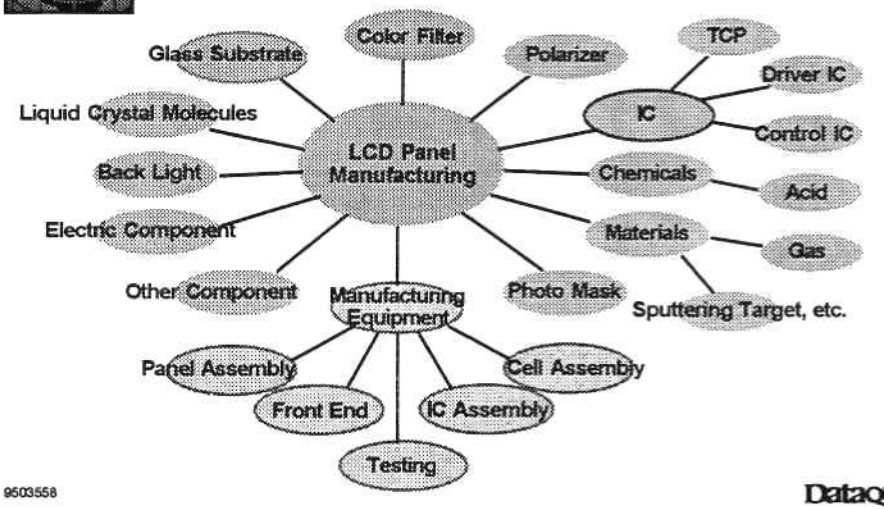
Standardization

LCD Industry Food Chain



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Standardization

Dependence on PC Market DRAM and TFT LCD

- Share of PC applications in total consumption

	DRAM	TFT LCD
1994	62%	62%
2000	60%	63%

- Huge investment is required
- High risk, and high return?

9503559

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Standardization

LCD Glass Substrate Sizes: If Based on Market Demand Forecast (mm x mm)

	<1993	1994	1996...2000	>2000
■ First generation	300x400			
■ Second generation 4 panels/substrate		370x470		
■ Third generation 6 panels/ substrate 0.7mm thickness			480x560	
■ Fourth generation For large LCD 4 to 6 panels/ substrate 1.1mm thickness			620x730	
■ Fifth generation Wide-screen TV				740x880

Source: Dataquest
9503560

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Standardization

LCD Display Size Trend (Inches)

	1994	1995	2000
Subnotebook PC	8.4	8.4-9.5	9.5
Notebook PC			
Standard	9.5	10.4	10.4
High end	10.4	10.4-12	12
Monitor			
VGA	9.5	10.4	10.4
XGA	10.4	10.4-13	13-15
SXGA		15-16	15-19

Source: Dataquest
9503561

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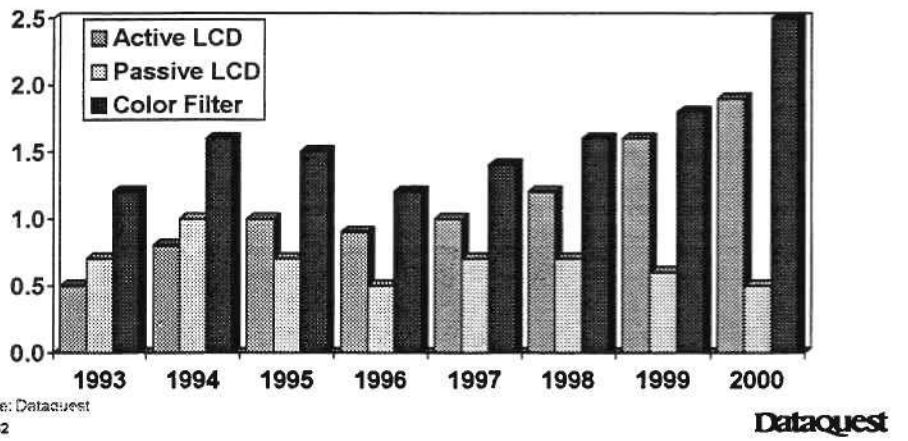
LCD Manufacturing
Supply Capacity Expansion



Source: Dataquest
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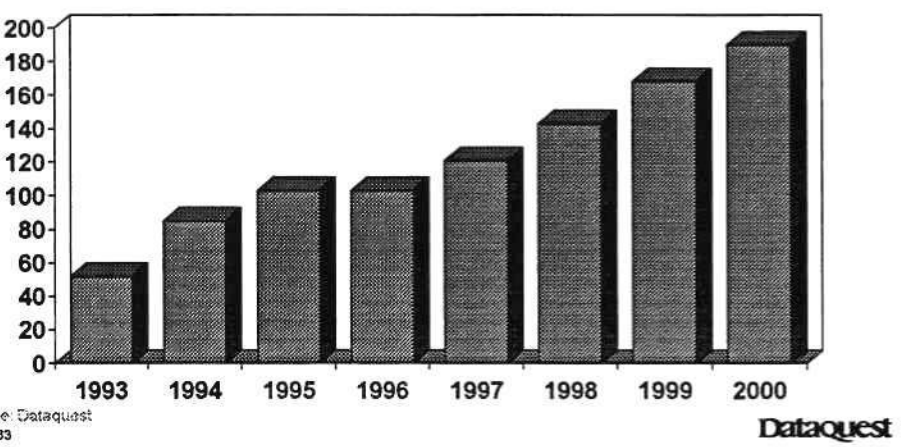
LCD Manufacturing
Manufacturing Equipment Market Forecast



Source: Dataquest
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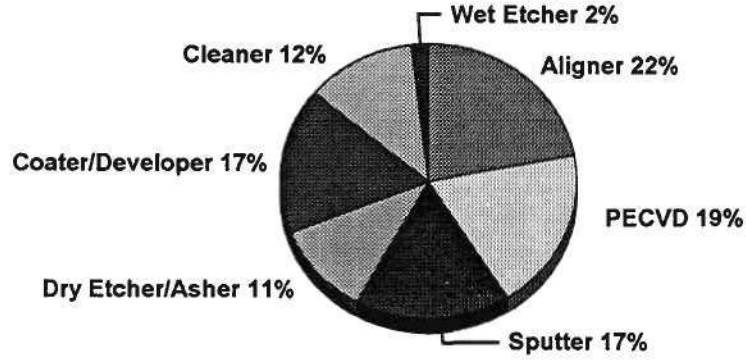
LCD Manufacturing
1994 Manufacturing Equipment Market by Type



Total: 85 Billions of Yen
(834 Millions of Dollars)

Source: Dataquest
9503564

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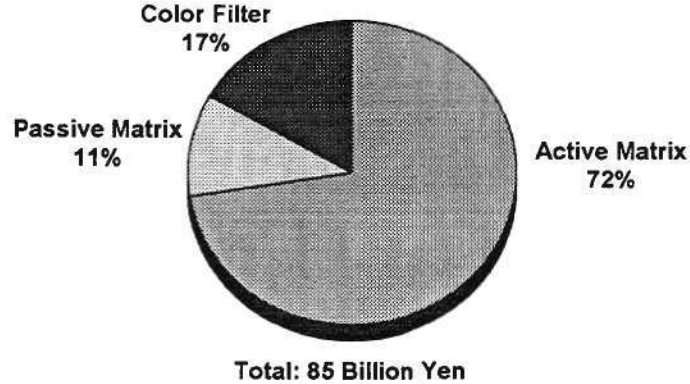
LCD Manufacturing
1994 Manufacturing Equipment Market by Use



Total: 85 Billion Yen
($834 Million)

Source: Dataquest
9503565

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LCD Manufacturing
Requirements for Equipment

- High throughput
  - Substrate transfer speed
  - Operation reliability
  - Small footprint
  - Deposition/etching rate
- Low-cost process
  - PECVD: same temperature deposition (gate insulator, a-Si, contact n -a-Si)
  - Etching: Dry or wet
  - Lithography: Stepper or mirror projection or proximity
  - Resist coating: Spin or scanning coat
- Low cost of ownership
- Maintenance free (self-cleaning)

9503566

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Dataquest Conclusions
LCD Market

- LCD market in 2000
  - 2,152 billion yen ($21.7 billion)
  - CAGR (compound annual growth rate, 1994-2000)

Passive LCD	7.3%
Active LCD	28.2%

  - Share

Active LCD	74%
Computers Demand	63%

- LCD market driver/notebook/subnotebook PCs
- Market growth depends on low price, standard panel
- Standardization supports LCD market growth
- Active color LCD is most promising FPD

9503567

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Dataquest Conclusions
LCD Manufacturing Equipment Market

- 1994 LCD manufacturing equipment market
  - 85 billion yen ($834 million)
  - For active matrix manufacturing: 72%
  - For passive matrix manufacturing: 11%
  - For color filter manufacturing: 17%
- LCD manufacturing equipment market forecast
  - 190 billion yen ($1,912 million) in 2000
  - Expected CAGR = 14.3%
- High reliability and advanced concept system required

9503568

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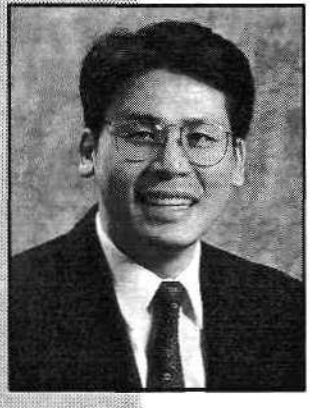
Notes:

Semiconductor Fabs: Bigger, Fewer, and Better

Calvin Y. Chang, Ph.D.

Industry Analyst
Semiconductor Equipment, Manufacturing, and Materials Service
Semiconductor Group
Dataquest Incorporated



Mr. Chang is an Industry Analyst in the Semiconductor Equipment, Manufacturing, and Materials service of the Semiconductor group.

Prior to joining Dataquest, Mr. Chang performed research on the kinetic studies of deposition and etch processes in semiconductor fabrication at Stanford University. His research led to numerous publications in the areas of LPCVD, PECVD, sputter etch, and high-density plasma processes. Mr. Chang also has a diverse range of experiences that include semiconductor process development, CAD tools design (the Boeing Co.), and corporate strategic planning.

Mr. Chang earned B.S. degrees, with distinction, in physics, mathematics, and computer science from the University of Washington and a Ph.D. in materials science and engineering with a minor in electrical engineering from Stanford University (Summer 1994).

Agenda

- Semiconductor production market
- New fabs:
  - Where, how much capacity, what wafer size, who builds them
- New fabs are getting fewer, bigger, and costlier
  - Who can afford them
  - Rise of foundries
  - Capacity utilization

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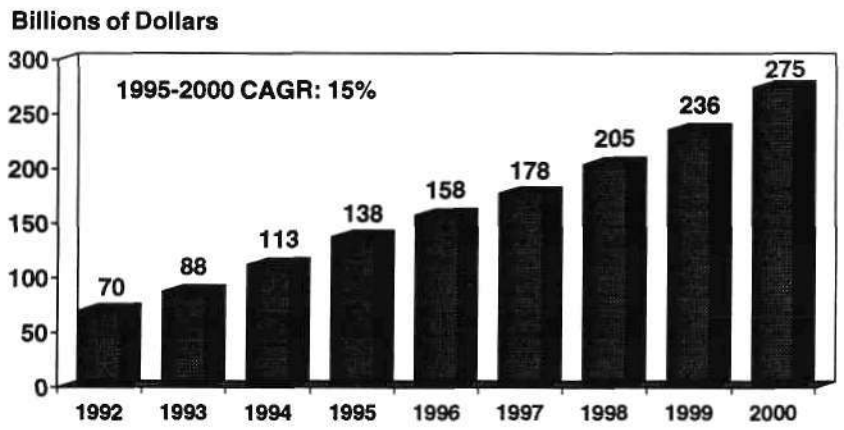
Worldwide Semiconductor Production Market Forecast



Source: Dataquest
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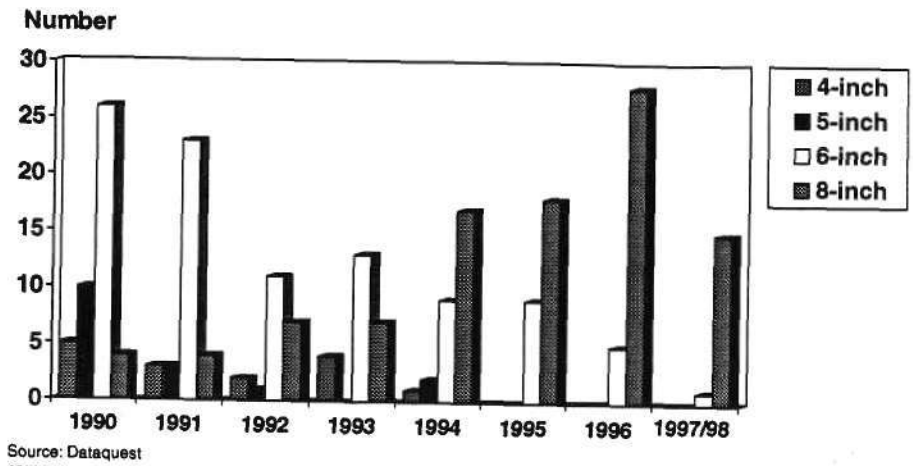
New Fabs: About 25 to 30 a Year



Source: Dataquest
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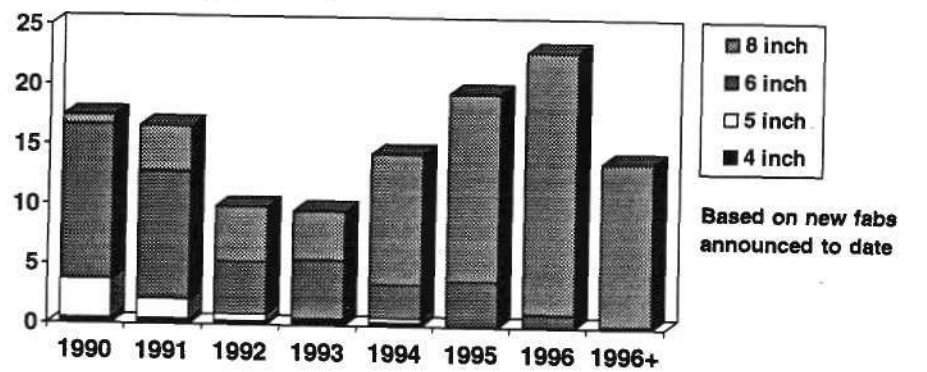
New Fab Capacity: Nearly All 8-inch



Source: Dataquest
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New Capacity by Wafer Size

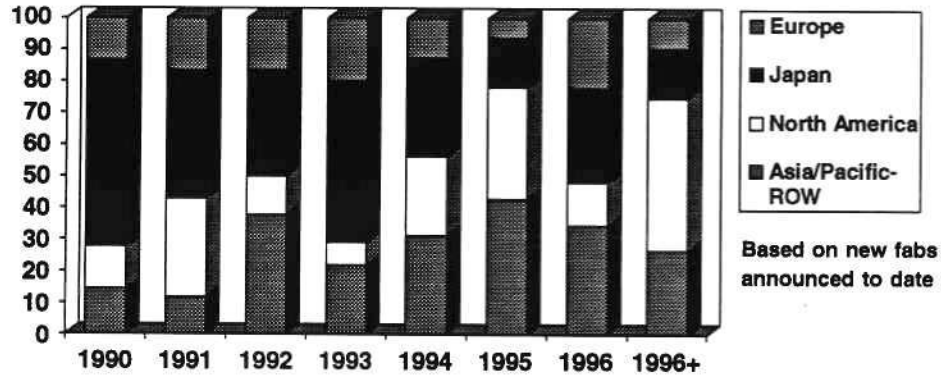
	First Production Fab	First Year Dominance	Last Year Dominance	Year of <10% New Capacity
8-inch	1988	1994	>2003	>2005
6-inch	1978	1986	1993	1996
5-inch	1970	1984	1985	1991
4-inch	1960s	1970	1983	1990

Source: Dataquest
9503805

Dataquest

New Capacity: Asia/Pacific and North America Dominate

Regional Distribution in New Capacity
(Percentage)



Based on new fabs announced to date

Source: Dataquest
9503805

Dataquest

New Fabs: Where Are They?

9503808

Dataquest

Who Is Building New Fabs?

	Projected New Capacity (8-Inch Equivalent)	Number of New Fabs (Announced)
Intel	71,619	4
Toshiba	67,000	3
LG Semicon	65,000	3
Samsung	60,000	3
Hyundai	60,000	2
TSMC	60,000	2
Fujitsu	55,690	4
Texas Instruments	52,000	3
NEC	50,000	2
Motorola	41,000	2

Source: Dataquest
9503808

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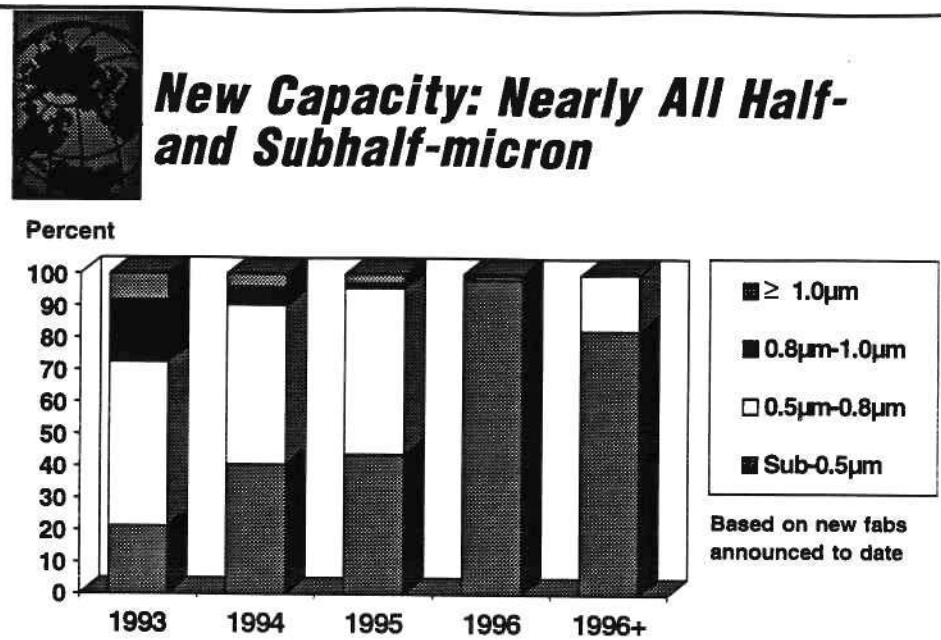
New Capacity: Nearly All Half- and Subhalf-micron



Source: Dataquest
9503806

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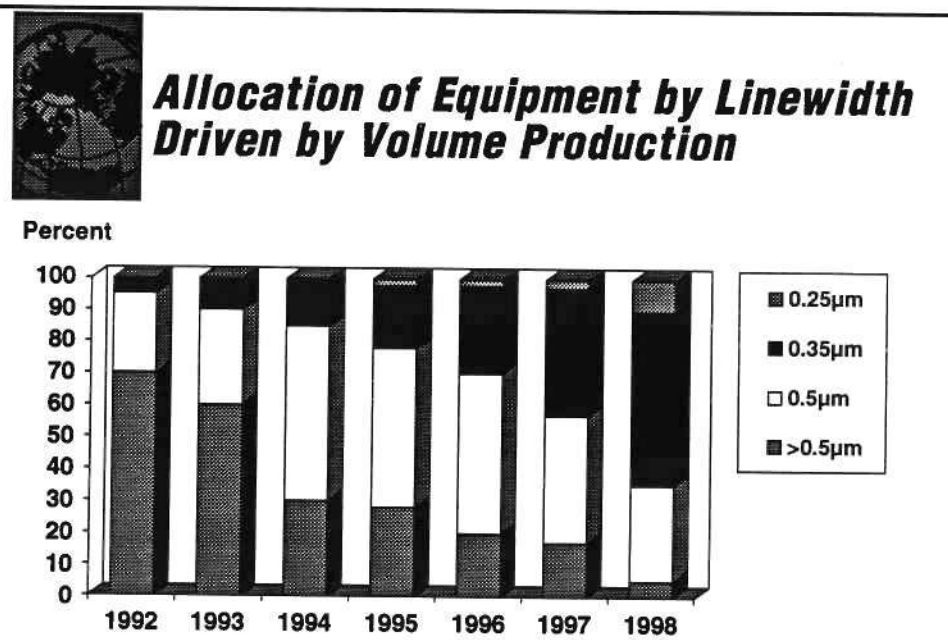
Allocation of Equipment by Linewidth Driven by Volume Production



Source: Dataquest
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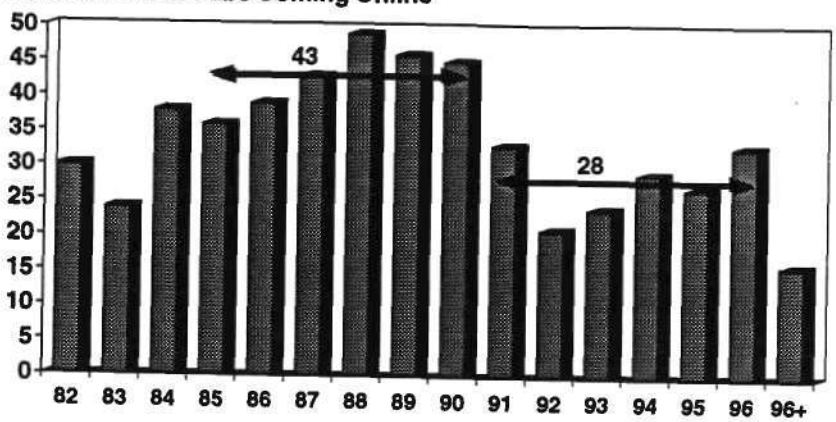
New Fabs Are Fewer

Number of New Fabs Coming Online



Source: Dataquest
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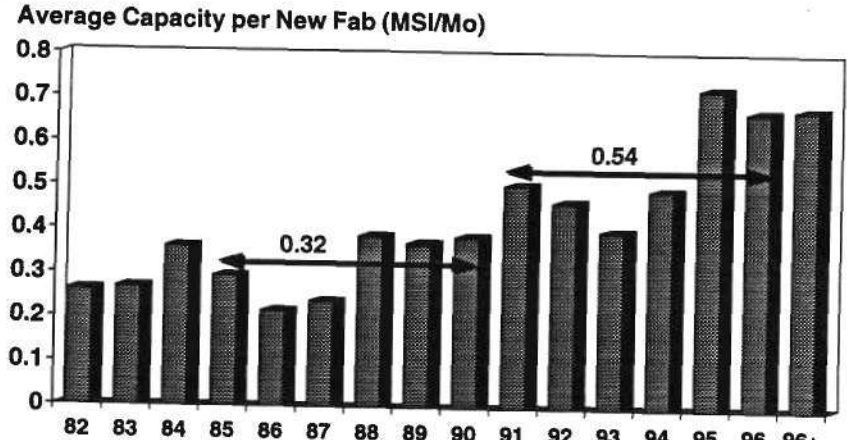
New Fabs Are Bigger

Average Capacity per New Fab (MSI/Mo)



Source: Dataquest
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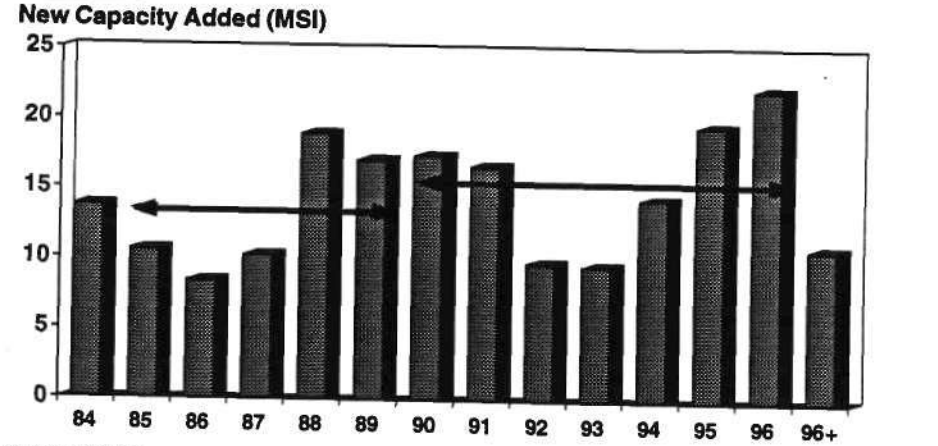
But New Capacity Added per Year is About the Same



Source: Dataquest
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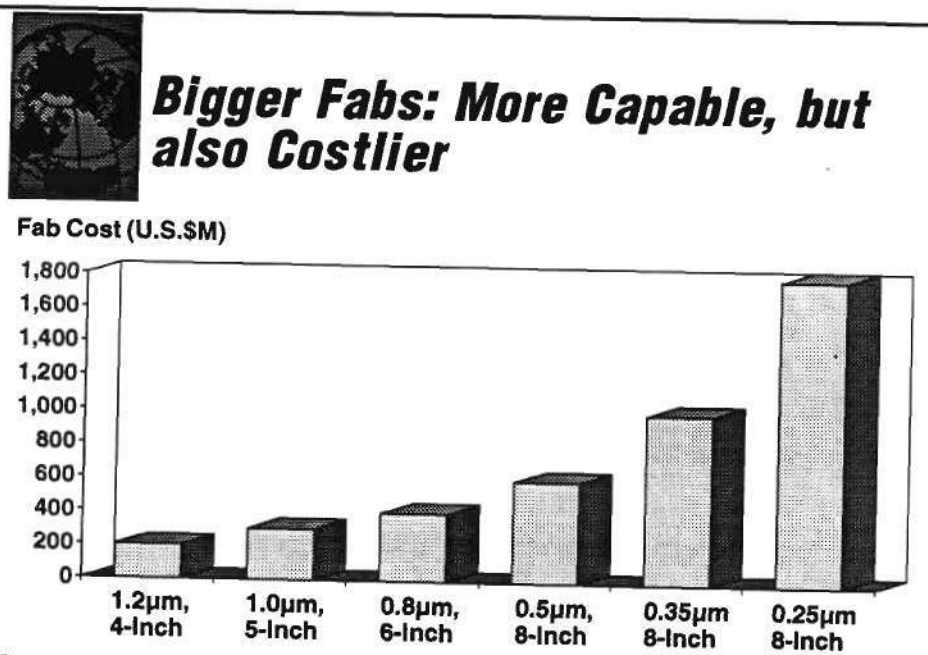
Bigger Fabs: More Capable, but also Costlier



Source: Dataquest
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As Fabs Get Bigger, Few Can Afford Building Them

	1988	1994	2000
Companies with Revenue >2 X Cost of a New Fab	20	18	~14

	1985-1990	1991-1996	1997-2002
New fabs	258	168	~135
Companies building new fabs	134	87	~65

Source: Dataquest
9503817

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Impact

- Fewer new fabs will be built by fewer companies
- New fabs will be bigger and more expensive
- Companies building fabs will be
  - Integrated device manufacturers (IDMs)
    - Commodity, high-volume products (DRAM, SRAM, MCU)
    - High-margin, leading-edge logic products (MPU, ASIC)
  - Foundries
    - PC ICs (chipset, graphic, audio, etc.), PLDs

9503817

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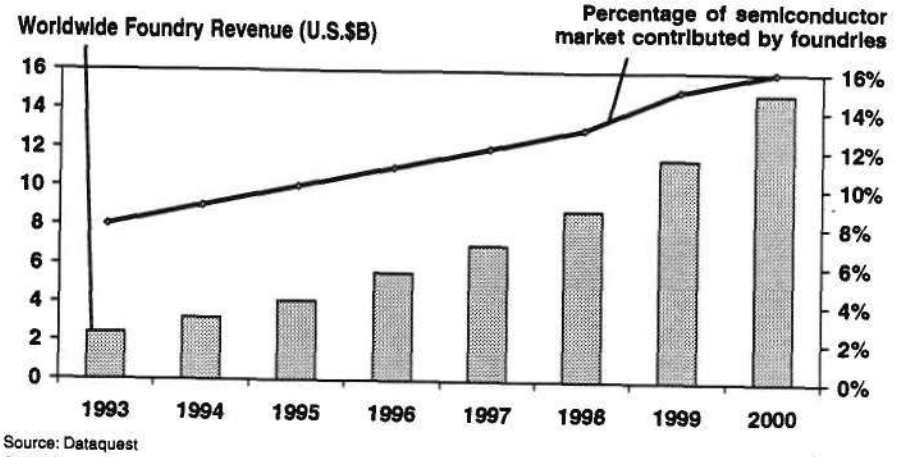
The Rise of Foundries



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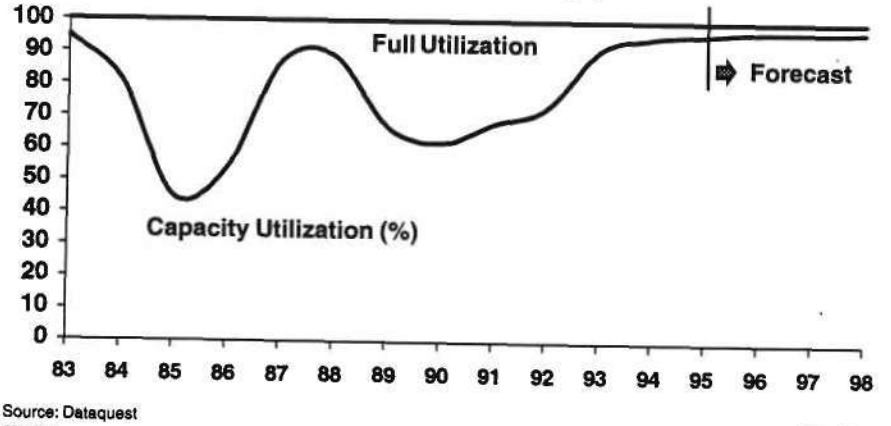
Semiconductor Production Capacity Utilization—Full Utilization



Source: Dataquest
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Conclusions

- Era of 8-inch fabs: Next 10 years
- North America and Asia/Pacific dominate new fabs, 1995-1998
- New fabs will be fewer and bigger
- Companies building new fabs are fewer
- More and bigger foundries
- Industry capacity will be efficiently utilized

Source: Dataquest
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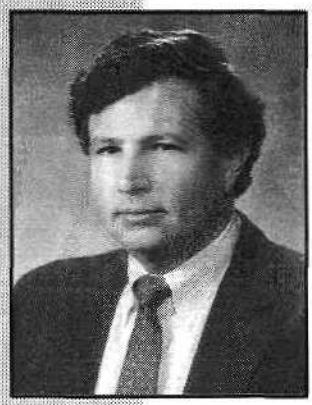
Flexible Manufacturing Fab Design

Jorge Carbó

Director
Worldwide Marketing and Sales
SubMicron Technology



Mr. Carbó is the Director of Worldwide Marketing and Sales for SubMicron Technology. He has 29 years of experience in the semiconductor industry, including 16 years at Texas Instruments, 7 years at Fairchild and National Semiconductor, and 3 years at UTMC. Since 1993 Mr. Carbó has been a consultant in the area of semiconductor marketing and sales.

Mr. Carbó's diverse background includes positions in quality and reliability, process control, manufacturing operations, and product line management. For the last 12 years, he has focused on marketing and sales management, holding positions as Division Marketing Manager, Corporate Strategic Marketing Manager, and Vice President of Marketing and Sales.

Mr. Carbó received a B.S. degree in chemical engineering from Villanova University and an M.B.A. in marketing from the University of Dallas.

Flexible Manufacturing Design

This paper describes the design philosophy used for flexible manufacturing design of SubMicron Technology's new submicron 200mm foundry

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What Does It Take for a Foundry's Success?

- No. 1—Achieve good profits, justifying the large financial investment (about $1 billion)
- No. 2—Provide customers manufacturing service with robust processes, high yield, and fast response times
- No. 3—Earn high wafer prices, by supporting customer's high chip prices, by staying in leading-edge manufacturing for highest performance chips:
  - Upgrade process tools every few years
  - Replace toolset every two generations:
    - 0.50/0.35-micron toolset (start-up)
    - 0.25/0.18-micron toolset (6 years later)

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What Does It Take for a Foundry's Success?

- No. 4—Follow the market, responding to customer needs faster than the customer's competition
- Requires:
  - Fast flexibility in manufacturing
  - Fast product qualification time
  - Fast production cycle times

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Factors Essential to Profitability

- No. 1—Low wafer-contamination performance during flexible manufacturing activities:
  - Affects—Die yield, process technology, selling price, customer satisfaction
- No. 2—High process tool utilization:
  - Affects—Wafer manufacturing cost, cycle time, customer response time
- No. 3—Stable, reliable, facility process-critical systems and environments:
  - Affects—Line-yield, die-yield, design rules, selling price, cycle time, customer satisfaction

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Factors Essential to Profitability

- No. 4—Short production cycle time:
  - Affects—Yield, yield improvement rate, customer satisfaction, response to market
- No. 5—Ability to upgrade tools and facility systems, during ongoing manufacturing:
  - Affects—Process technology, tool utilization, selling price, customer satisfaction, response to market
- No. 6—Predictable and reliable process tool performance:
  - Affects—Wafer manufacturing cost, cycle time, customer response time
  - Affects—Line-yield, die-yield, design rules, selling price, cycle time, customer satisfaction

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Submicron Technology 1

- New world-class submicron 200mm semiconductor factory for foundry services (SMT 1)
- SMT 1 capable of more than 5,000 CMOS wafer-outs per week, at 0.5 microns
- SMT 1 starting up with 0.5/0.35-micron toolset
- SMT 2 capable of more than 9,000 CMOS wafer-outs per week (several years later)
- SMT 1 + SMT 2 are located together, in Bangkok, Thailand

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SMT 1 Manufacturing Technology Plan (Assumes Four-Year Technology Cycle)

Year	1996	2000	2004	2004
Feature size (Microns)	0.05	0.35	0.25	0.18 (development)
Chip Sizes Up to (Mils per Side)	400	500	600	700
Equivalent DRAM	15MB	64MB	245MB	1GB

Source: SMT

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SMT 1 Schedule

- Project design start — 12/94
- Configuration frozen — 3/95
- Ground broken — 6/95
- Office building occupancy — 2/96
- Facility technical occupancy — Summer 1996
- Start-up tool installation — Fall 1996
- Process qualification — Fall 1996
- Start production ramp — 12/96

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Flexible Manufacturing Design Approach

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Fast Response to Customer Charges

- Manufacturing makes adjustment to different product mixes, plus different SMT standard processes mix, at each shift start
- Requires:
  - Robust processes and design rules, with products run on SMT standard processes, not "tweaked"
  - CIM soft-automation system does rebalancing calculations, tool assignments, reticle scheduling, and ensures next-cassette at each tool early
  - CIM uses keyless "smart-tracker-system" to keep track of locations of product-cassettes and reticles, in tools and in smart-stockers

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Hard-Automation Benefits

- SMT is still studying whether to use rail-transportation hard-automation between smart-stockers
- So far, our studies have shown no profitability benefit to recover the investment and maintenance costs:
  - The rail automation should be paid for by improved tool utilization, but SMT does not find such an improvement
  - High tool utilization mostly comes from the CIM system, by ensuring cassettes arrive early at their next tool
  - People have plenty of time to make this delivery
    - They are very inexpensive as transporters, and they are more flexible

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Clean Manufacturing Environment

- Wafers are protected by minienvironments on tools, plus wafer cassette handling in SMIF PODS:
  - Class 0.1 environment at the wafer (operating)
  - Achieved during all manufacturing and tool-work operation
  - Not just for standby, as required by FED STD 209
- Open "Class 100-Turbulent" ballroom for tool service personnel

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Ability to Work on Tools During Manufacturing

- SMT 1 manufacturing operates 24 hours per day, 7 days per week, 51 weeks per year:
  - Tools must be worked on during ongoing manufacturing
- Class 0.1 minienvironments and SMIF pods provide total particle isolation from work of repairing, installing, moving tools
- Facility's subfab tool services design allows connection and removal of process tools, while a facility service remains "hot":
  - Allows other tools to operate on the same service, without disturbing the ongoing manufacturing

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Ease of Work

- Tools can be placed anywhere in the ballroom for manufacturing convenience
- Free-standing tools:
  - No bulkhead walls to interfere with service
  - Minienvironments with access doors at all service points
  - Immediate access around entire tool
- People in comfortable gowning:
  - No face masks makes people more comfortable and communication easier
  - Standard Class 100 gowning
  - More productive in operations and maintenance
  - Same persons can do dirty tool work and then deliver wafer pods

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Ease of Work Benefits

- Due to minienvironment and SMIF-POD isolation, plan to run yield-qualification runs during time of maximum tool installation work:
  - Don't have to wait for tool installation to finish
- From the ease of work plus from yield-qualification being done during tool installation, SMT experts to save two months in start-up:
  - This time savings was experienced by TSMC Fab II, during its start-up ... for the same reasons
  - The two months saved millions of dollars in avoided tool and facility depreciation costs, and in wage and expense costs of the start-up team

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High-Yield Design

- Data from existing minienvironment/SMIF fabs indicates a better die yield is obtained, when the fab does a lot of tool working during manufacturing (flexible manufacturing)
- SMT decided that minienvironments and SMIF-POD handling are essential for our foundry-type operation
- "Smart-Tracker-System," for tracking the POD-cassettes, has a keyless entry system. Two fabs have reported a wafer-yield improvement of 3% due to elimination of operator keyboard errors

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Facility Process-Critical Systems

- Robust process-critical facility systems will operate to specifications 24 hours/day, 7 days/week, 51 weeks per year, regardless of equipment failures
- Stable systems:
  - Process-critical systems operated by statistical process control
  - Critical parameters monitored online and computer tracked
  - Industrial-grade controls and sensors used for stability
- Reliable systems:
  - Sufficient redundancy in process-critical systems to allow servicing and repair without affecting operating tools
  - Redundancy prevents failures from disturbing operating tools

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Facility Process-Critical Systems

- Facility emphasizes flexible manufacturing and long technical life (greater than 10 years):
  - Able to upgrade facility systems without shutdown
  - Facility designed to go from 0.5-micron to 0.25-micron manufacturing/0.18 development, without renovation
  - Plan to upgrade facility performance, as needed, during operations

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Facility Process-Critical Systems

- Ultrapure chemistry:
  - Refiltered/pumped all ultrapure chemicals
  - Purifier technology on H_2S0_4, HF, IPA
  - Blending on ultrapure NH_40H
  - State-of-art metrology laboratory
- Ultrapure gases:
  - Ultradry technology
  - Local gas-purifiers
  - Scintered-metal filters
  - Noncorrosion technology
  - Low leak rates for <10-PPB purity
  - State-of-art instrumentation

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Facility Process-Critical Systems

- Ultrapure water:
  - RO membrane technology
  - Ozone
  - Vacuum degassification
  - One-pass resin technology
  - Warm or hot DI (later)
  - State-of-art instrumentation

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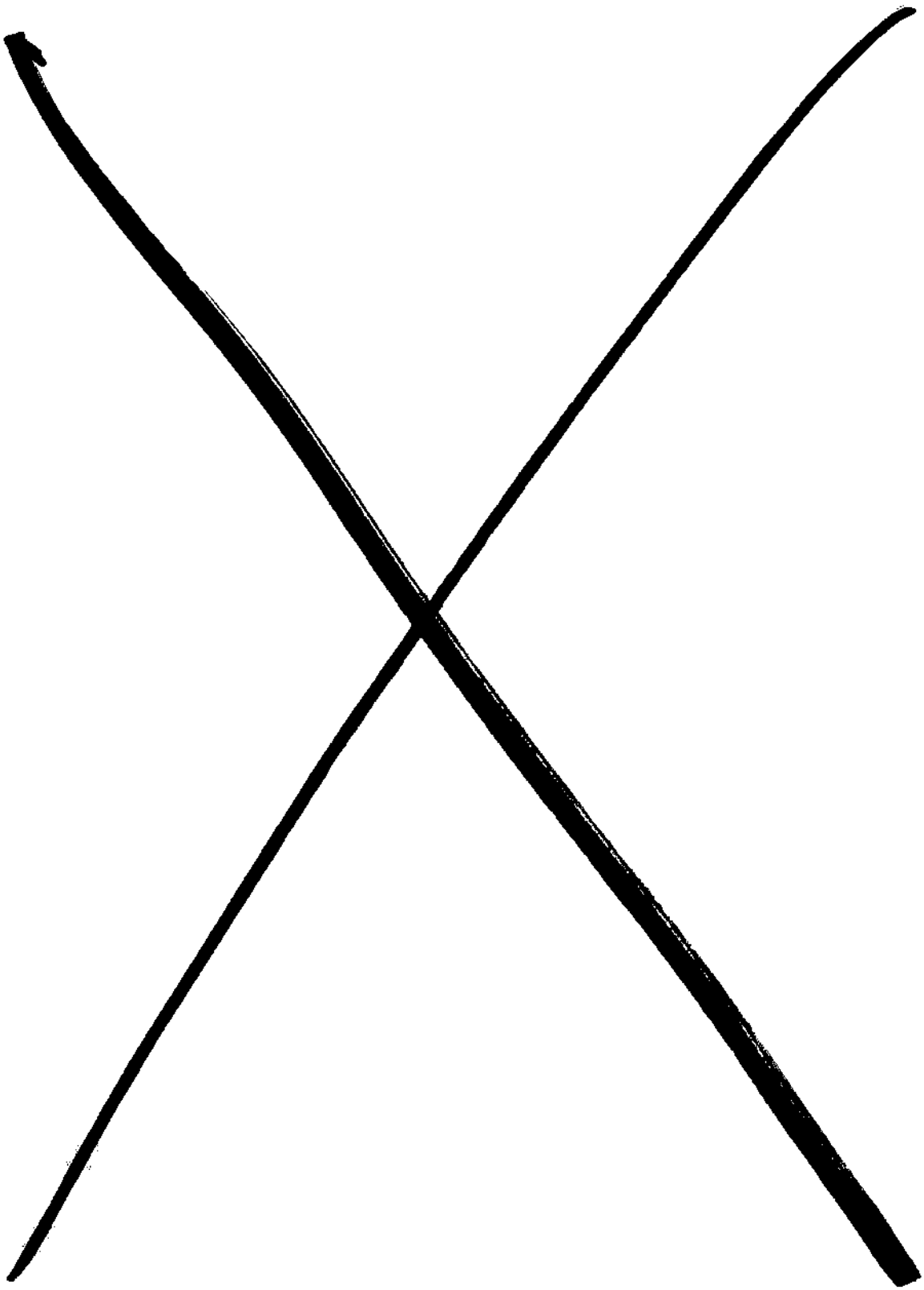
Notes:

Notes:



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