



ANA Hotel San Francisco June 17

SEMICON/West Seminar Status 1992

Dataquest°

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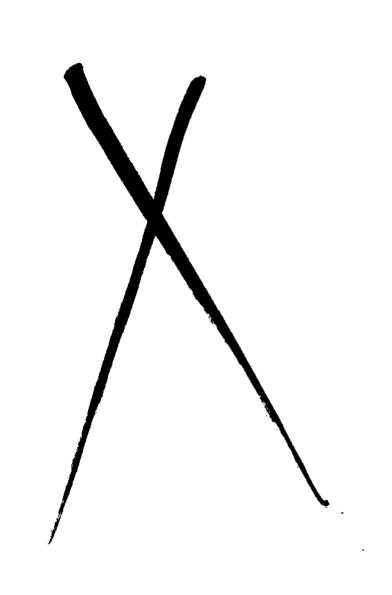
Complete Agenda

: Attendees

Attendee List by Company

Presentations

Slides and Notes



Agenda

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June 17, 1992 ANA Hotel San Francisco, California

Wednesday, June 17

7:30 a.m. Registration and Continental Breakfast
8:30 a.m. Welcome
Peggy Marie Wood
Principal Analyst
Semiconductor Equipment, Manufacturing, and Materials Service
8:35 a.m. Focus on Market and Product Issues in the Wafer Fab Equipment Industry
Peggy Marie Wood
Principal Analyst
Semiconductor Equipment, Manufacturing, and Materials Service
9:00 a.m. Financial Benchmarking of You and Your Competitor

9:00 a.m. Financial Benchmarking of You and Your Competitor
Joseph Grenier
Director
Manufacturing and Applications Group

9:30 a.m. The Trickle-Down Theory in the Electronics Food Chain
Mark FitzGerald
Senior Industry Analyst
Semiconductor Equipment, Manufacturing, and Materials Service

10:05 a.m. Coffee Break

10:25 a.m. Portable PCs: The Race to Get in Your Pocket First!
Nicholas Samaras

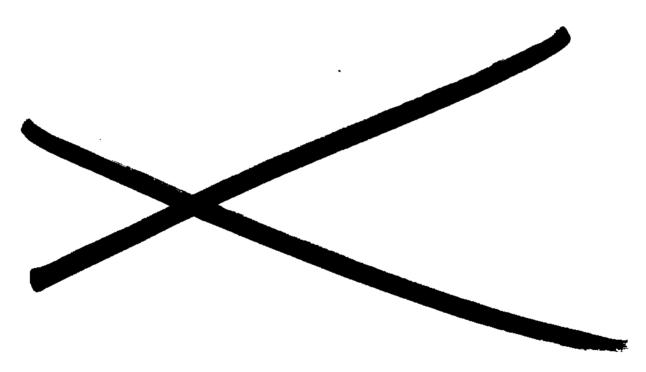
Principal Analyst Semiconductor Applications Markets

11:00 a.m. The 1Gb DRAM: ROI or RIP?

Lane Mason Principal Analyst

Semiconductor Memories

11:40 a.m. Session concludes



ABN AMRO Bank N.V.

Jeff French Vice President Robert Hartinger Vice President

Air Products & Chemicals, inc.

Arthur Katsaros
Vice President & GM, Electronics Div
Alex Schwars
R&D Manager

Airce/BOC

Philip Blakey
Vice President, Electronics

Applied Materials Japan

Katsuji Miyashita Director, Marketing

Applied Materials, Inc.

Clydene Bultman
Manager, Investor Relations
George Canavan
Global Marketing Manager
Don Fuller
Manager, Marketing Services
James M. Moriarity
Director, Global Marketing

BID-Service

Paul Cusa Sales Representative

Barclays Bank Pic

Richard Durnwald
Director

Business Week

Robert Hoff Editor

CFM Technologies, Inc.

Pam McCardell Sales Manager

Climet Instruments Co.

Raymond Felbinger General Manager

Comdisce Electronics Group

Paul Edstrom
Steve Grundon
Chip Halverson
Mike Herman
Mike Mardesich
Bob Plowman

Daifuku U.S.A. Inc.

Sam Nakajima Manager, Clean Room FA Group

Dynachem

Paul Augsburger
Director, Sales & Marketing

E.I. DuPont de Nemours & Company

Neil Washburn Senior Development Specialist

ETEC Systems Inc.

John Stirniman
Director of Marketing

Edwards High Vacuum International

Bob Adams
Vice President, Marketing

Electro Scientific Industries, Inc.

Russ Schlager Product Manager

Electronic Engineering Times

Stan Baker Western Editor

Electronic News

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Jonah McLeod
Editor in Chief

Ethyl Corporation

Fred Anderson
Business Manager

FSI International

Peter Pope
Executive Vice President
Laurie Walker
Marketing Services Manager

Fusion Semiconductor Systems

John Matthews Vice President

GE Capital

Richard Gumbrecht Marketing Manager

BE Capital Corporation

Mike Brown
Region Sales Manager
Mike Pilot
Mountain Region Manager

GaSonics/IPC

Lou Perrone
Vice President, Marketing & Technology

HTE Research

Sheldon Edelman Senior Associate

Hampshire Instruments, Inc.

Christopher Hayden
Director, Customer Operations

Hemlock Semiconductor Corporation

Duane Townley
Vice President, Marketing, Sales, Quality

Heechst Celanese Corperation

Tim Snelling Marketing Manager

Kughes Danbury Optical Systems, Inc.

John Callahan
Director, Marketing
Dhirendra Mathur
Manager
Peter Mumola
Director, Technology Development

Intel Corporation

Louisa Louie
Senior Industry Analyst
Mark Reagan
Senior Industry Analyst
Jacques J. Vuye
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Intelligence Capitai

Ken Tachibana President

JIJI Press

Mikio Koike Editor Mike Yukawa Reporter

KPMG Peat Marwick

Charles Dilisio Senior Manager Sam Paisley Partner

Lam Research Corporation

Henk Evenhuis CFO & Senior Vice President Carolyn Schwarts Investor Relations Manager

Liquid Air Corporation

Robert Welch Manager, New Business Development

MRC

Edward Erny
Director of Marketing

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Machine Technology, Inc.

Scott Pawenski
Vice President, Sales & Marketing

Matheson Electronics Products Group

Richard Darlow
Director, Marketing & Sales

Metec Alcatel

Ignace Borde
Process & Equipment Engineering Manager

Minnesota Valley Engineering

Ed Powell
Vice President, Sales & Marketing

Montgomery Securities

Krishna Shankar Research Analyst

Mosaid Technologies Inc.

Russell Fields
President & CEO

NEC Electronics. Inc.

Kevin L. Krehbiel Business Analyst

Mitte Denke America

Ron Blankenhorn Marketing Manager

OCG Microelectronic Materials, Inc.

James LaCasse
Director, Marketing

OTC Semicenductor Corporation

Robert Baracani EPI Tokuyasu Osumi Director Takashi Yamada Manager, Scheduling

OnTrack Systems, Inc.

Jerry Cuteini Vice President, Sales & Marketing

Oxford Instruments

Allan Goodbrand Director

Prism Technologies, Inc.

Bobby Greenberg
President

Prometrix Corporation

Steve Westrate
Vice President of Sales

Prudential Securities Inc.

Jay Deahna Research Assistant

Rebertson, Stephens & Co.

Dan Klesken Partner

Rudolph Research

Richard L. Budsinski Director of Sales

Semiconductor Systems, Inc.

Mike Parodi President

Skipley Company, Inc.

Eric Alling
Director, Business Development II

Siemens AG

Guenther Moenkemeyer Executive Director Winfried Ruettenauer

Silicon Valley Group, Inc.

Tom St. Dennis
V.P., Process Tech & Strategic Ping

Siltren, Inc.

Dae-Hong Kim
Executive Director, Planning & Marketing

Solid State Measurements, Inc.

John Snyder Manager, Marketing And Sales

Solitec. inc.

William Parrette General Manager

Speedfam Corporation

Ellis Ponton Assistant General Manager

Sumishe Electronic Systems, Inc.

Hiroshi Ishiwata Mgr., Semiconductor Equipment Dept.

Teisan K.K.

Yukinobu Nishikawa Manager, Technical Development

Tencor Instruments, Inc.

Jon Tompkins
President/CEO

Texas instruments, inc.

Mark England
Product Engineer

Tokyo Electron, Ltd.

Isumi Arai Section Mgr., Process Equipment Dept

Ultratech Stepper, Inc.

Daniel Berry
Vice President, Sales & Service
Joe Nava
Executive Director, Sales
Arthur Zafiropoulo
President

Union Carbide industrial Gases Inc.

Thomas Nelson
Product Manager, Electronics

Unit instruments, inc.

David Sheriff
Director, Marketing & Sales

Varian Associates

Giovanni Nocerino Marketing Manager

Watkins-Johnson Company

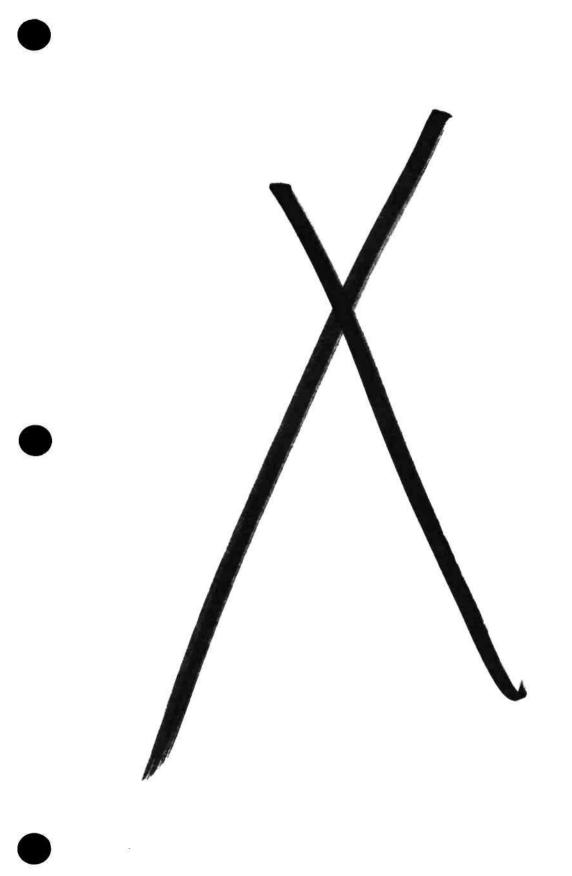
Ken Agarwal Manager, Marketing Ronald Lessack Vice President

Westech Systems, Inc.

Robin Peters
Marketing Account Manager

Graydon Larrabee

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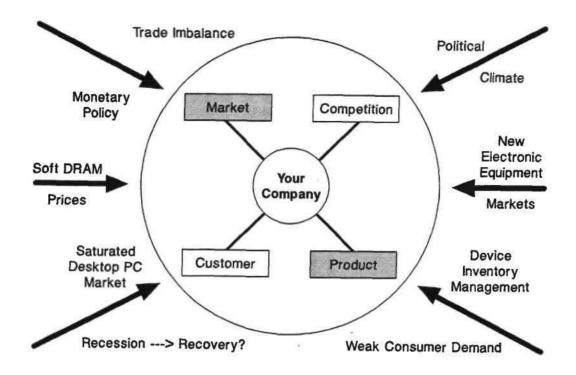


Peggy Marie Wood, Ph.D.
Principal Analyst
Semiconductor Equipment,
Manufacturing, and
Materials Service



Ms. Wood is a Principal Analyst for Dataquest's Semiconductor Equipment, Manufacturing and Materials Service. Her responsibilities include research and analysis of the semiconductor industry with respect to wafer fabrication equipment, electronic materials for semiconductor processing, and the technology and trends of semiconductor manufacturing. Prior to joining Dataquest, Ms. Wood was a postdoctoral research affiliate in the Department of Chemistry at Stanford University. While at Stanford, she supervised the installation of new research facilities and was responsible for the purchase of optical, electronic, and laser equipment. In addition to pursuing her own research in nonlinear chemical dynamics, Ms. Wood taught

undergraduate laboratory courses and supervised graduate student research. Ms. Wood received a B.S. degree in Chemistry from California State University at Sacramento and a Ph.D. in Chemistry from Stanford University.



THE CHANGING FACE OF THE WAFER FAB EQUIPMENT MARKET

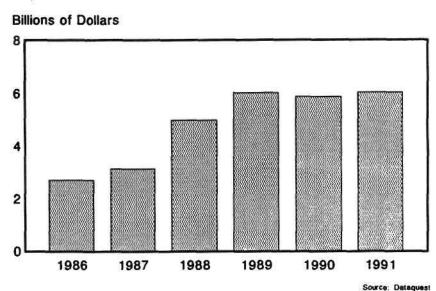
- Regional market shifts
- Changes in regional company market share
- Impact of new technology drivers
- How these changes will affect the wafer fab equipment market

Focus on Market and Product

: Issues in the Wafer Fab

Equipment Industry

WORLDWIDE WAFER FAB EQUIPMENT MARKET

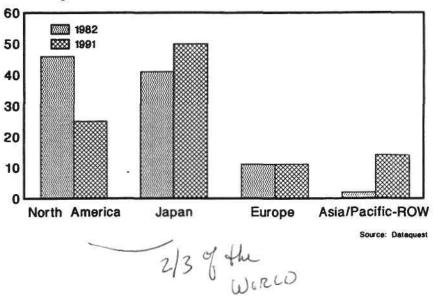


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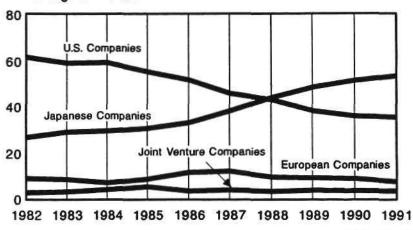
REGIONAL SHIFTS IN THE WORLDWIDE WAFER FAB EQUIPMENT MARKET

Percentage of Dollars



WAFER FAB EQUIPMENT MARKET BY REGIONAL OWNERSHIP OF COMPANIES

Percentage of Dollars



Source: Dataquest

1991 JAPANESE COMPANY SHARE FOR KEY SEGMENTS OF WAFER FAB EQUIPMENT

	Japanese Companies	Change from 1990
Steppers	82%	4%
Wet Process	67%	-6%
Track	62%	1%
Diffusion	61%	9%
CD	61%	1%
PVD	57%	-1%
CD PVD Dry Etch/Dry Strip Wafer Inspection	45%	0%
Wafer Inspection	42%	17%
CVD	26%	2%
I mplanters	18%	1%
	-	Source: Dataquest

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WHAT HAPPENED IN 1991?

Changes in Regional Company Share Relative to 1990

	U.S. Companies	Japanese Companies	European Companies	(ملتمان ا
North America	ļ	\bigcirc	→	120/2 Lower 1
Japan	1	Ī		1100 Comple
Europe	1	<u>‡</u>	1/	
Asia/Pacific	Ī	\bigcirc	1	
World	-0.5%	1.9%	-1.3%	. last
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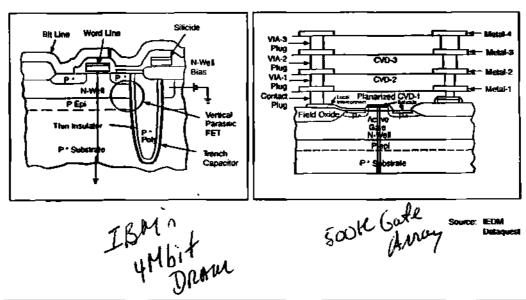
TECHNOLOGY DRIVERS FOR SEMICONDUCTOR FABRICATION

- DRAMS
 - High volume/low cost
 - Advanced device structures
 - Submicron lithography 1/
 - "Hardwired" automation
- ASICs
- ASICs Liper, MPU'A
 Low volume/time to market

 - Design automation
 - Multilevel interconnect 4
 - "Flexible" automation

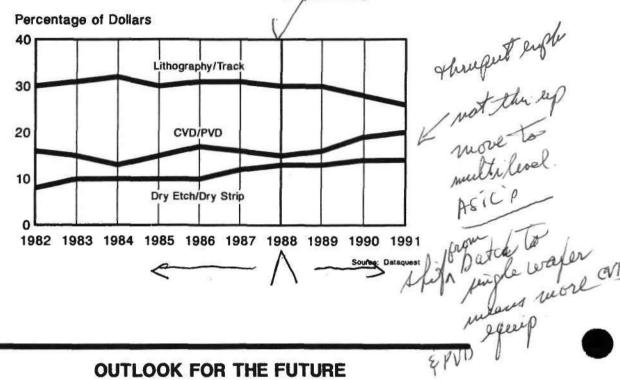
Source: Dataquest

DIVERGING MEMORY AND LOGIC DEVICE STRUCTURES



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> **KEY SEGMENTS AS A PERCENTAGE OF TOTAL** WAFER FAB EQUIPMENT SPENDING



Fabs in Japan and Asia/Pacific accounted for almost

WAFER FAB EQUIPMENT MARKET TRENDS

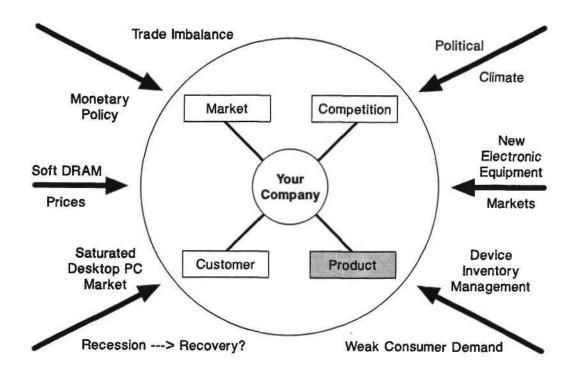
- two-thirds of worldwide wafer fab equipment demand - Spending patterns in the Far East dictate worldwide market growth dynamics
- Japanese equipment companies continue to dominate many key segments of wafer fab equipment
 - But slowdown in erosion of U.S. company share observed ... does one year make a trend?
- Diversification of the semiconductor product mix toward more ASIC/advanced logic
 - Thin film processing equipment will continue to garner a larger portion of the total equipment pie

more PVD & CVD spending in fedure

- Focus on Market and Product
- : Issues in the Wafer Fab
- : Equipment Industry

OUTLOOK FOR THE FUTURE WORLDWIDE WAFER FAB EQUIPMENT FORECAST

		November 1991 Forecast	What the Market Outlook Is Today
	1992 1993	Down 8 percent Up 16 percent	Down 10 to 14 percent Up 12 to 16 percent In this year? 1993?
	• What	's behind the slowdow	on this year? Chilffy to
		's fueling the upturn in	1993? Secult
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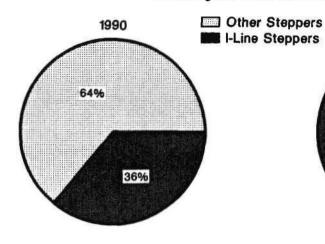
THE CHANGING NATURE OF WAFER FAB EQUIPMENT PRODUCTS AND TECHNOLOGY

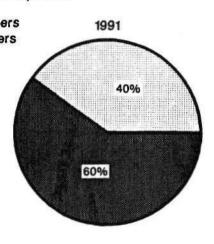
- Product/technology trends for key segments of wafer fab equipment
 - Steppers
 - Etch
 - Deposition
- · How these changes are affecting users
- How these changes are affecting equipment vendors

I-LINE EXPLOSION

Percentage of Worldwide Shipments







Source: Dataques

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STEPPER PRODUCT AND TECHNOLOGY TRENDS

- Advanced DRAM lithography strategies still being thrashed out
 - Phase shift masks limited by lack of repair technology
 - Excimer/deep-UV waiting for production-worthy resists
- Extension of conventional i-line to sub-0.4-micron
 Nikon's SHRINC and Canon's QUEST technologies
- X-ray push-out continues to 256Mb/1Gb DRAM generations
- 1991 -- year of the wide-field lens
 - But, getting wide is getting tough

DRY ETCH EQUIPMENT -- SOURCE TECHNOLOGY
IS THE NAME OF THE GAME

(Percentage Dollars)

Plasma

RIE, MERIE

Microwave/ECR

A0%

20%

ource: Dataquest

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DRY ETCH PRODUCT AND TECHNOLOGY TRENDS

- New plasma source technologies emerging
 - Inductively coupled plasma (ICP)/TCP
 - Helicon source
- Emerging OEM plasma source companies
- Integrated solution for dry etch, dry strip, and wet clean

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DEPOSITION PRODUCT AND TECHNOLOGY TRENDS

- What's driving deposition technology?
 - Multilevel interconnect processes
- Gradual integration of PVD/CVD interconnect solutions
 - RTP, tungsten CVD/etchback, PVD integration
- CVD TiN, DCS silicide, and CVD copper: New markets
- Challenge to traditional intermetal dielectric processing
 - Chemical-mechanical polishing (CMP)

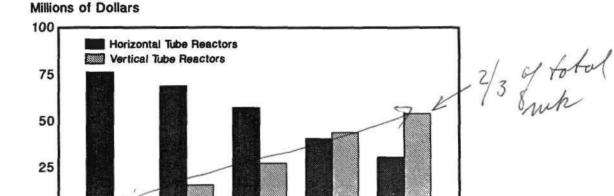
1987

1988

Vertical tube reactor technology attains dominance

HORIZONTAL DECLINE

Diffusion, LPCVD, and PECVD Markets



1989

1990

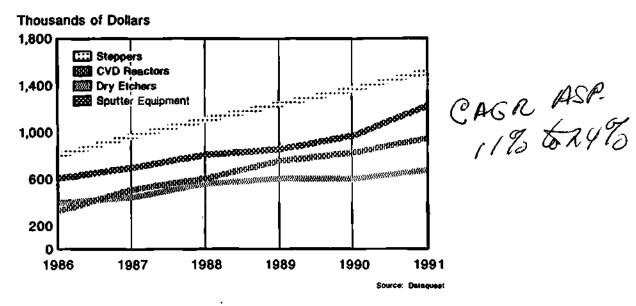
Source: Dataquest

1991

Je toler Departure

- **Focus on Market and Product**
- Issues in the Wafer Fab
- **Equipment Industry**

ESCALATING WAFER FAB EQUIPMENT ASPS



		 		
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HOW PRODUCT/TECHNOLOGY CHANGES ARE AFFECTING EQUIPMENT USERS

5 to 3 years

- Equipment depreciation schedules
- Cost of ownership
 - Users want to make apples-to-apples comparison on competitive products
- Extending the useful life for equipment
 - Design device product families around common set of equipment and process recipes ("harmonization")
 - Leasing used equipment
- Technology used to be No. 1, but now other factors are also key elements of the buy decision
 - Vendor's financial stability and long-term viability
 - Global service/support network

HOW PRODUCT/TECHNOLOGY CHANGES ARE AFFECTING EQUIPMENT VENDORS

chiffmits less # of

- · Cost of ownership -- new marketing battleground
- Horizontal partnering between equipment companies
 - -The whole is greater than the sum of the parts
- Huge outlays for R&D next-generation product development
- Joint vendor/customer development programs
 - Share the burden, risks, and rewards

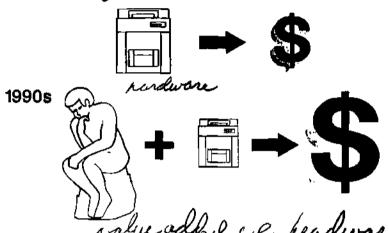
Focus on Market and Product

: Issues in the Wafer Fab

: Equipment Industry

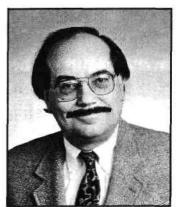
EMPHASIS IS ON "HEADWARE," NOT JUST HARDWARE ANYMORE

1970s through the late 1980s



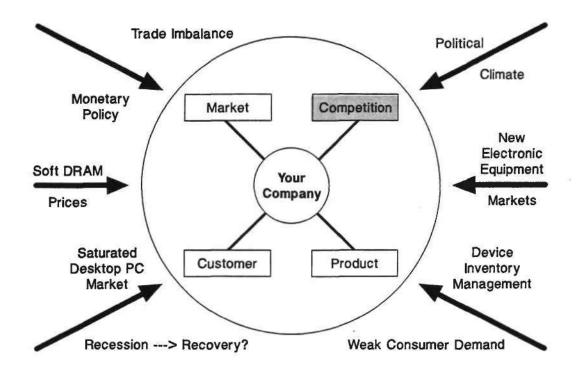
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Joseph Grenier
Director
Manufacturing and
Applications Group



Mr. Grenier is Director of Dataquest's Manufacturing and Applications Group. He is responsible for managing the research activities of the Semiconductor Equipment, Manufacturing, and Materials service; the Semiconductor Applications Markets service; and the Semiconductor Procurement service. Prior to joining Dataquest, Mr. Grenier was Product Marketing Manager at GCA Corporation, where he managed marketing activities for the reactive ion etch program. He was also International Marketing Manager at GCA and was responsible for the overseas marketing of wafer processing equipment. Previously, he worked as a Product Manager at Varian Associates/Instrument Division, as a Systems Engineer at the USAF Satellite Test Center, and as a Test

Engineer at General Motors' Noise Vibration Laboratory. Mr. Grenier received a B.S.E.E. degree from the University of Detroit and an M.B.A. degree from the University of Santa Clara.



SOME THINGS YOU SHOULD KNOW ABOUT YOUR COMPETITION

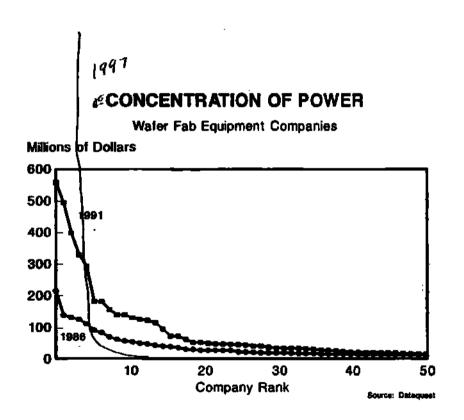
- The product package:
 - The product itself
 - Process support capability
 - Warranty policy
 - Service support
- The company package:
 - Strength of company management
 - Company philosophy
 - Sales and service organization
 - Strengths and weaknesses
 - Its financial strength or financial benchmarking

FINANCIAL BENCHMARKING THE COMPETITION (AND YOUR COMPANY)

- General wafer fab equipment company growth trends
- Financial benchmarking of companies

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Wafer Fab Equipment Company Growth Trends



CONCENTRATION OF POWER WAFER FAB EQUIPMENT COMPANIES

	19	986	16	991	CAGR (%) 1986-1991
Companies 1-10	\$1,085	(40%)	\$2,859	(47%)	21
Companies 11-20	374	(14%)	890	(15%)	19
Companies 21-30	218	(8%)	416	(7%)	14
Total Top 30 Companies	\$1,677	(62%)	\$4,165	(69%)	20
All Other Companies	1,036	(38%)	1,875	(31%)	13
Total Wafer Fab				` ,	
Equipment Market	\$2,713	(100%)	\$6,040	(100%)	17

Source: Delaquest

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COMPANY RANKINGS FOR SALES OF WAFER FAB EQUIPMENT

(Millions of Dollars)

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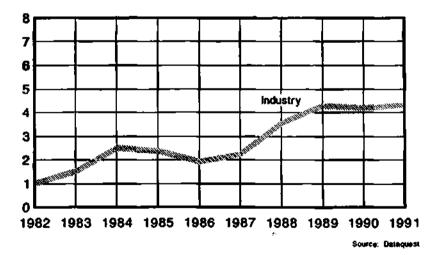
1991		<u> 1986</u>	
Nikon	557	Perkin-Elmer	213
Applied Materials	493	Nikon	137
Tokyo Electron Ltd.	397	Canon	130
Hitachi	328	Applied Materials	124
Canon	292	Varien*	119
Varian*	275	GCA	89
Silicon Valley Group	180	ASM International	82
Anelva	155	General Signal	77
Kokusai Electric	138	Ulvac	65
Dainippon Screen	13 8	TEL/Thermco	60

^{*}Includes TEL/Varian and Varian/TEL sales

Source: Detequest

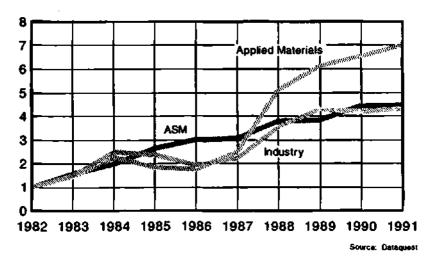
WAFER FAB EQUIPMENT

industry Sales
Sales Growth Normalized to 1982



WAFER FAB EQUIPMENT

Industry and Company Sales Sales Growth Normalized to 1982

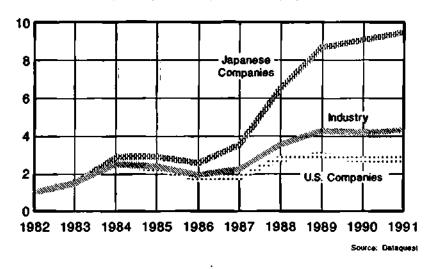


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WAFER FAB EQUIPMENT

Industry and Company Sales Sales Growth Normalized to 1982



How does your company's growth compare with the industry?

Financial Benchmarking of You and Your Competitor

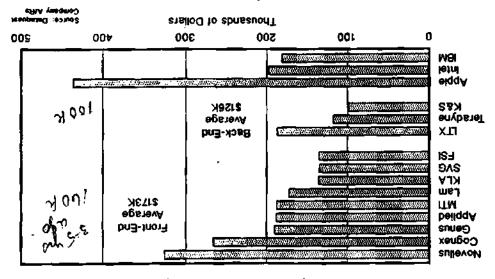
Financial	Benchmarking	of	Companies

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Financial Benchmarking of You and Your Competitor

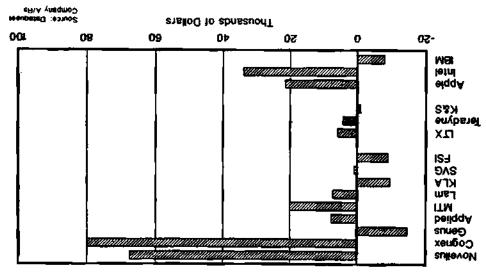
REVENUE PER EMPLOYEE (FY 1991)

(Thousands of Dollars)



PROFIT PER EMPLOYEE (FY 1991)

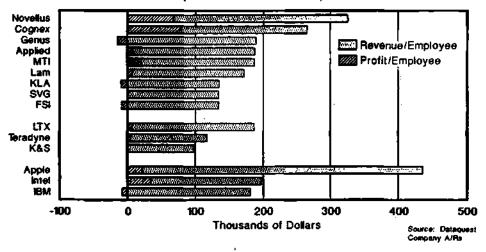
(Thousands of Dollars)



Financial Benchmarking ofYou and Your Competitor

REVENUE PER EMPLOYEE AND PROFIT PER EMPLOYEE (FY 1991)

(Thousands of Dollars)



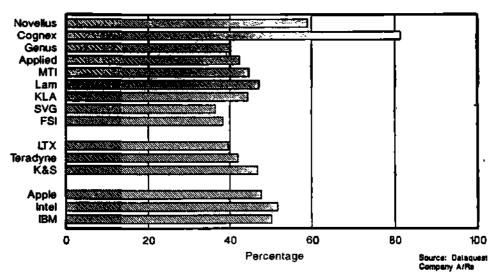
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Financial Benchmarking of You and Your Competitor

AN ACCOUNTING DEFINITION

GROSS MARGIN (FY 1991)

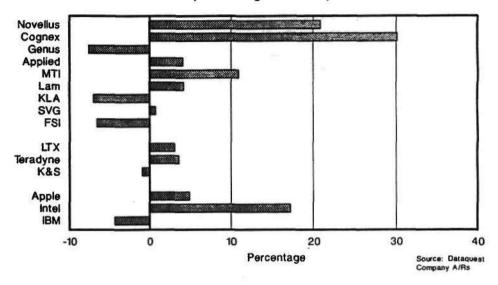
(Percentage of Sales)



Financial Benchmarking ofYou and Your Competitor

NET INCOME (FY 1991)

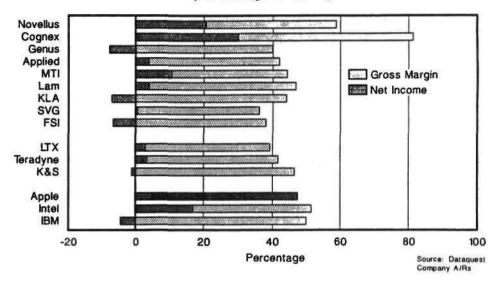
(Percentage of Sales)



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GROSS MARGIN AND NET INCOME (FY 1991)

(Percentage of Sales)



ANOTHER ACCOUNTING DEFINITION

Net sales

- Cost of sales (COS)
- Selling, general, and administrative expense (SG&A)
- R&D expenditures

Operating income

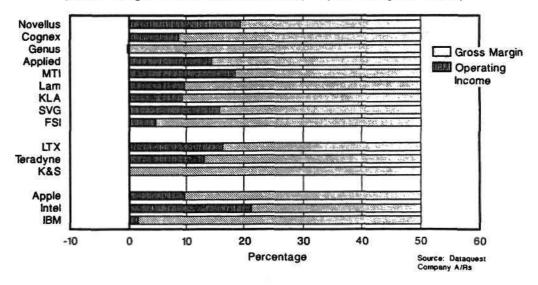
- Interest expense (income)
- Extraordinary items
- Income taxes

Net income

Financial Benchmarking of You and Your Competitor

GROSS MARGIN AND OPERATING INCOME (FY 1991)

(Gross Margin 50% for All Companies) -- (Percentage of Sales)

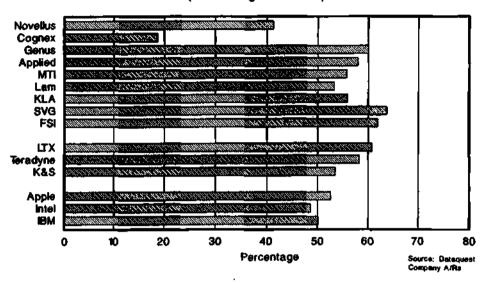


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Financial Benchmarking of You and Your Competitor

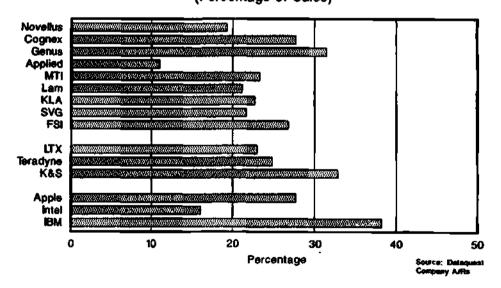
COST OF SALES (FY 1991)

(Percentage of Sales)



SG&A EXPENSE (FY 1991)

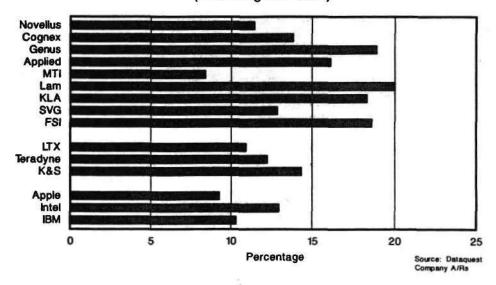
(Percentage of Sales)



Financial Benchmarking ofYou and Your Competitor

R&D EXPENSE (FY 1991)

(Percentage of Sales)

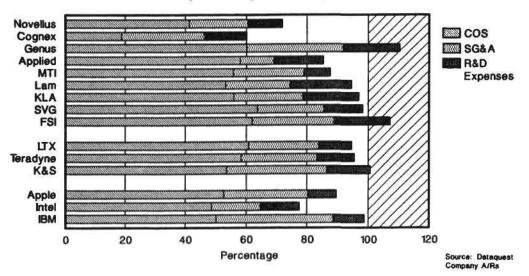


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Financial Benchmarking of You and Your Competitor

COS, SG&A, AND R&D EXPENSES (FY 1991)

(Percentage of Sales)



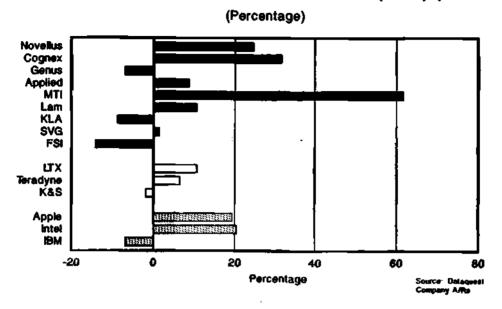
THE PROBLEM

		Direction of Pressure
Net Sales	100%	1
- Cost of Sales	50%	Ť
- R&D Expense	15%	↑
- SG&A Expense	25%	Ť
Operating Income	10%	
- Taxes (40%)	4%	
Net Income	6%	1

Source: Dataquest

Financial Benchmarking ofYou and Your Competitor

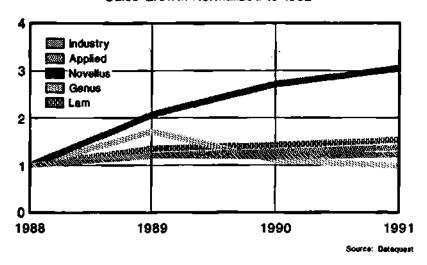
RETURN ON SHAREHOLDERS'S EQUITY (ROE) (FY1991)



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WAFER FAB EQUIPMENT

industry and Company Sales Sales Growth Normalized to 1982



CONCLUSIONS

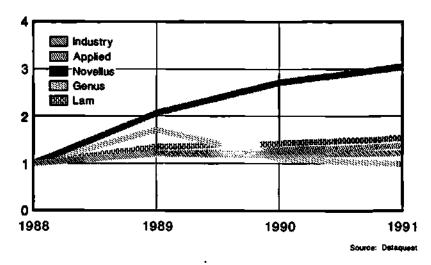
- Intensively study your competition from all angles
- Financially benchmark your company vis-a-vis your competition, or the industry
- To be an excellent company you must outperform the market
- Improve your financials by striving for excellence

Strive for excellence in everything your company does no matter how seemingly unimportant the task is. Such a company attitude ultimately adds up to make your company profitable, and a finely honed competitive force in the industry.

Financial Benchmarking ofYou and Your Competitor

WAFER FAB EQUIPMENT

Industry and Company Sales Sales Growth Normalized to 1988



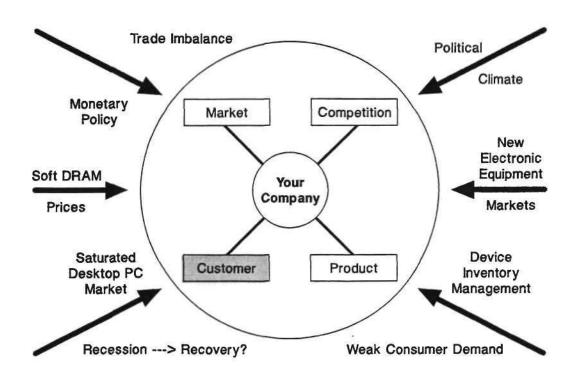
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Mark FitzGerald
Senior Industry Analyst
Semiconductor Equipment,
Manufacturing, and Materials
Service

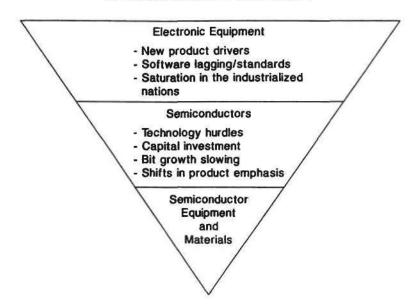


Mr. FitzGerald is a Senior Industry Analyst for Dataquest's Semiconductor Equipment, Manufacturing, and Materials service. He is responsible for research and analysis of semiconductor materials. Prior to joining Dataquest, Mr. FitzGerald was Western Region Sales Manager for Materials Technology, a manufacturer of epitaxial susceptors and high-performance ceramic coatings. Previously, he worked as an Application Chemist in the Applied Research and Development Department of the Semiconductor Group at Air Products and Chemicals Inc. and as a Research Chemist of Exxon Corporation's Long Range Research Group. Mr. FitzGerald received a B.A. degree in Literature and a B.S. degree in Chemistry from McGill University in Montreal, Canada, and an M.B.A. degree from Duke

University in Durham, North Carolina.



STRUCTURAL CHANGE



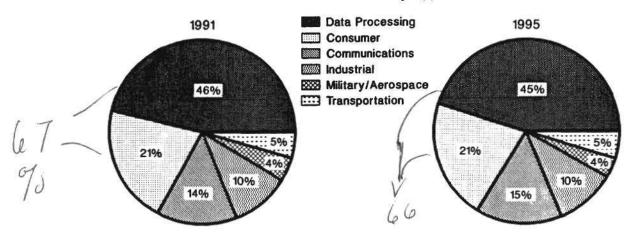
AGENDA

• Electronic equipment

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WHERE DO THE CHIPS GO?

Worldwide % Revenue by Application

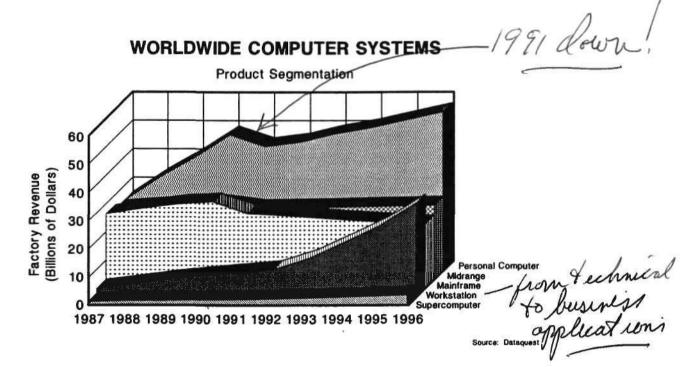


Source: Dataquest

THE COMPUTER INDUSTRY HAS CHANGED

- Growth, which slowed rapidly, may not return to past levels for the foreseeable future
- Competition will intensify as entry barriers continue to drop and boundaries blur
- Profit margins, which have been squeezed, will continue to be squeezed

Source: Dataquest



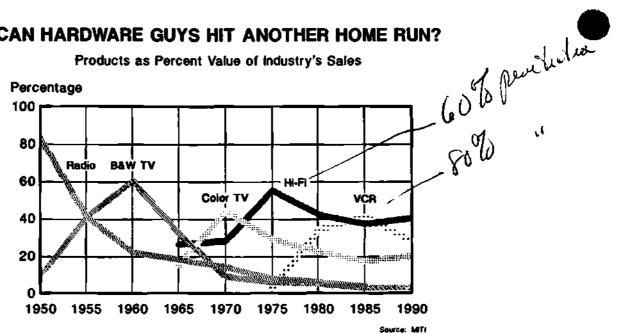
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CONSUMER ELECTRONICS HAS CHANGED

- The trend to digital appliances has set a collision course for consumer and computer electronics
- · Software skills, memory chips, and fast MPUs will be at the heart of new consumer products
- Consumers in the developed countries are growing choosier and older

Source: Dataquest

CAN HARDWARE GUYS HIT ANOTHER HOME RUN?



AGENDA

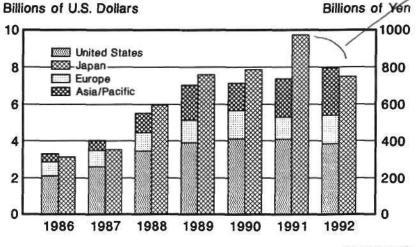
• Semiconductor industry

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U.S. chip may de sons

SPENDING EXPLODED IN THE LATE 1980s

Capital Spending



Source: Dataquest

RESULTS OF THE SPENDING BINGE

- · Capital spending drops off
- · Fab production overcapacity
- Fab closures/delays increase

plaked for Alul Josepher Josepher Level July Josepher Jos

Foundry activity rises

DISTRIBUTION OF THEORETICAL CAPACITY BY ESTIMATED MINIMUM LINE GEOMETRY NORMALIZED TO SIX-INCH WAFER EQUIVALENTS PER FOUR-WEEK PERIOD

Worldwide Merchant Semiconductor Fabs

. 🗸	Linewidth	1988	1989	1990	1991	1992	1993	CAGR (%) 1988-1993
الم ا	≤0.5	1,033	1,033	1,033	1,922	3,699	3,699	29.1
- ・ レリ - ラペ	> ≥0.5 & <0.8	96,927	117,927	253,990	380,699	669,915	895,393	56.0
44, 600	≥0.8 & <1.0	292,851	533,597	779,401	1,062,572	1,151,931	1,288,719	34.5
256KS RAM	Total	390,811	652,557	1,064,424	1,445,193	1,825,545	2,187,811	41.1

Source: Dataquest

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CAPACITY UTILIZATION, DISTRIBUTION OF 1992 SLICES (≥0.5 AND <0.8) INTO 4Mb DRAM DIE (77mm² DIE SIZE/170 DIE PER WAFER)

70% of 113 H = 55.4 Forecast 4Mb Demand = 34.3 Million Units per Month in 1992 Theoretical Die Capacity * 113 Million Units per Month in 1992 80 90 60 70 100 Assumption of Percent Theoretical 50 Die Capacity in 4Mb Production 55.4 63.3 Adjusted Theoretical Die Capacity 39.6 47.5 79.1 Assuming 70% Yield Capacity Utilization (%) 86.8 72.3 62.0 48.2

DELAYED 200mm FAB PLANS IN JAPAN

	Products	Type of Fab
Fujitsu	16Mb DRAM	Production
Hitachi	4Mb/16Mb DRAM	Production
KTI	ASIC	Production
Matsushita	16Mb DRAM	R&D
Matsushita	16Mb/64Mb DRAM	Production
NEC	16Mb DRAM, MPU	Production
NEC	4Mb/16Mb DRAM, EPROM	Production
NKK	4Mb SRAM, ASIC, MPU	Pilot
Oki	16Mb DRAM	Production
Sanyo	16Mb DRAM	Production
Sharp	4Mb DRAM, ROM	Production
Toshiba	16Mb DRAM	Pilot
Toshiba	4Mb/16Mb DRAM	Production
Toshiba	4Mb/16Mb DRAM	Production
Toshiba	16Mb DRAM	Production
		Source: Dataquest

FAB CLOSURES IN 1991 PEAK

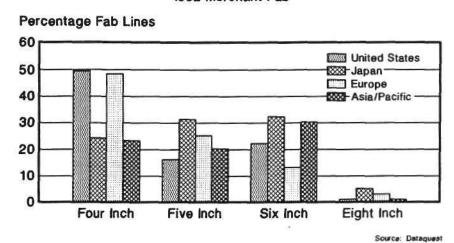
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Source: Dataquest

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UNITED STATES AND EUROPE LAG IN THE MOVE TO LARGE-DIAMETER WAFERS

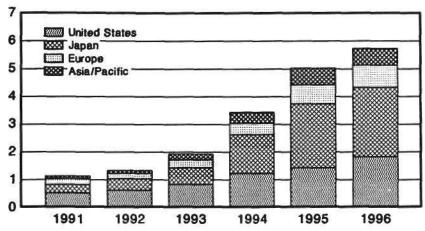
1992 Merchant Fab



LARGE-DIAMETER WAFERS WILL GROW

8-Inch Wafer Forecast

Millions of Wafers



Source: Dataquest

8" water for Il Jan 193

Illuited States

JAPAN AND ASIA/PACIFIC HEAVILY LEVERAGED ON MOS MEMORY

1992 Merchant Fabs

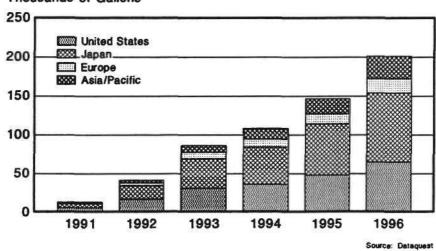
Millions Square Inches per Four Weeks

	50 40 30 20 10 0 Mem	ory ASIC	Discrete	Europe Asia/Pacific MPU		
Notes:	Jpn	KONEA	fles	ibility (Clexer & a	Ra)
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ADVANCED I-LINE RESIST WILL GROW

I-Line Resist Volumes

Thousands of Gallons



OPPORTUNITIES IN NEW MATERIALS

- New capacitor dielectric materials with high dielectric constants may allow DRAM companies to economically continue scaling cell sizes
- Polysilicon CVD films for BiCMOS emitter gate, local polycide, interconnect, load resistor, and poly-thin film transistor in advanced SRAM applications
- New environmental solutions for gases/chemicals

CONCLUSIONS

- The pace of growth will slow until a new product driver or major new market materializes
- The opportunity for companies in a slower growth environment is to provide leading-edge materials as the technology envelope will continue to push out

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Portable PCs: The Race to Get in Your Pocket First!

Nicolas Samaras Principal Analyst

Semiconductor Applications

Markets



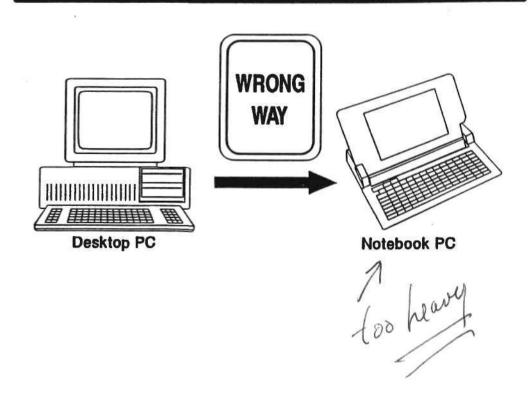
Mr. Samaras is a Principal Analyst in Dataquest's Semiconductor Applications Markets group. He is responsible for both analyzing semiconductor consumption in data processing applications and tracking of trends in nonvolatile memory products and markets. Previously, Mr. Samaras founded Telamon, a marketing and research firm specializing in the emerging Smart Card/Memory Card technology. Prior to that he was Director of the Microcomputer Division of Catalyst Semiconductor Inc. During his tenure at Catalyst, he was the principal developer of a new serial EEPROM architecture (CAT35C704), which was named best of both 1988 and 1989 by *Electronic Design* magazine. Prior to Catalyst, Mr. Samaras spent nine years at National Semiconductor

Corporation in a variety of engineering and marketing positions. Mr. Samaras received a B.S.E.E. degree from McGill University in Montreal, Canada. He is currently pursuing his M.B.A. at the University of Phoenix.

TYPES OF PORTABLE PCs

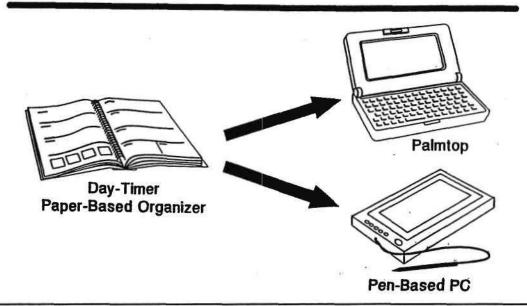
- · Hand-held
- Pen-based
- Notebook
- Laptop

DOWNSIZING



Portable PCs: The Race to Get in Your Pocket First!

EMULATION OF FUNCTION

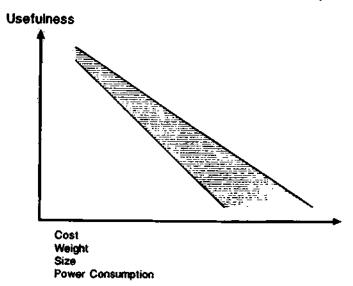


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WHAT IS DRIVING THE PORTABLE MARKET?

- Usefulness
- Ease of use
- Cost

USEFULNESS (PORTABLE PCs)



Portable PCs: The Race to Getin Your Pocket First!

MAN-MACHINE INTERFACE

- Keyboard
- Pen
- Voice
- Hybrids

PID PIE	
PIE	
PIE	
	
	

OPPORTUNITIES

- Semiconductors
- LCD displays + duplay dreven
 Mass storage
 Software

OPPORTUNITIES

- Semiconductors
 - Memories

DRAM

Flash

PSRAM

- Microprocessors 8088/86/286 → 386/486
- ASIC/ASSP
- Telecom
- Mixed-signal

OPPORTUNITIES

- Mass storage
 - Hard disks (form factor)
 - 3.5" → 1.8" → 1.3" → 1.0"
 - Solid-state storage
 - PCMCIA memory card form factor 2-20MB today → 1GB by 1999

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TECHNOLOGY DRIVERS (PORTABILITY NEEDS)

- Improved man-machine interface
 - Pen input
 - Voice input/output
 - Pen-based operating systems (O/S)

TECHNOLOGY DRIVERS (PORTABILITY NEEDS)

- Low-power CMOS ICs 3V now → 1.0V in the future
- Nonvolatile memories and mass storage
 - High-density Flash memories
 - Solid-state disks (Flash)
- Communications hardware
 - Fax, modem, voice ICs
 - Wireless (RF, IR)

Portable PCs: The Race to Get in Your Pocket First!

ENABLING TECHNOLOGIES

- Low-power CMOS ICs (3V going to 1.5 / 1.0V)
- High-density Flash memories 8Mb today → 64Mb by 1995
- High-resolution B/W and color LCD displays
- High-performance / Low-power microprocessors

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ENABLING TECHNOLOGIES (SEMICONDUCTORS)

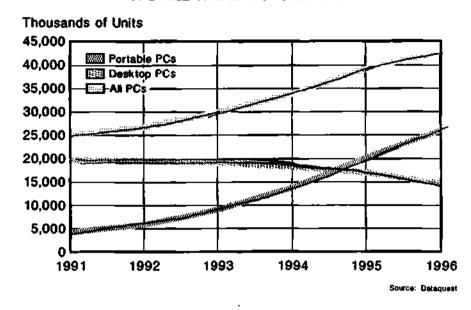
- Highly integrated microprocessors
 - Single-chip 286/386/486 type CPUs + chip set functions
- Flash memories
 - Solid-state disks (SSD)
 - Memory cards PCMCIA
- Data compression ICs
 - Key technology for solid-state storage

ENABLING TECHNOLOGIES (SOFTWARE)

- Pen-based operating systems
- Connectivity / communications software

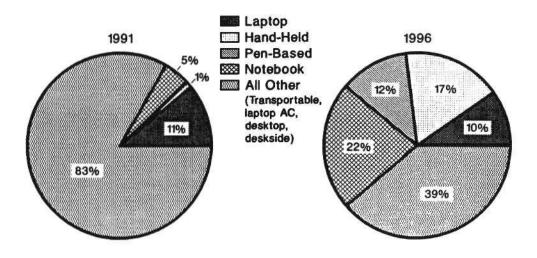
Portable PCs: The Race to Get in Your Pocket First!

WORLDWIDE PC SHIPMENT



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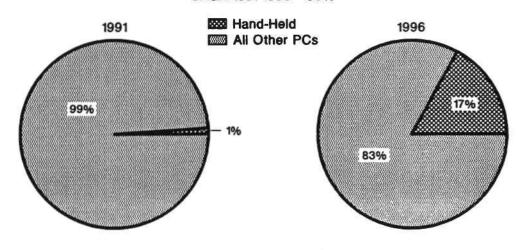
WORLDWIDE PC SHIPMENTS (UNITS)



Source: Dataquest

WORLDWIDE HAND-HELD PC MARKET FORECAST (UNITS)

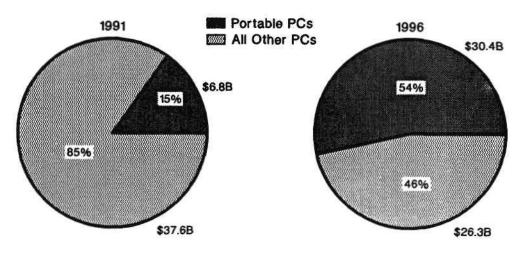
CAGR 1991-1996 = 98%



Source: Dataquest

Portable PCs: The Race to Get in Your Pocket First!

REVENUE FORECAST -- PORTABLE PCs



Source: Dataquest

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COST

(Or what it will take to get into your pocket)

	1992	1996 Est.	
• Hand-Held	\$300-\$1,000	\$280	
• Pen-Based	\$1,500-\$3,000	\$2,300	
 Notebook 	\$1,200-\$3,000	\$1,100	

Source: Detaquest

We are moving toward a wireless distributed computer environment

Portable PCs: The Race to Get in Your Pocket First!

We are entering the era of Personal Information and Communication Devices PICDs

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Lane Mason
Principal Analyst
Semiconductor Memories



Mr. Mason rejoined Dataquest in January 1992. He is responsible for analyzing and forecasting trends in the DRAM and video RAM market. Having helped start Dataquest's memory research in 1978, he served as Senior Memory Analyst from 1981 to 1986. His early efforts established the databases that form the basis of Dataquest's current memory research. Prior to rejoining Dataquest, Mr. Mason was founder of Viking Research, a market research company specializing in strategic alliances and DRAM market research. Mr. Mason has 14 years experience in market research for the semiconductor industry. Mr. Mason received a B.S. degree in Physics from the California Institute of Technology and attended UCLA Graduate School of Economics.

At issue: Will the 1Gb DRAM be a viable product in the marketplace?

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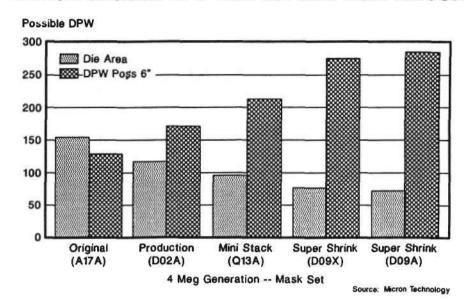
If not, why not and what else?

PROGRAM

- · Why we can do it!
- Yeah, but whaddabout . . .
 alternative technology development directions

	d 402	Curus from	:	☆	16Hb=10.0	0
	E New	lier genera ble DPW AND D	Fix The 1	Gb DRAM: RO	or RIP?	
	1 MEG POSSI	BLE DPW AND D	IE SIZE COM	MPARISON	\$5.50	
	Possible DPW 900 800		Die Area	s 6° (888)	/Mb = 12 \$3,20	0.00
	700 600 500 400 300 200 100	East Shrink Sacord Shr		Hyper Shrink	\$ 3.20 & bottom 256 K \$ 1.80 was flee bettom	
	Original (A10A)	(A10S) (A10U) 1 Meg Generation	(D12A) Mask Set	(D16X) e: Micron Technology	,	
	256Mb	inv. 28/1	Billeon	lachy	unelion	
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4 MEG POSSIBLE DPW AND DIE SIZE COMPARISON



CELL SIZE COMPARISON

Industry-standard EPROM technology versus WSI's patented EPROM technologies

25	17.5	12.5	10.8	7.5
Industry	Virtual	Partitioned	Staggered	Alternate
Standard	Ground	Virtual	Virtual	Metalless
		Ground	Ground	Ground
Design Rules				
$1.2\mu c = 25\mu^2$	$17.5\mu^{2}$	12.5μ²	10.8μ²	$7.5\mu^{2}$
$0.8\mu c = 8\mu^2$	$6.2\mu^{2}$	5.5µ²	4.25µ²	7.5μ² 3.0μ²
			Sauran	Waterscale telegration

Source: Waterscale Integration

Ballestie from Jemostech
The 1Gb DRAM: ROI or RIP?

Over the past 35 years, the cost of integrated circuits has decreased an average of 25-30% per year. The accompanying increase in productivity of over one million times is expected to continue for at least two more decades, well into the 21st Century.

JBM-developed for the per the a of the 466 DD AM

In 1990 an integrated circuit manufacturing facility capable of starting 20,000 wafers per month cost \$400 million. By 1995 the cost will exceed \$1 billion. By 2005 projected costs are in excess of \$2 billion.

CONCLUSIONS

- At the right time, we will invent new technology tools (like we always have)
- We're already far along on 256Mb technology, far in advance of need
- The potential for productivity improvements will draw capital into advanced process development

BUT, WHAT ABOUT

- Economics
- Investment
- Return on investment
- Profit potential
- Opportunity cost

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ECON I

- Companies make products
- Ultimately, products must return a net profit
- Investment returns face lengthy time horizons

Hestory (1570 At 500)

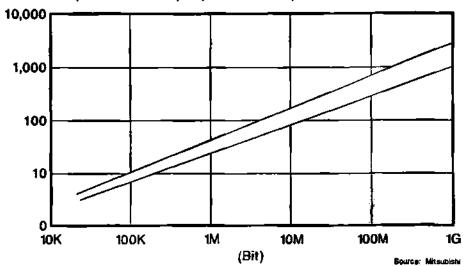
As 1 30%

ECON II -- THE INDUSTRY

- Industry growth slowing
- Process development costs rising
- Capital costs rising
- Bit growth slowing/ PPB decline slowing

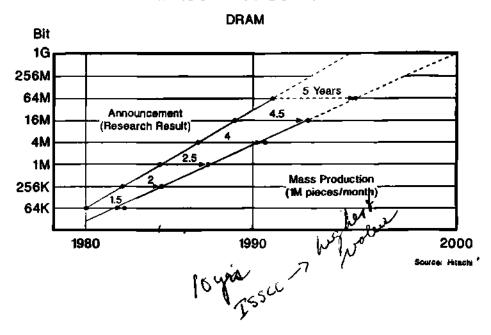
ENORMOUS INVESTMENT

Investment (3M Units/Month) -- (Billions of Yen)



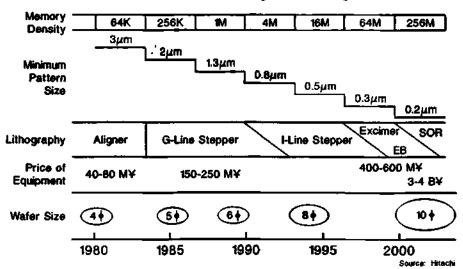
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INCREASING R&D REQUIRES LONGER TIME UNTIL MASS PRODUCTION



CEASELESS TECHNOLOGICAL INNOVATIONS





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Absent a shortage condition in the market, DRAMs will never be

DRAW justy projected from the survey from the project of the proje

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Manufacturing-intensive products (e.g., DRAMs) do not confer sufficient competitive advantage to warrant gigabuck investments.

90% Deone of the super

So what can we do to postpone

Denn & &B

What - Scenaria ?

- Spring femancial Result

- There femancial Result

- The lost many be 6-4 gen

- 18 % 20 People in malt

- 18 % 20 People to drop out

- losh for people to drop

COLLECTIVE ACTION:

Memory Alliances in Action (I)

• Hitachi - T.I

16Mb and 64Mb DRAMs

• Siemens - IBM

16Mb and 64Mb DRAMs

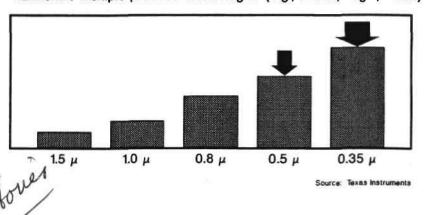
• Toshiba - Motorola MPU for memory

DRAM patents (qualified)

Notes:

R&D COST TRENDS/ACTIONS

- Amortize development cost over more revenue
- Leverage R&D investments and reduce risk (e.g., customers, suppliers, Sematech, Hitachi)
- Harmonize multiple process technologies (e.g., DRAM, Logic, Flash)



IF NOT PRESENT DIRECTION, THEN WHAT?

- Payer metal process Special process -- 3LM in MPU Intel
- Antifuse technology -- Actel
- Architecture -- Intel MPU
- IPR -- Texas Instruments
- Special-Function patents -- WSI, Exel
 Product definition -- Cirrus Logic

51B over

NEXT CONCLUSIONS

- Financial considerations will slow rate of technical development especially in very advanced products
- Collective actions and resource sharing can extend technology development trends--but not indefinitely

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MORE CONCLUSIONS

 Profit requirements will redirect development dollars from sheer "me-too" process- and manufacturing-intensive approaches to less expensive, quicker return, patent-protected specialty processes, methods, architectures, and designs

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