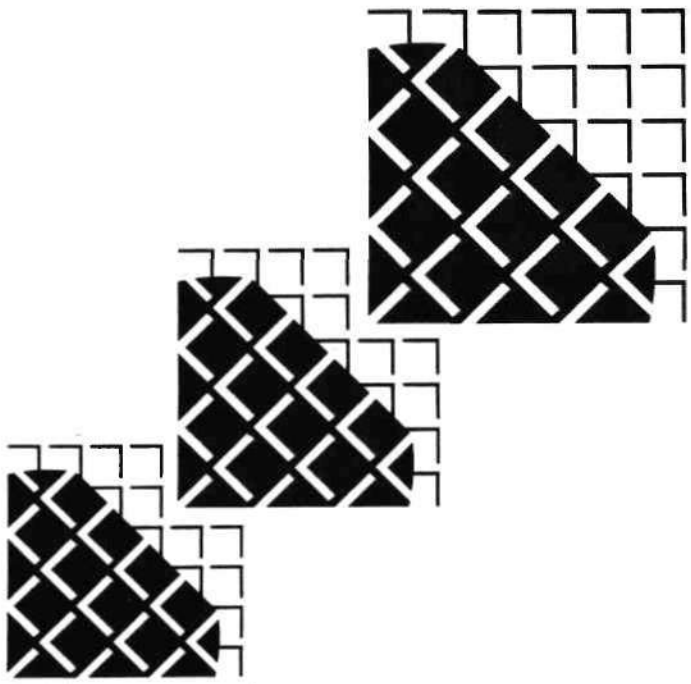
Semiconductor Equipment and Materials Service

The Ninth Annual SEMICON/West Seminar: Status 1990



Dataquest Incorporated

May 23, 1990
Hotel Sofitel San Francisco Bay
at Redwood Shores

Dataquest
a company of
The Dun & Bradstreet Corporation

THE NINTH ANNUAL SEMICON/WEST SEMINAR: STATUS 1990

May 23, 1990

AGENDA

7:00–8:00 a.m.	**Registration and Continental Breakfast**
8:00 a.m.	**Welcome and Introduction** Joseph Grenier Director Semiconductor Equipment and Materials Service
8:10 a.m.	**Electronic Equipment Outlook and the Next PC Boom** Terrance Birkholz Semiconductor User and Applications Group
8:40 a.m.	**Semiconductor Industry Status** David Angel Vice President and Director Semiconductor Industry Service
9:10 a.m.	**New Manufacturing in the Submicron Decade** Mark Reagan Semiconductor Equipment and Materials Service
9:40–9:55 a.m.	**Break**
10:00 a.m.	**Some Key Performance Measures of the Semiconductor Equipment Industry** Joseph Grenier Director Semiconductor Equipment and Materials Service
10:30 a.m.	**Fab Equipment Trends in the '90s** Krishna Shankar Semiconductor Equipment and Materials Service
11:00 a.m.	**Staying in the Materials Race through the '90s** Mark FitzGerald Semiconductor Equipment and Materials Service
11:30 a.m.	**Trends in Packaging** Stan Bruederle Vice President Components Group Consulting
	Adjourn

SEMINAR INFORMATION

Location

Hotel Sofitel San Francisco Bay at Redwood Shores
223 Twin Dolphin Drive, Redwood City, California 94065
Telephone (415) 598-9000

1290 Ridder Park Drive, San Jose, CA 95131-2398 (408) 437-8000 Telex 171973 Fax (408) 437-0292

Dataquest

a company of The Dun & Bradstreet Corporation

1990 SEMICON/WEST SEMINAR QUESTIONNAIRE

In order to continually improve the Semiconductor Equipment and Materials SEMICON/West Seminar, we need to better understand your information needs. Please help us by completing the following questionnaire. We would appreciate it if you would list your company name and/or attach your business card.

---

1. Is your company a Dataquest client? ____Yes ____No

2. Which of the following best describes your company's primary activities?

   _____Semiconductor manufacturer

   _____Semiconductor equipment supplier, Front end ____, Back end____

   _____Semiconductor materials supplier

   _____Other_____
   (Please specify)

3. Which of the following best describes your position/title?

   _____CEO, President, Vice President

   _____Strategic Planning/Business Development

   _____Sales and Marketing Management

   _____Product Development/R&D/Engineering Management

   _____Other_____
   (Please specify)

4. How did you learn about this seminar?

   _____The brochure was mailed directly to me

   _____Someone in my company gave me the brochure

   _____Someone from Dataquest called me

   _____Other_____
   (Please specify)

1290 Ridder Park Drive, San Jose, CA 95131-2398 (408) 437-8000 Telex 171973 Fax (408) 437-0292

5. Please list your main reasons for attending this seminar:

_____

_____

	Highest				Lowest
6. How well did the seminar meet your objectives?	5	4	3	2	1

7. In the future, should the length of this seminar be:
_____Shorter _____Longer _____About the same?

What is the best day and time to hold the seminar?
_____ Day _____ Time?

Please comment on this location?

_____

_____

8. Please rate the speakers and their speech content:

	Speaker Delivery					Speech Content				
	Highest				Lowest	Highest				Lowest
Terrance Birkholz	5	4	3	2	1	5	4	3	2	1
Dave Angel	5	4	3	2	1	5	4	3	2	1
Mark Reagan	5	4	3	2	1	5	4	3	2	1
Joseph Grenier	5	4	3	2	1	5	4	3	2	1
Krishna Shankar	5	4	3	2	1	5	4	3	2	1
Mark FitzGerald	5	4	3	2	1	5	4	3	2	1
Stan Bruederle	5	4	3	2	1	5	4	3	2	1

9. Topics you would like to hear about at next year's seminar:

_____

_____

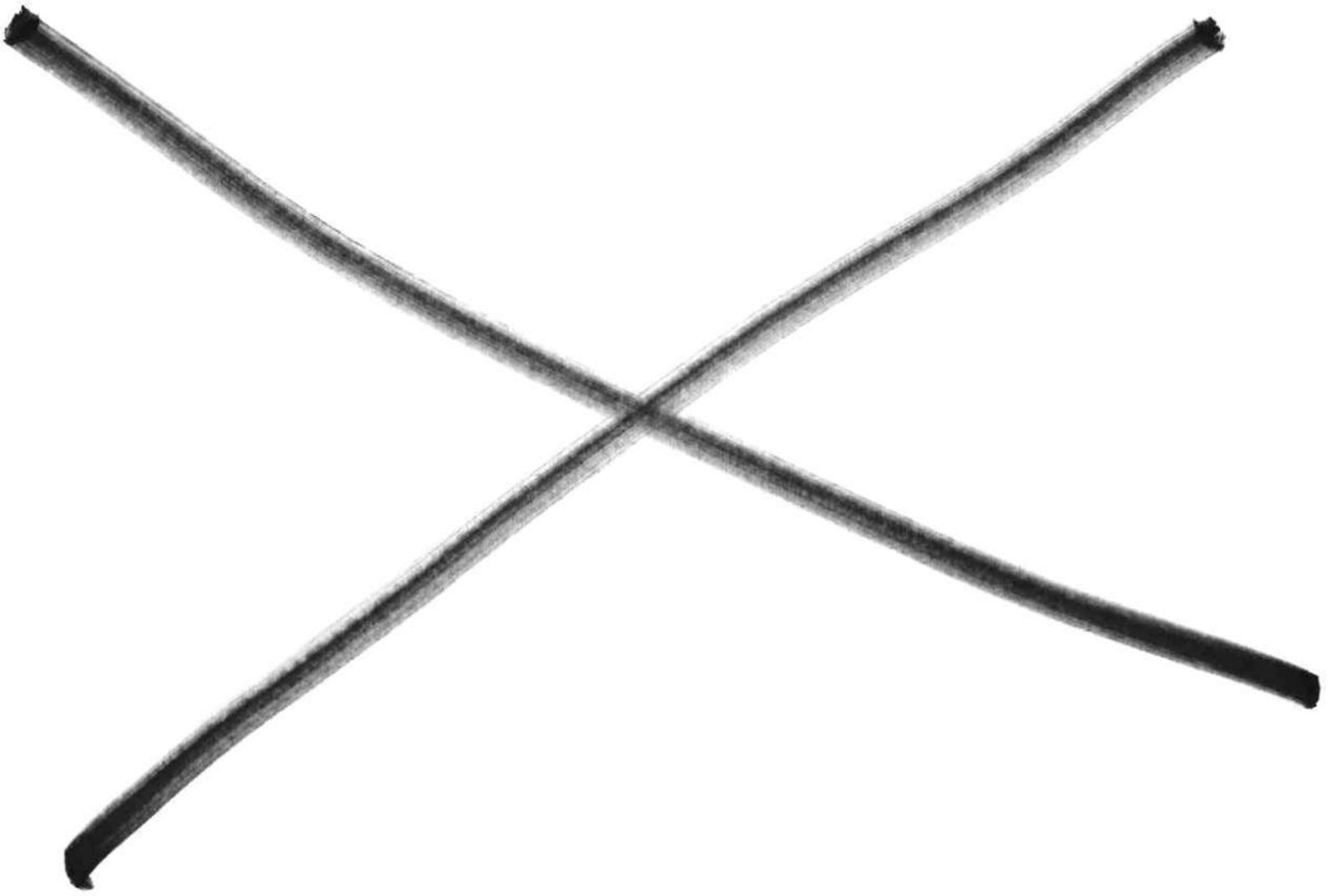
10. Please use this space for your comments on any aspect of our seminar:

_____

_____

_____

Name_____
(Optional)



Dataquest

a company of The Dun & Bradstreet Corporation

SEMICON/West Seminar
May 23, 1990
Redwood City, California

List of Attendees

AG Associates	Donald M. Yoshikawa, Marketing Manager
ASM International N.V.	Herbert Lakens, Director Marketing
ATEQ Corporation	Barry Cox, President Monty Zach, Marketing Administrator
Air Products & Chemicals, Inc.	Dean Duffy, International Business Manager Stephen Hensler, Commercial Manager Bob Nolan Robert Shay, Commercial Development Manager
Airco/BOC	Philip Blakey, Vice President of Electronics
Applied Materials, Inc.	Dana C. Ditmore, Vice President, Customer Service Division Michael George, Director of Marketing Dennis Hunter, Director, Corporate Development Noella Kwan, Research Analyst David Orgill, Manager, Investor Relations Dave Reis
Aseco Corporation	Ken Lee, Vice President Engineering
Ashland Chemical Company	James A. Duquin, Vice President & General Manager, Electronic & Lab Products
Assembly Technologies	Joseph Savarese, Vice President and General Manager
Bandgap Technology Corporation	Volker Heilmann, Vice President & General Manager

1290 Ridder Park Drive, San Jose, CA 95131-2398 (408) 437-8000 Telex 171973 Fax (408) 437-0292

Bank of Boston	Elizabeth Everett, Assistant Vice President Oscar Jazdowsky, Director
Bank of the West	Thomas A. Hannen, Assistant Vice President
Bertram Laboratories, Inc.	Les G. Polgar, Vice President, Marketing & Sales
Branson International Plasma Corporation	Lou Perrone, Vice President, Marketing & Technology
Brooks Instruments	Joseph Dille, Product Manager Harry Lund, Vice President, Sales
Cybeq Systems	Kanegi Nagai, President and Chief Executive Officer
Daifuku U.S.A. Inc.	Takehide Hiyashi, Section Manager Hajime Maeda Sam Nakajima, Sales Manager
Delta Design Inc.	Jim Donahue, President
Dexter Electronic Materials	Ron Benham, President
DuPont Photomasks, Inc.	Bob Machado, Technical Service Manager
E.I. DuPont de Nemours & Company	Neil Washburn, Senior Development Specialist, Specialty Polymer Division
ESEC USA Inc.	Gary Spray, Vice President and General Manager
Eaton Corporation	Carl Noblitt, Director, Marketing Geoffrey Ryding, Vice President & Director, Marketing, Sales & Services, Semiconductors

Edwards High Vacuum International	Ameeta Soni, Product Marketing Manager
Electro Scientific Industries, Inc.	Russ Schlager, Product Manager
Equitable Lomas Leasing Corporation	Chuck Beckmire, Vice President & Director, Vendor Programs Louie Coffman, Executive Vice President, Operations Dean Cuplin, Vice President, Manufacturer/Vendor Products Paul Edstrom, Vice President, Equipment Steven Grundon, Vice President, Marketing Services Colleen Lusian, Assistant Vice President, Equipment Evaluation Mike Mardesich, Appraiser John McEwen, Account Representative Ellie Sanchez, Market Research Manager
FSI International	Walt Kalin, Director of Marketing Laurie Walker, Communications Manager
First Interstate Bank	Robin Apple Linda Ometer Pam Robichaux Marc J. Verissimo, Vice President
GCA Corporation	Gary A. Mezack, Vice President, Marketing
General Signal/Xynetics	Nancy McKereghan, Market Analyst Gordon C. Westwood, Vice President, Marketing
Genus, Inc.	Ron Dornseif, Vice President, Corp. Excellence Program William W.R. Elder, President and Chief Executive Officer Robert McGeary, Vice President, Marketing and Sales
Hewlett-Packard Company	James K. Lee, Procurement Engineer

Hughes Aircraft Company	Gordon Chang, Manager, DMS Integrated Solutions Rich Cimino, Director of Sales & Marketing
Intel Corporation	Joe Louie, Q & R Manager Jacques J. Vuye, Manager, Competitive Analysis
KTI Chemicals, Inc.	Dave Zaring, Technical Marketing Manager
Kobe Development Corporation	Takeo Tanaka, General Manager
Kokusai Electric Co., Ltd.	Noriaki Yamamoto, Assistant Marketing Manager
Kulicke & Soffa Industries, Inc.	Ron Clunk, Director of Corporate Marketing Asuri Raghavan, Director of Business Division
Kyocera America, Inc.	Chuck E. DeMars, Vice President, Microelectronics Division
Lam Research Corporation	Henk Evenhuis, Senior Vice President, Finance & CFO Debbie McGovan, Manager, Investor Relations John Osborne, Senior Vice President, Strategic Development
Liquid Air Corporation	Denis Rufin, Manager of Technology
Lumonics Corporation	Pat Austin, President, Marking Systems Division
Materials Research Corporation	Irwin Grater, Director of Marketing
Matheson Gas Products	Pat Carlucci

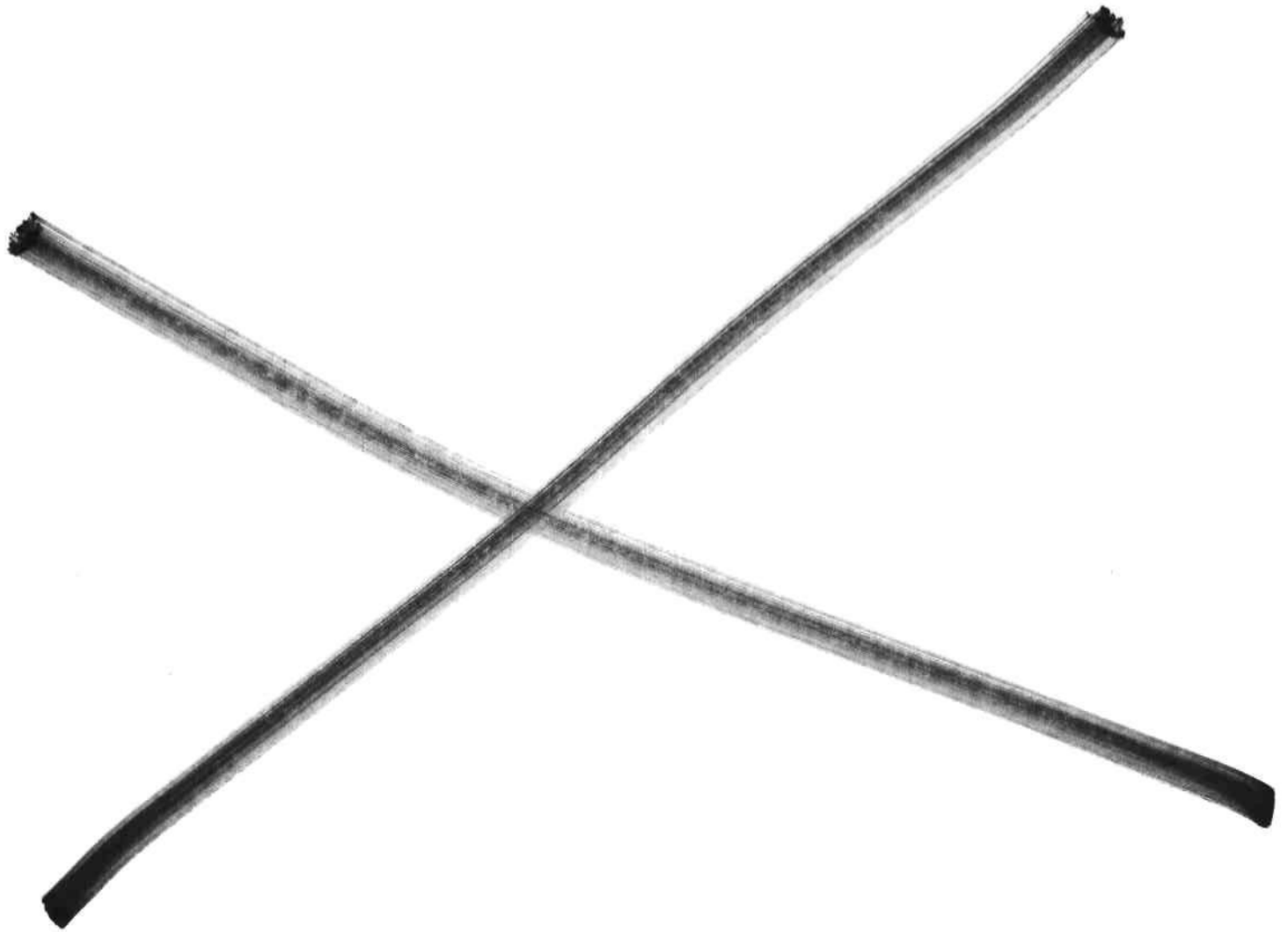
Mattson Technology, Inc.	Ralph Martin, Vice President of Engineering Brad Mattson, President
Meissner+Wurst GmbH+Co	Jurgen Giessmann, Managing Director
Micro Mask	Bob Jaynes, Corporate Vice President, Marketing & Sales Russ Weiss, Executive Vice President and COO
Mitel Corporation	Luc Gagnon, Product Marketing Manager
Mitel Semiconductor	Gord Harling, Director, Process R&D
Mitsubishi Semiconductor America Inc.	Tad Mizoguchi, President
Montgomery Securities	Jonathan Joseph Tom Thornhill, Vice President
NBK Corporation	Joseph Arruda, Director of Sales and Marketing
NCR Corporation	Timothy P. McCarthy, Director of Manufacturing
Nikon Precision, Inc.	David Kettering, Product Line Manager
Oki Electric Industry Co., Ltd.	Jim Cantore, Manager, Strategic Marketing
Osaka Sanso Kogyo, Ltd.	Michael Solomon, General Manager Electric Gases, The BOC Group
Outokumpu Corporation	Asko Vehanen, Development Manager
Pall Ultrafine Filtration Corp	Reed Sarver, Electronics Sales Manager

Price Waterhouse Technology	Paul Turner, Director
Prism Technologies, Inc.	Bobby Greenberg, President Bob Williams
Prometrix Corporation	Steve Westrate, International Marketing Manager
Prudential-Bache Capital Funding	Mark Edelstone, Junior Semiconductor Analyst
Prudential-Bache Securities	Chad Keck, Managing Director
Ramtron Corporation	Jon Downing, Logistics & Acquisitions Manager
Rapro Technology, Inc.	Tom Kandris, Vice President, Sales/Service
Raychem Corporation	Charles K. Cheng, Marketing Manager
Rudolph Research	Richard L. Budzinski, Director of Sales
SEEQ Technology, Inc.	Michael Van Hoy, Vice President of Marketing
SEMATECH	Michael Stark, Competitive Analyst
Samsung Semiconductor & Tel. Co., Ltd.	S. L. Choi, Senior Planning Manager Kyung W. Kim, Planning Manager
Sandia National Laboratories	Douglas L. Weaver, Department Manager, 2130
Security Pacific Bank	Joe Foster, Vice President
Seiko Instruments USA, Inc.	Hiroshi Fukino, Chairman and Chief Executive Officer

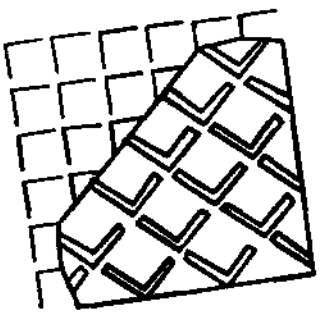
Semiconductor Services	Katherine B. Evans, Customer Relations
Semiconductor Systems, Inc.	Eric Hsu, Sales Manager
Signetics Corporation	Jim Bilham-Boult, Senior General Management Staff, Die Manufacturing Operations
Solid State Measurements, Inc.	John Snyder, Marketing Manager
Sumisho Electronic Systems, Inc.	Hiroshi Ishiwata, Sales & Marketing Manager
Swagelok Company	Donald Levengood, General Manager, Nupro Company David M. Simko, Manager, Marketing
Taiwan Semiconductor Manufacturing Co., Ltd.	Klaus C. Wiemer, President
Temescal	Russell J. Hill, Director, Technology
Tencor Instruments, Inc.	Dale Guidoux, International Accounts Manager John Scott, Vice President Roberta Wong, Marketing Communications Manager
Teradyne, Inc.	James Prestridge, Vice President
Texas Instruments, Inc.	Pallab Chatterjee, Vice President, Corporate Staff Graydon Larrabee, Director, MMST Program
Therma-Wave, Inc.	Charles Shalvoy, President and Chief Operating Officer
Toppan Electronics USA Inc.	Teruo Hisano, President

Toshiba America Electronic Components, Inc.	Kin Tang, Product Marketing Engineer
Tosoh SMD, Inc.	Steven L. Bardus, Product Manager
Tracor Northern, Inc.	Robert Hirche, National Sales Manager, Electron Beam Instruments
Ultratech Stepper, Inc.	Kay Mascoli, Director of Marketing & Research, Government Relations
Union Bank	Frank Hall, Vice President Anthony Kwee, Assistant Vice President Ed Schultz, Regional Vice President James Weber, Vice President
Union Carbide Chemicals & Plastics Co.	Mike Bilancetti H. Parks Brame Bill Gittere Jan Maurits Bob Ricciardi James L. Young
Union Carbide Corporation	Thomas Nelson, Applications Manager, Electronics Walter Willett, National Sales Manager
Union Carbide Industrial Gases Inc.	Bill Schmeh, Region Sales Manager Thomas L. Singman, Marketing Manager
United Microelectronics Corporation	Alvis Ho Wei-Jyh Liu
Varian Associates	James Crosskill, Planning Specialist Steve Jensen, Vice President, Marketing
Watkins-Johnson Company	John F. Lunden, Manager, Commercial Equipment Development
Weitek Corporation	Jim Gay, Manager, Business Development

Westech Systems Inc.	Dave Anderson, Marketing and Sales Manager
Zilog, Inc.	Michael Bradshaw, Vice President of Operations Larry Thomas
Zitel Corporation	Karl Schiavo, Purchasing Supervisor



Dataquest's Ninth Annual
SEMICON/West Seminar
Status 1990
May 23, 1990



Electronic Equipment Outlook and the Next PC Boom

Terrance A. Birkholz

Industry Analyst
Semiconductor User and Applications Group
Dataquest Incorporated

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

- Near-term outlook
- Long-term outlook
- Summary

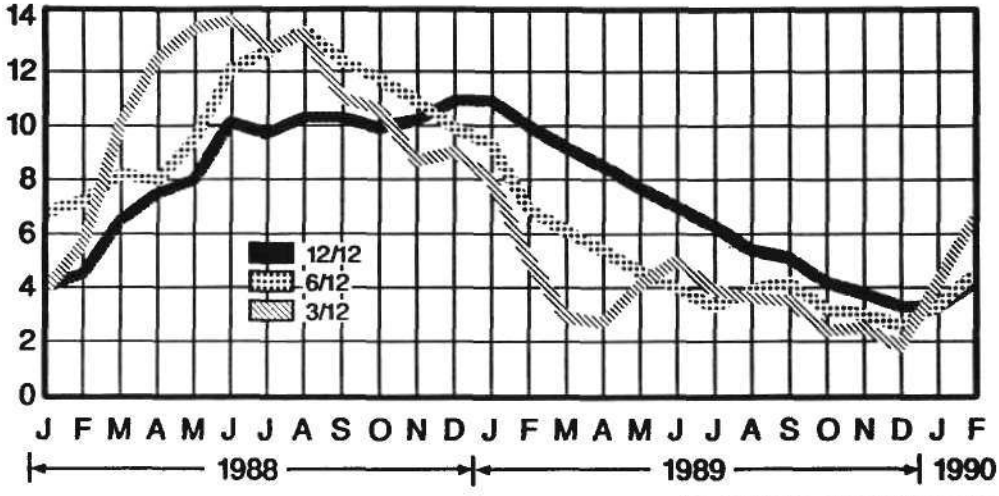
NEAR-TERM OUTLOOK

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

U.S. COMPUTERS AND OFFICE EQUIPMENT

Shipments Growth (1988-1990)

Percent Change

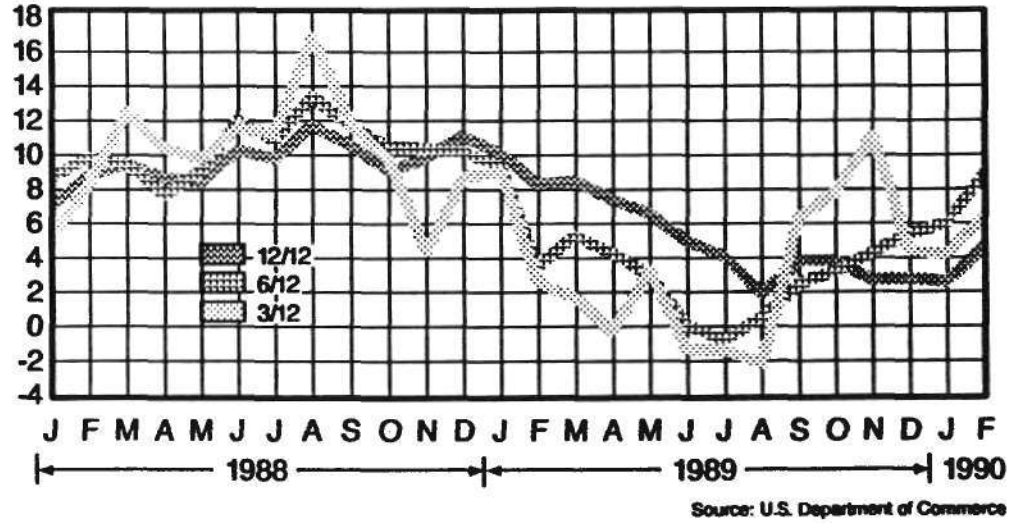


Source: U.S. Department of Commerce

U.S. COMPUTERS AND OFFICE EQUIPMENT

Orders Growth (1988-1990)

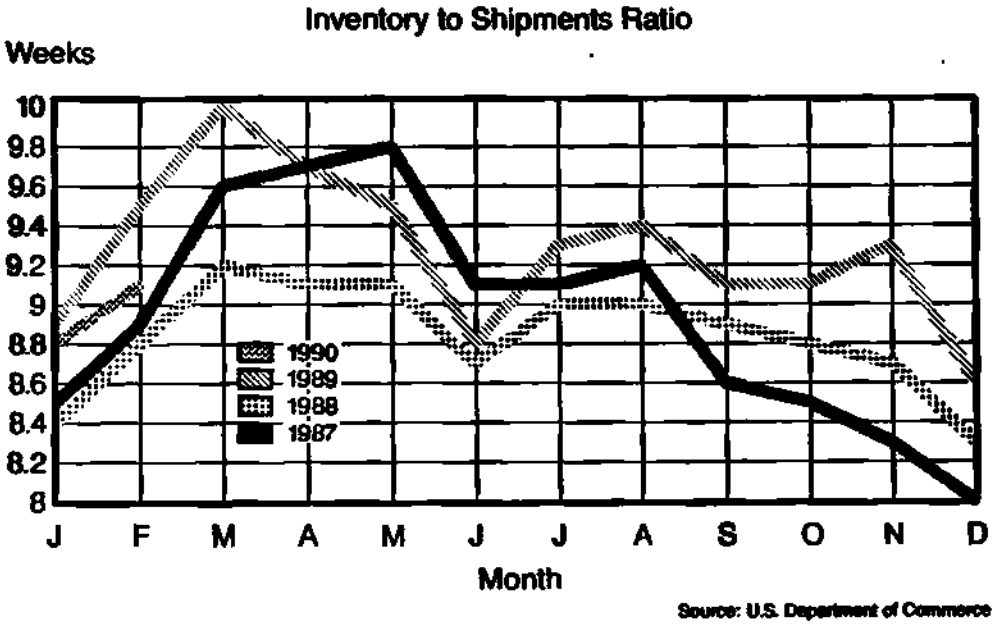
Percent Change



Source: U.S. Department of Commerce

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

U.S. COMPUTERS AND OFFICE EQUIPMENT



Source: U.S. Department of Commerce

U.S. COMMUNICATIONS EQUIPMENT

In February:

- Three-month-ended orders: 11.1% above year-earlier orders
- Three-month-ended shipments: 10.5% above year-earlier shipments
- Inventory at 9.9 weeks was 1.1 weeks less than February 1989

Dataquest expects:

- Orders growth to stabilize
- Shipments growth to remain brisk, then stabilize

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

U.S. INSTRUMENTS

In February:

- Three-month-ended orders: 6.1% above year-earlier orders
- Three-month-ended shipments: 3.6% above year-earlier shipments
- Inventory at 10.4 weeks was 0.4 week less than February 1989

Dataquest expects:

- Upcoming months to be marked by relatively stable growth

ELECTRONIC EQUIPMENT PRODUCTION FORECAST

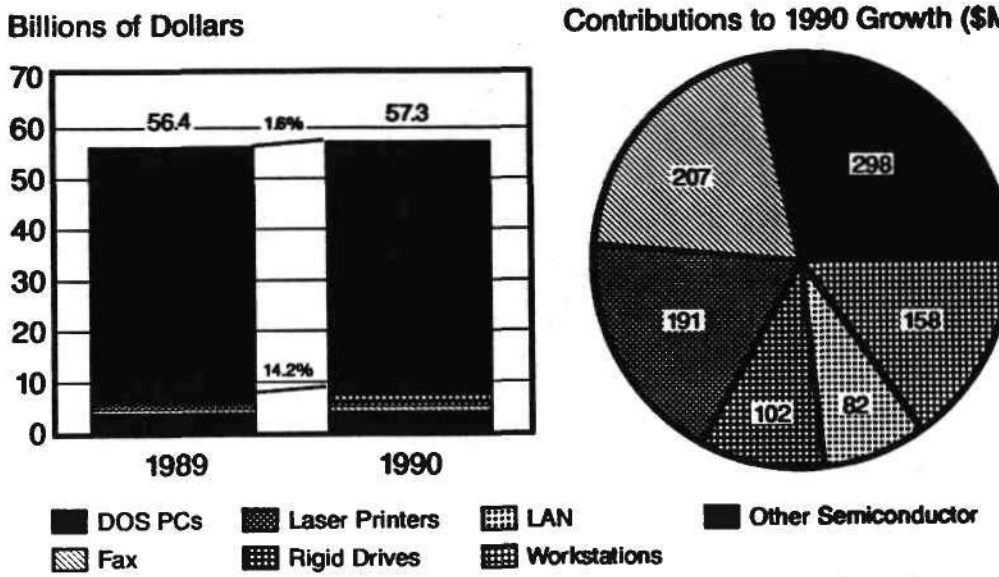
(Billions of Dollars)

	1989	1990	%Δ
Total Worldwide	653.1	689.7	5.6
North America	269.2	285.0	5.8
Japan	181.1	183.7	1.4
Europe	149.0	159.6	7.1
Asia/Pacific	53.8	61.5	14.3

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

NEAR-TERM SEMICONDUCTOR MARKET DRIVERS

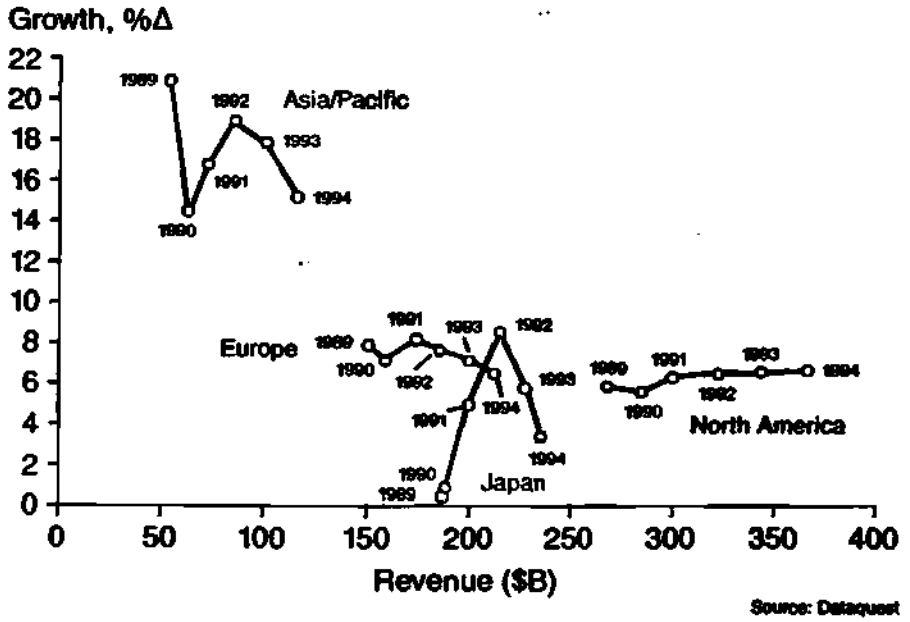


Source: Dataquest

LONG-TERM OUTLOOK

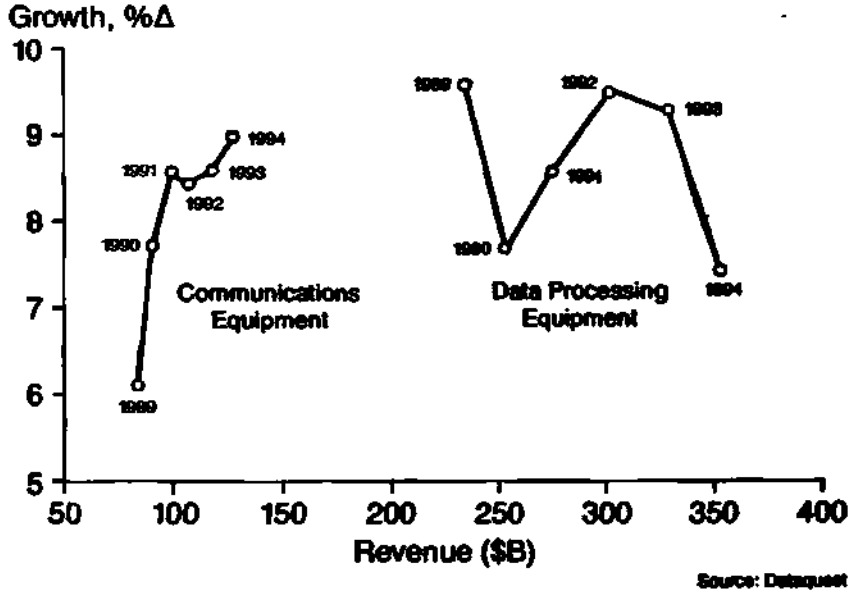
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

ESTIMATED WORLDWIDE ELECTRONIC EQUIPMENT PRODUCTION OUTLOOK BY REGION



Source: Dataquest

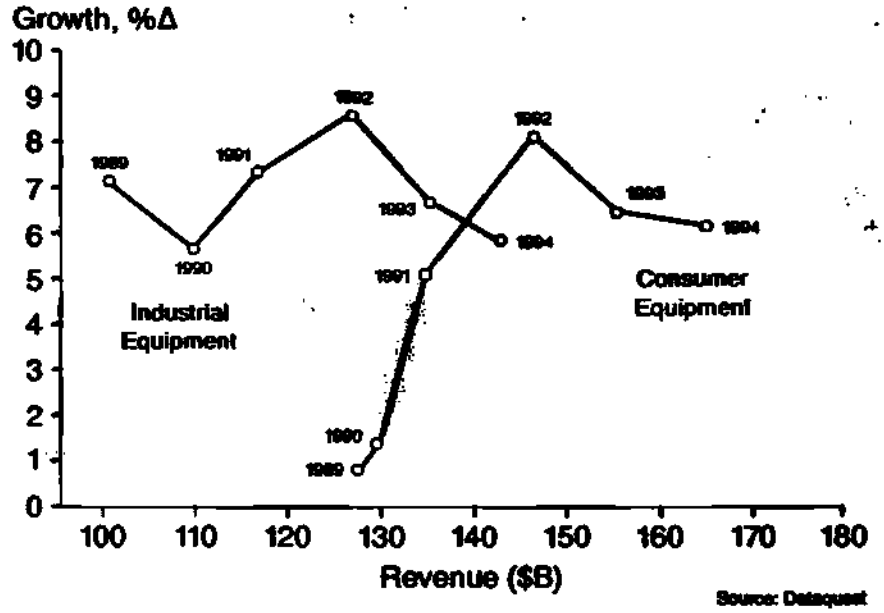
ESTIMATED WORLDWIDE ELECTRONIC PRODUCTION OUTLOOK



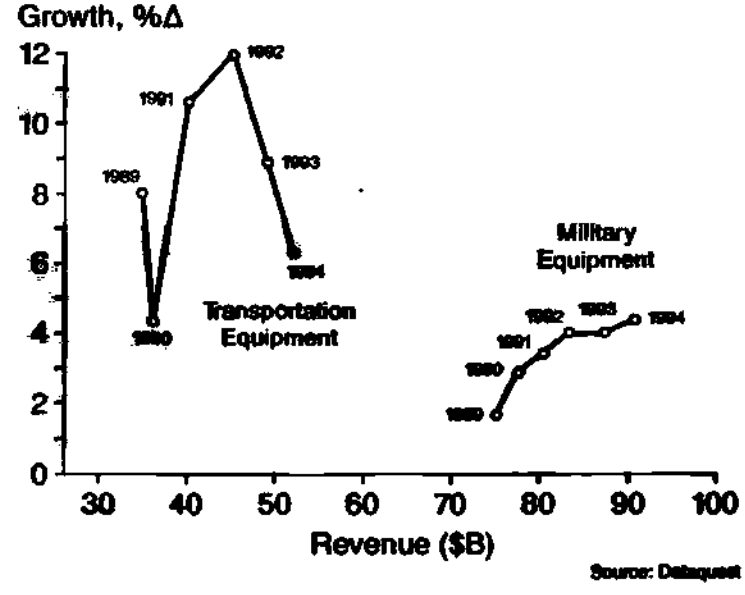
Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

ESTIMATED WORLDWIDE ELECTRONIC EQUIPMENT PRODUCTION OUTLOOK

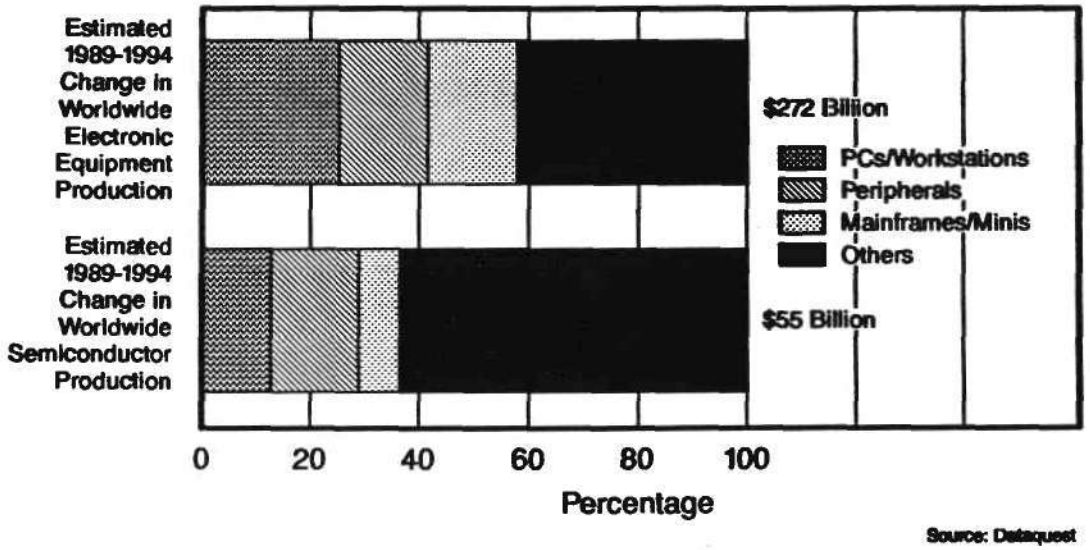


ESTIMATED WORLDWIDE ELECTRONIC EQUIPMENT PRODUCTION OUTLOOK



Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

LONG-TERM SEMICONDUCTOR MARKET DRIVERS



Source: Dataquest

WORLDWIDE LONG-TERM OUTLOOK

- Electronic equipment production growth to accelerate to 7.3% in 1991 from 5.4% in 1990
- Growth to peak at 8.6% in 1992
- Noncomputer semiconductor growth up sharply
- Greatest semiconductor growth opportunities within data processing – smart peripherals and subsystems
- Asia/Pacific and Japan are fastest-growing regions in 1992
- Rising trade protectionist sentiment and production cost minimization necessitate evenly distributed, regionalized production
- Eastern Europe and China – emerging markets (?)

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

SUMMARY

In the near term:

- 5.4% worldwide electronic equipment production growth forecast in 1990
- Semiconductor consumption fueled by a few healthy application markets
  - (0.7%) worldwide overall semiconductor consumption growth
  - 3.6% worldwide nonmemory semiconductor consumption growth

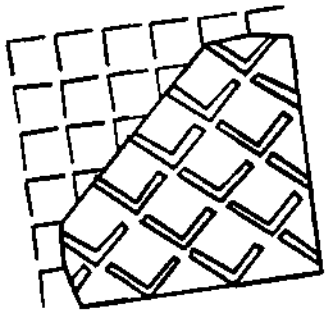
In the long term:

- 8.6% worldwide electronic equipment production peak growth forecast in 1992
- PC boom extending to smart peripherals

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

Dataquest's Ninth Annual
SEMICON/West Seminar
Status 1990
May 23, 1990



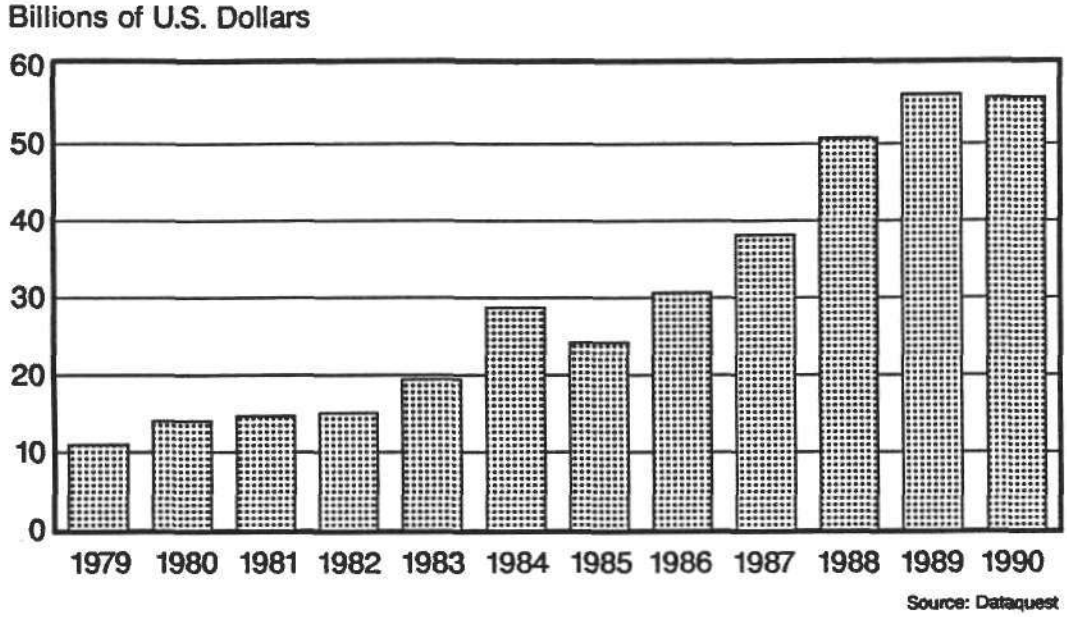
Semiconductor Industry Status

David L. Angel

Vice President and
Director of Worldwide Research
Semiconductor Industry Service
Dataquest Incorporated

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

WORLDWIDE SEMICONDUCTOR MARKET

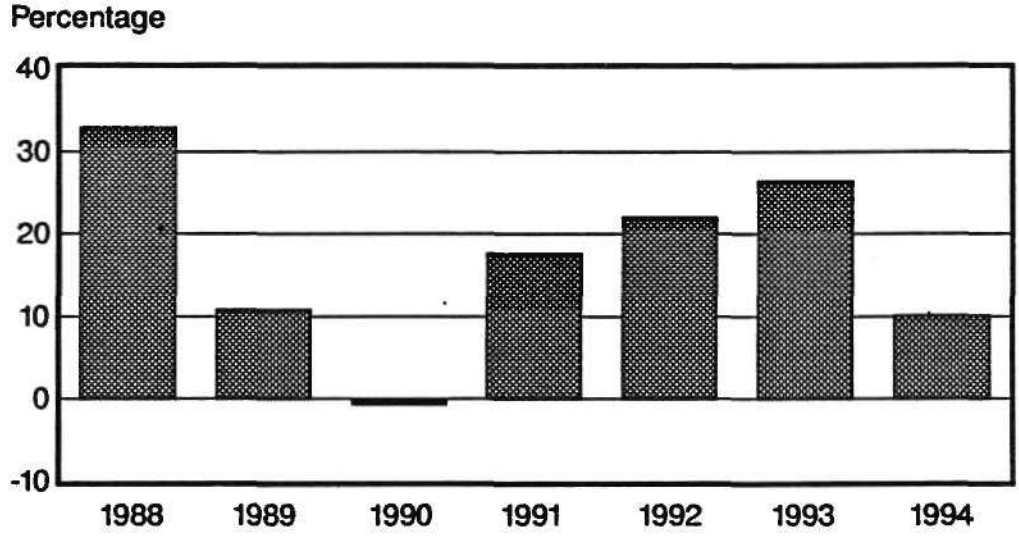


Source: Dataquest

Forecast: 1990 and Beyond

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

WORLDWIDE SEMICONDUCTOR INDUSTRY REVENUE GROWTH FORECAST



Source: Dataquest

OUTLOOK

- Peak of next boom will be in 1993
- Market will surpass $100 billion in 1993
- MOS memory will remain fastest-growing segment
- Bipolar digital memory and logic will continue to decline due to BiCMOS alternative
- Stabilizing factors now occurring
- 1990: A year of challenges

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

REGIONAL OUTLOOK

North America

- CAGR 1989-1994 ~15% (1990 down 3%)
- Slow, steady growth
- Slower GNP growth in 1990 than in 1989
- Workstations, PCs, laser printers, rigid disk drives are market drivers
- Will grow slightly faster than Japan through 1994
- Will remain second-largest market through 1994
- Consolidation will become significant

Source: Dataquest

REGIONAL OUTLOOK

Japan

- CAGR 1989-1994 ~13.5% (1990 down 2.0%)
- Flat market in 1990
- Changing from export-driven to domestic demand-driven economy
- Will remain largest market through 1994
- Will be slowest-growing market through 1994
- Fax machines, laser printers, PCs are driving markets
- China's political instability hurting Japanese exports
- GNP will remain strong in 1990

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

REGIONAL OUTLOOK

Europe

- CAGR 1989-1994 ~15% (1990 up 2%)
- PCs will continue to be market driver
- Fierce PC and DRAM competition from Asian suppliers
- GNP growth will be faster than in U.S., although U.K. is suffering
- Long-term growth equal to North America
- Will maintain market size position at #3 through 1994, in spite of Asia/ROW

Source: Dataquest

REGIONAL OUTLOOK

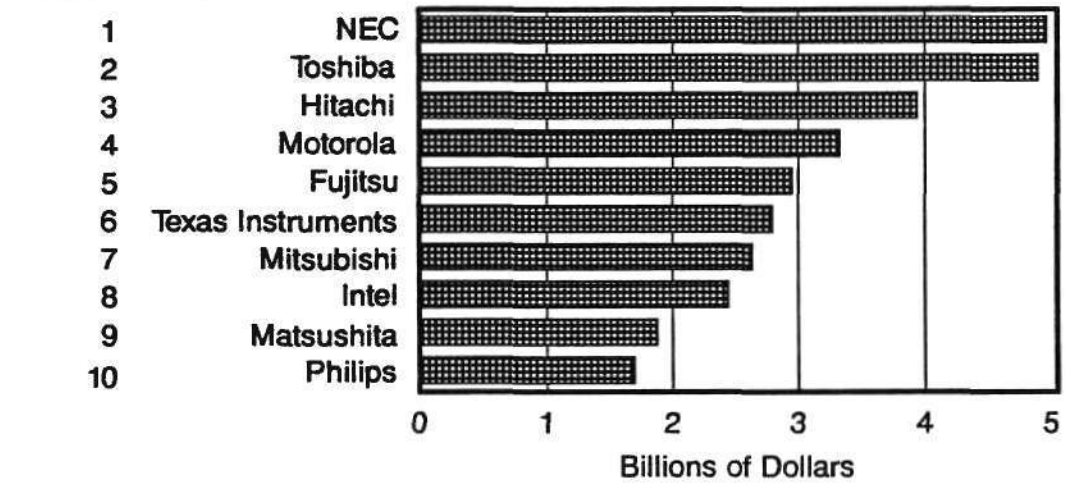
Asia/Pacific

- CAGR 1989-1994 ~20.1% (1990 up 6.0%)
- Personal computers are the name of the game in Taiwan
- Mergers, acquisitions, marketing channels are key
- Domestic demand picking up volume from decelerating exports
- Hong Kong companies moving some operations to Thailand and Malaysia
- Fastest-growing market through 1994
- Will remain smallest market through 1994

Source: Dataquest

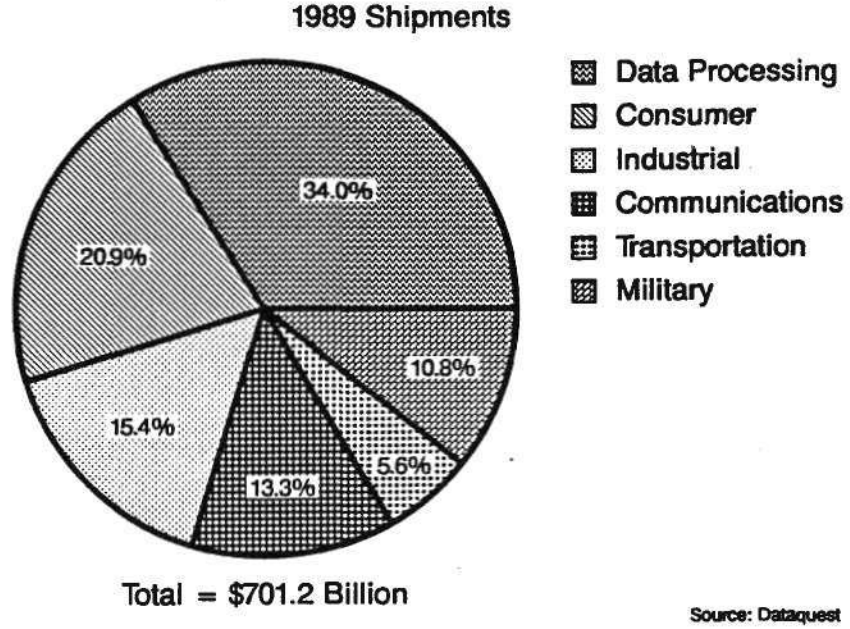
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

TOP 10 MERCHANT SEMICONDUCTOR COMPANIES' WORLDWIDE REVENUE IN 1989



Source: Dataquest

WORLDWIDE ELECTRONICS MARKETS



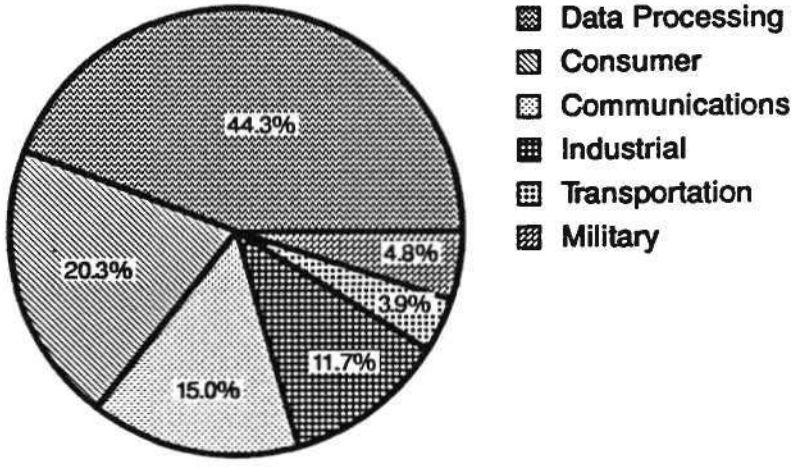
Total = $701.2 Billion

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

WORLDWIDE SEMICONDUCTOR CONSUMPTION BY APPLICATION MARKET

1989

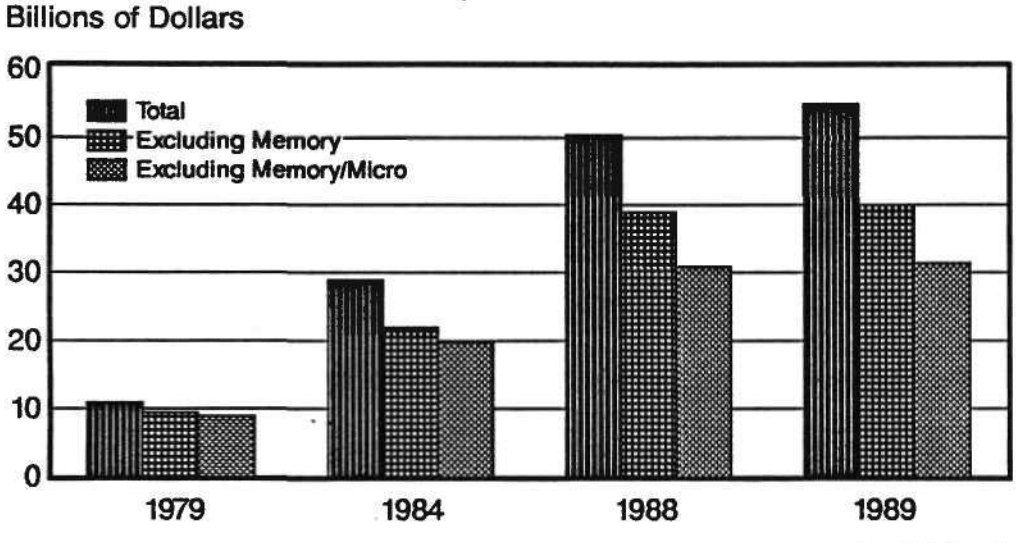


Total = $57.0 Billion

Source: Dataquest

1989: ANATOMY OF A MARKET

Memory and Micros: The Industry Drivers



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PRODUCT FORECASTS

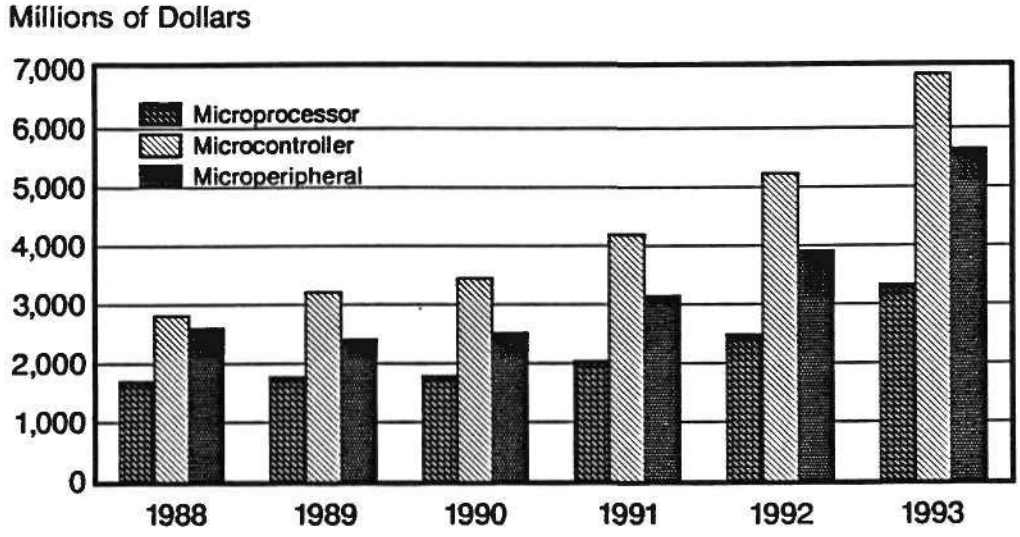
Memory	***Micros***
ASIC	***Analog***

PRODUCT FORECASTS

	Micros

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

WORLDWIDE MOS MICROPROCESSOR FORECAST



Source: Dataquest

1989 WORLDWIDE MOS MICROCOMPONENTS TOP 10 SUPPLIERS

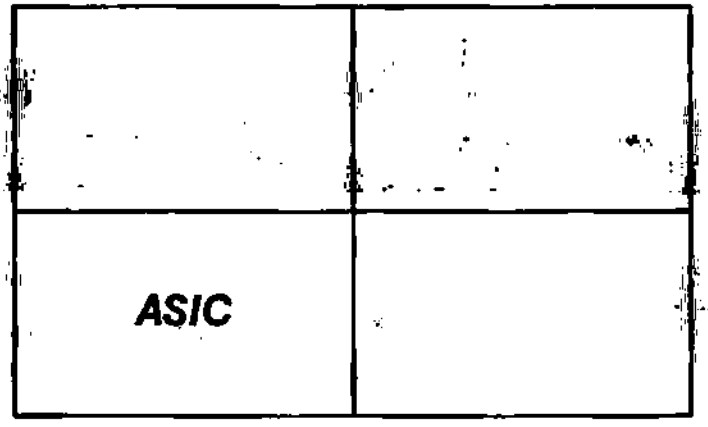
(Millions of Dollars)

1989 Ranking	1988 Ranking		1988 Revenue	1989 Revenue	Percent Change	1989 Market Share
1	1	Intel	1,835	1,929	5%	23.5%
2	2	NEC	790	937	19%	11.4%
3	3	Motorola	699	803	15%	9.8%
4	4	Hitachi	525	554	6%	6.8%
5	5	Mitsubishi	381	435	14%	5.3%
6	6	Toshiba	346	407	18%	5.0%
7	7	Texas Instruments	234	252	8%	3.1%
8	8	Matsushita	230	217	(6%)	2.6%
9	13	Chips & Technologies	130	216	66%	2.6%
10	9	Fujitsu	202	211	4%	2.6%

Source: Dataquest

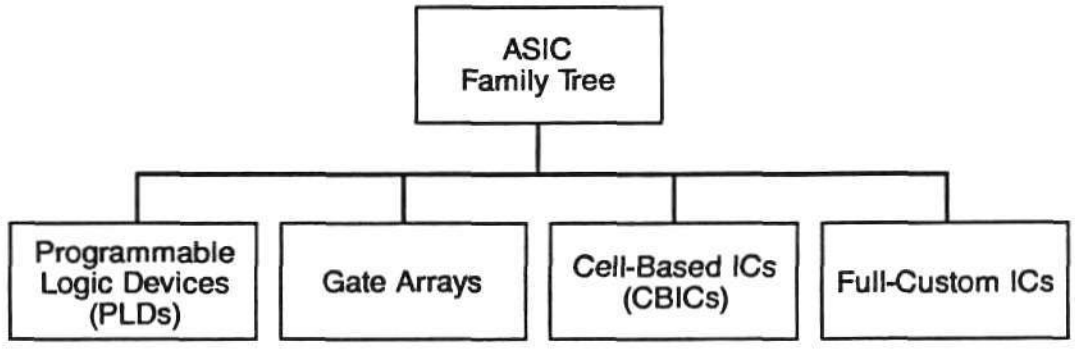
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PRODUCT FORECASTS

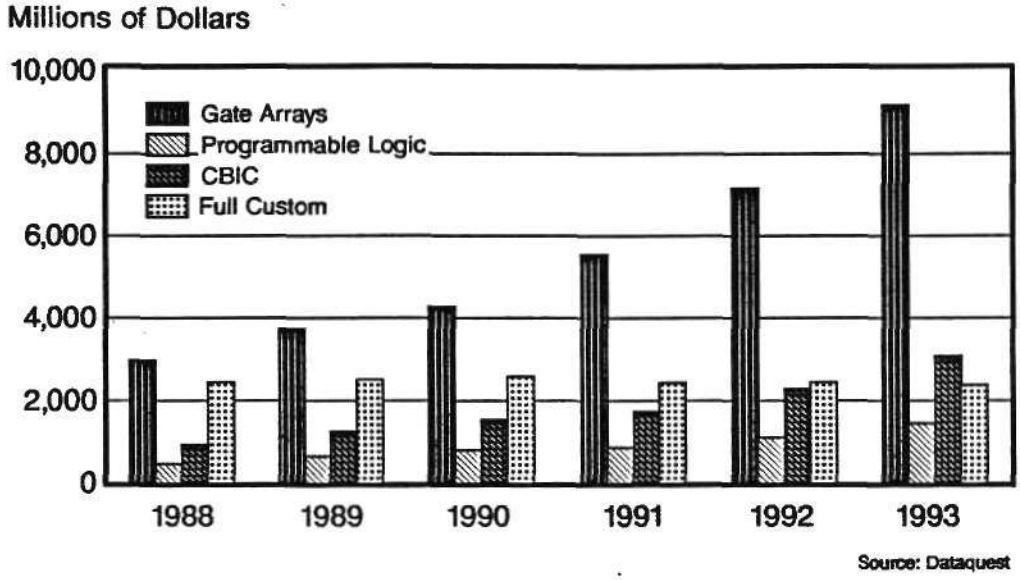


Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

ASIC FAMILY TREE



ESTIMATED WORLDWIDE ASIC CONSUMPTION BY TECHNOLOGY



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

1989 WORLDWIDE ASIC TOP 10 SUPPLIERS

(Millions of Dollars)

1988 Rank	1989 Rank		Gate Arrays	CBICs	PLDs	Total
1	1	Fujitsu	621	48	0	669
2	2	NEC	548	27	0	575
3	3	LSI Logic	420	37	0	457
4	4	Toshiba	299	101	0	400
5	5	Advanced Micro Devices	24	0	314	338
6	6	AT&T	46	257	0	303
7	7	Texas Instruments	28	155	91	274
8	8	Hitachi	263	6	0	269
10	9	VLSI Technology	47	122	0	169
9	10	National	106	12	42	160
		Total	2,402	765	447	3,614

Note: 1989 revenue estimates are preliminary.

Source: Dataquest

ASIC TRENDS

Gate Arrays

- Significant cut in design starts
- Heavy revenue impact from chip sets
- More complex PLDs will affect gate arrays
- Severe price competition
- BiCMOS: the new frontier
- RISC processors going on-chip

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

ASIC TRENDS

Cell-Based ICs

- Tied closely to application markets
- Good growth forecast
- Will not catch gate arrays
- Mixed-mode designs grow in popularity
- Testability a major challenge
- RISC processors to become critical cell in CBIC library

Source: Dataquest

ASIC TRENDS

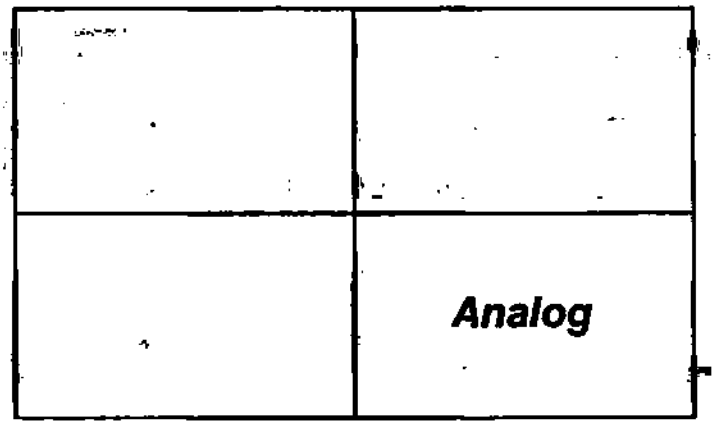
PLDs

- PLDs will become alternative to gate arrays
  - Watch for offshore competition
- Market driven by diverse architectures and innovative applications
  - Growth in complex PLDs
- Most new ideas coming from new entrants

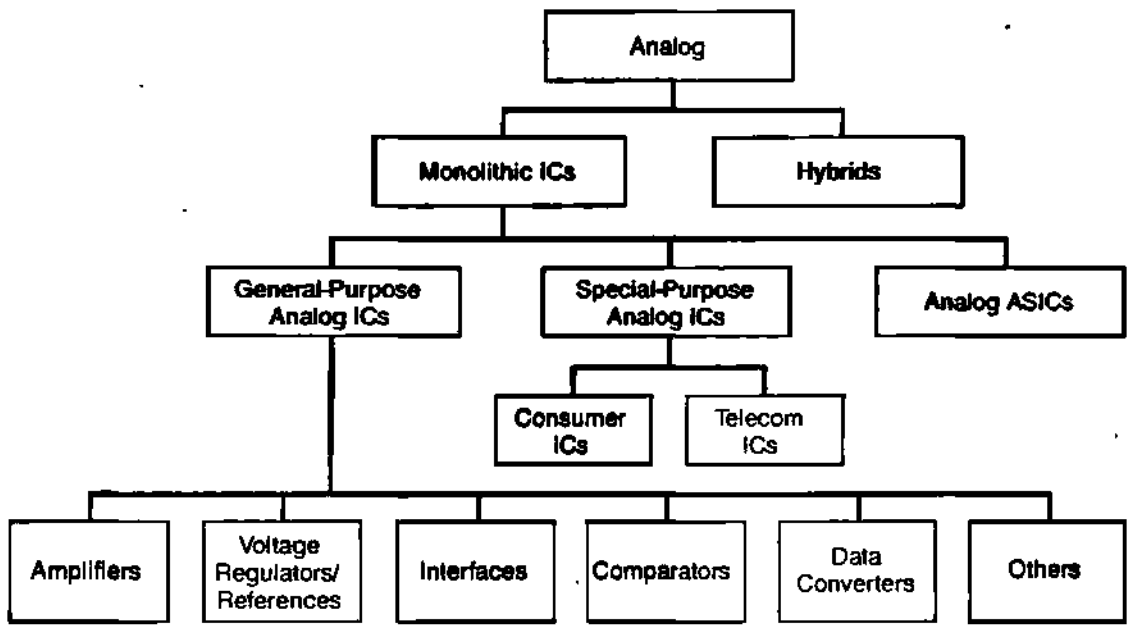
Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PRODUCT FORECASTS



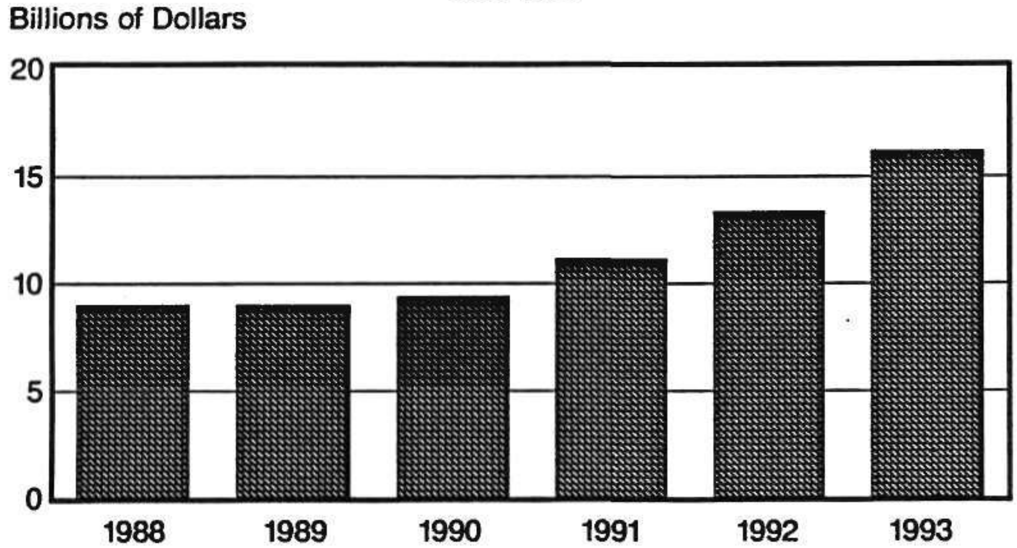
ANALOG FAMILY TREE



Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

WORLDWIDE ANALOG IC FORECAST

1988-1993



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

1989 WORLDWIDE ANALOG TOP 10 SUPPLIERS

(Millions of Dollars)

1989 Ranking	1988 Ranking		1988 Revenue	1989 Revenue	Percent Change	1989 Market Share
1	1	Toshiba	569	572	(1%)	6.1%
2	2	National Semiconductor	540	558	3%	5.9%
3	5	Sanyo	471	530	13%	5.6%
4	3	Philips	466	522	12%	5.6%
5	7	Motorola	425	445	5%	4.7%
6	6	Texas Instruments	426	417	(2%)	4.4%
7	4	NEC	469	415	(12%)	4.4%
8	11	SGS-Thomson	352	393	12%	4.2%
9	9	Mitsubishi	395	384	(3%)	4.1%
10	8	Matsushita	423	376	(11%)	4.0%

Source: Dataquest

THE ANALOG MARKET

- Rivals memory as largest IC segment
- Less cyclical than digital products
- Long life cycles
- Design intensive rather than process intensive
- Very fragmented in:
  - Products
  - Markets
  - Suppliers
  - Applications

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

THE ANALOG MARKET

Analog is key to . . .

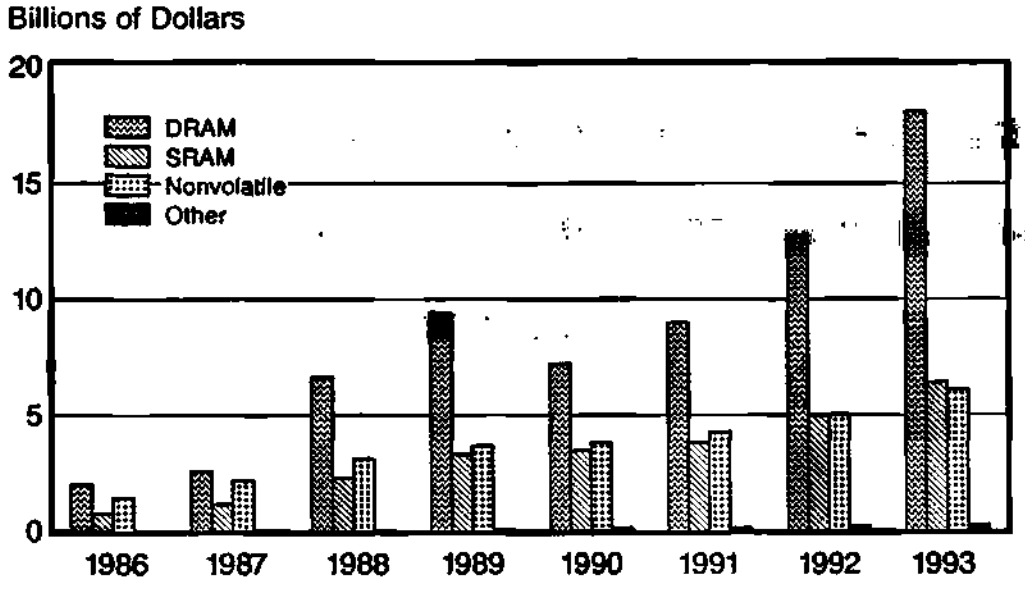
- Automotive electronics
- HDTV and consumer electronics
- Smart power and home automation
- High-resolution computer graphics and video
- Disk drive electronics
- Mixed-signal ASICs

PRODUCT FORECASTS

Memory	

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

MOS MEMORY FORECAST



Source: Dataquest

1989 WORLDWIDE MOS MEMORY TOP 10 SUPPLIERS

(Millions of Dollars)

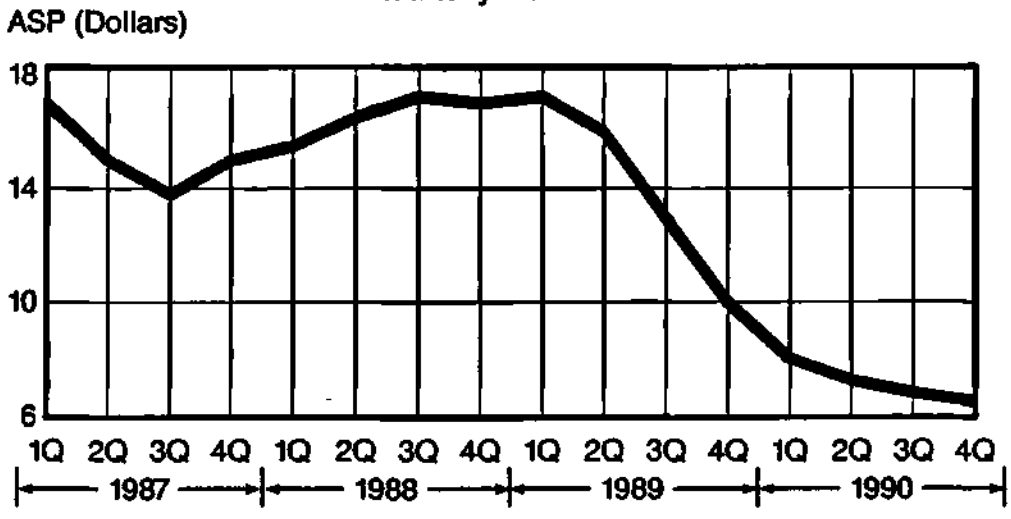
1989 Ranking	1988 Ranking		1988 Revenue	1989 Revenue	Percent Change	1989 Market Share
1	1	Toshiba	1,516	1,918	27%	11.7%
2	2	NEC	1,490	1,739	17%	10.6%
3	3	Hitachi	1,114	1,534	38%	9.4%
4	4	Fujitsu	1,067	1,265	19%	7.7%
5	5	Mitsubishi	966	1,161	20%	7.1%
6	6	Texas Instruments	834	1,095	31%	6.7%
7	7	Samsung	650	935	44%	5.7%
8	10	Sharp	344	476	38%	2.9%
9	9	Oki Semiconductor	353	473	34%	2.9%
10	8	Intel	392	433	10%	2.6%

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

ESTIMATED WORLDWIDE 1Mb DRAM PRICING

Quarterly: 1987-1990



Source: Dataquest

1990 OUTLOOK FOR 1Mb DRAMs

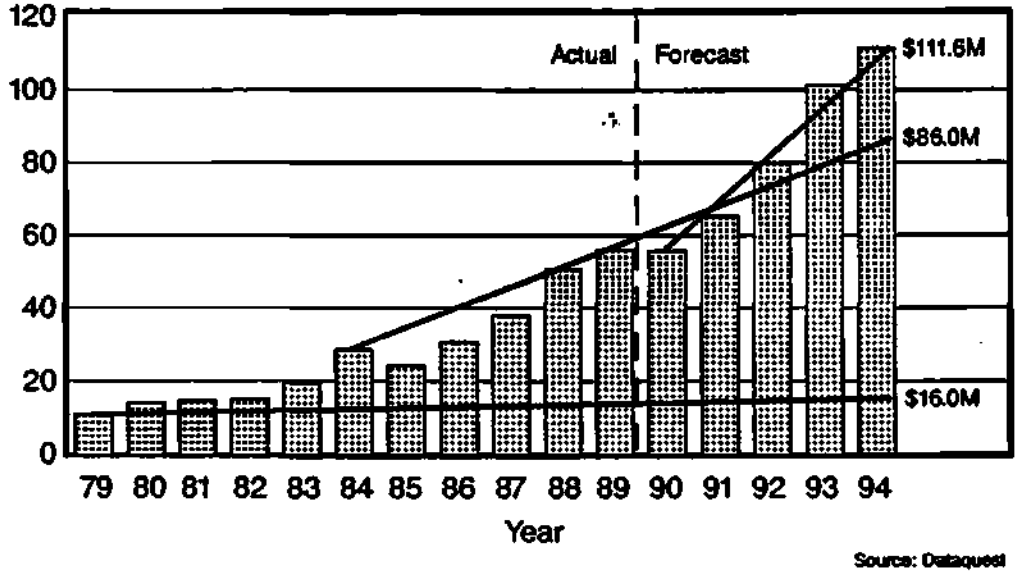
- First quarter oversupply
- Continued price erosion
- Possible political intervention
- Throttle-back of DRAM production
- Increased availability of SRAMs and PSRAMs
- Potential supply glitch during recovery
- Difficult 4Mb introduction

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

WORLDWIDE SEMICONDUCTOR MARKET

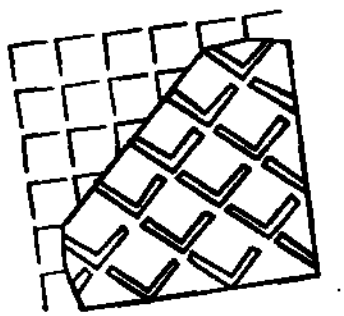
Billions of U.S. Dollars



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

Dataquest's Ninth Annual
SEMICON/West Seminar
Status 1990
May 23, 1990



New Manufacturing in the Submicron Decade

Mark T. Reagan

Semiconductor Equipment and Materials Service
Dataquest Incorporated

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

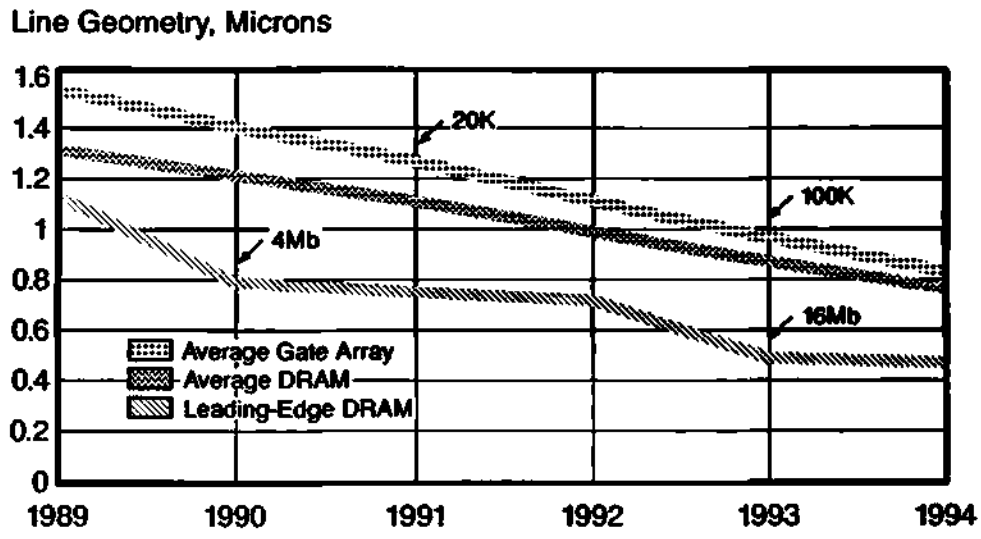
- Line geometries
- 200mm manufacturing
- New fabs
- Cost of a fab
- Capital spending

AGENDA

- Line geometries

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

CONVERGING TECHNOLOGIES: ASIC AND DRAM LINE GEOMETRIES



Source: Dataquest

THE ONE-MICRON BARRIER

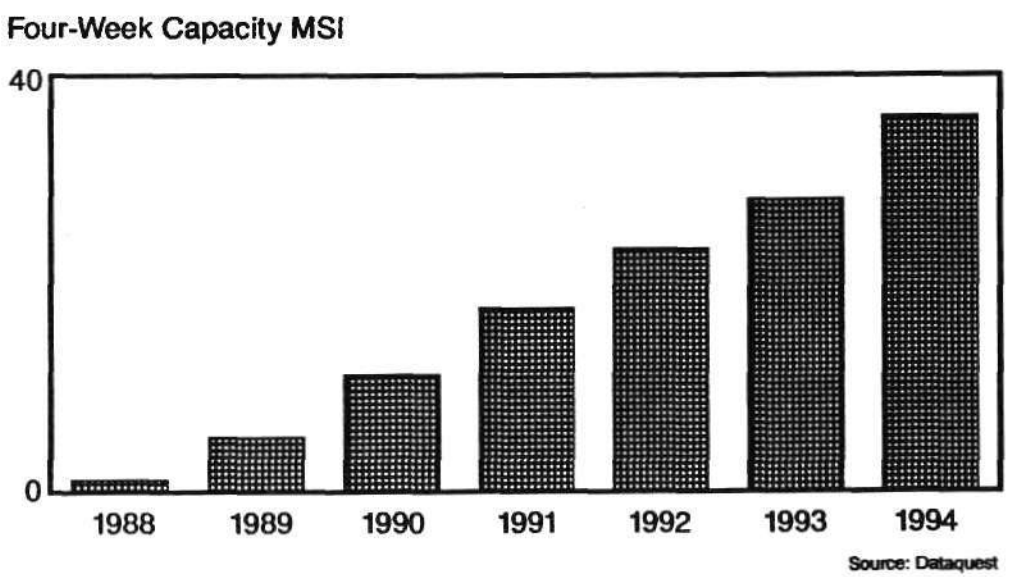
- 79 submicron lines worldwide
- Submicron lines represent 10.4 percent of all installed fab lines
- All 200mm lines have minimum linewidths at or below one micron

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

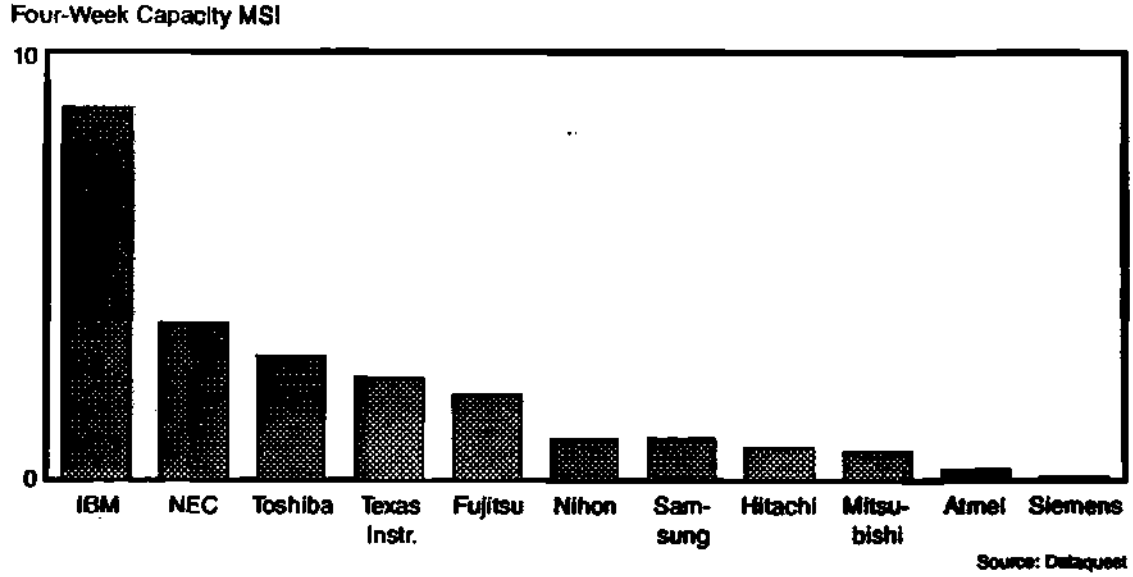
- Line geometries
- 200mm manufacturing

RUNNING TOTAL OF 200mm CAPACITY PER YEAR



Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

TOTAL 200mm CAPACITY BY COMPANY BY THE END OF 1992



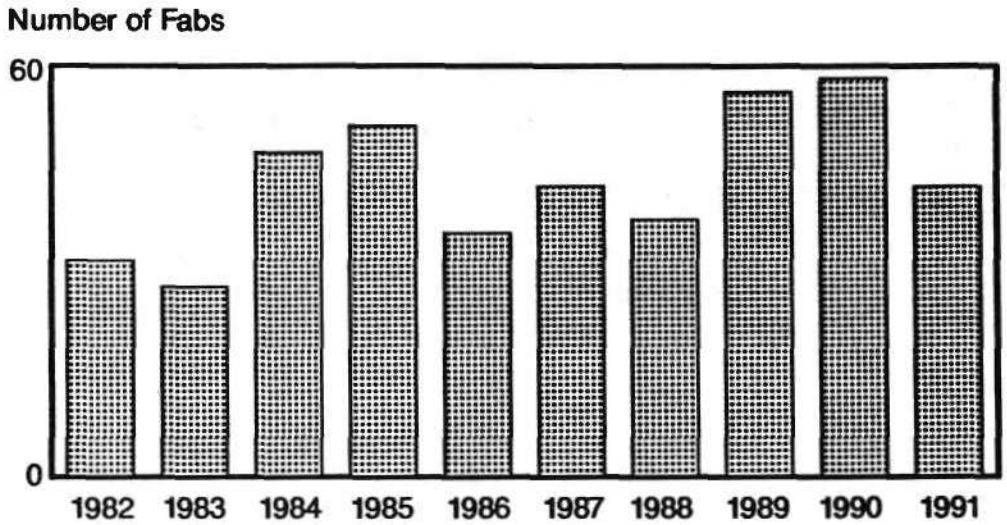
AGENDA

- Line geometries
- 200mm manufacturing
- New fabs

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

ESTIMATED NEW FAB LINES WORLDWIDE

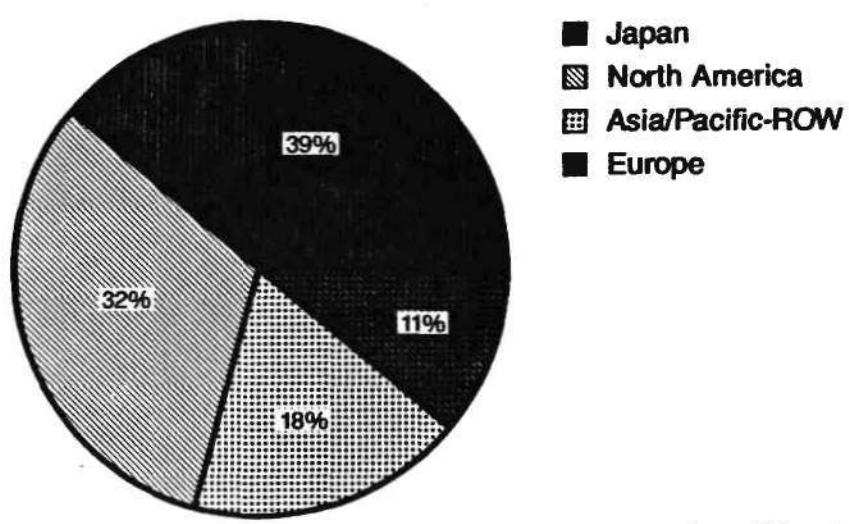
R&D and GaAs Not Included



Source: Dataquest

NEW CAPACITY BY REGION

1990 and 1991



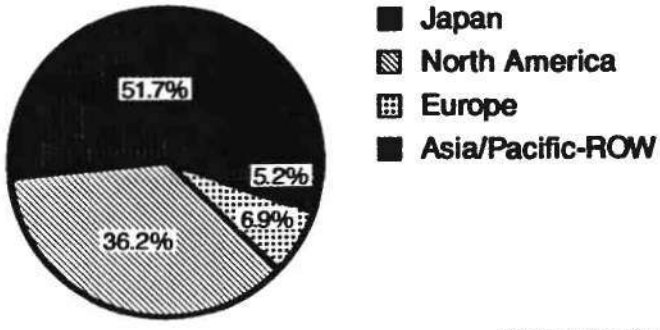
Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

NEW SUBMICRON CAPACITY BY REGION

1990 and 1991

- 49% of total capacity will be submicron
- Submicron portion is split as follows:



Source: Dataquest

NEW PLAYERS IN JAPAN

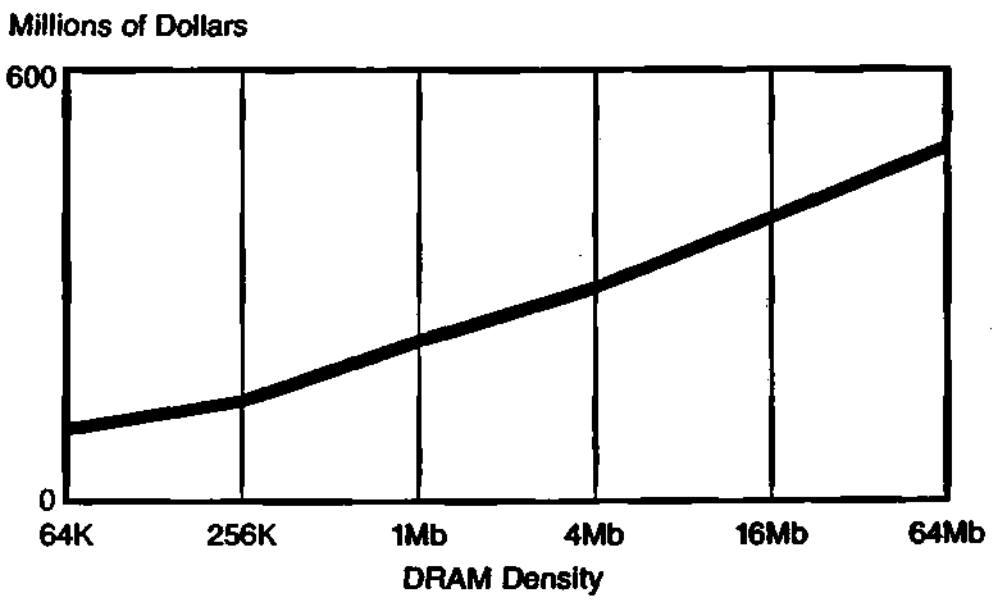
- Asahi Micro Systems
- Honda
- Isuzu
- Kawasaki Steel
- Kobe Steel
- Nippon Steel
- Nissan Motor
- NKK Steel
- Sumitomo Metal Mining
- TDK
- Toyota

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

- Line geometries
- 200mm manufacturing
- New fabs
- Cost of a fab

ESTIMATED COST OF A NEW DRAM FAB

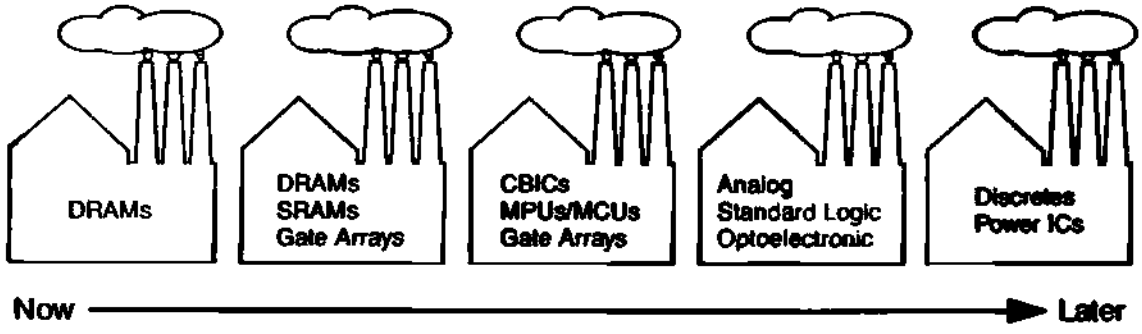


Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

FAB COST AMORTIZED OVER BOTH TIME AND PRODUCT

Span of 12 to 15 Years



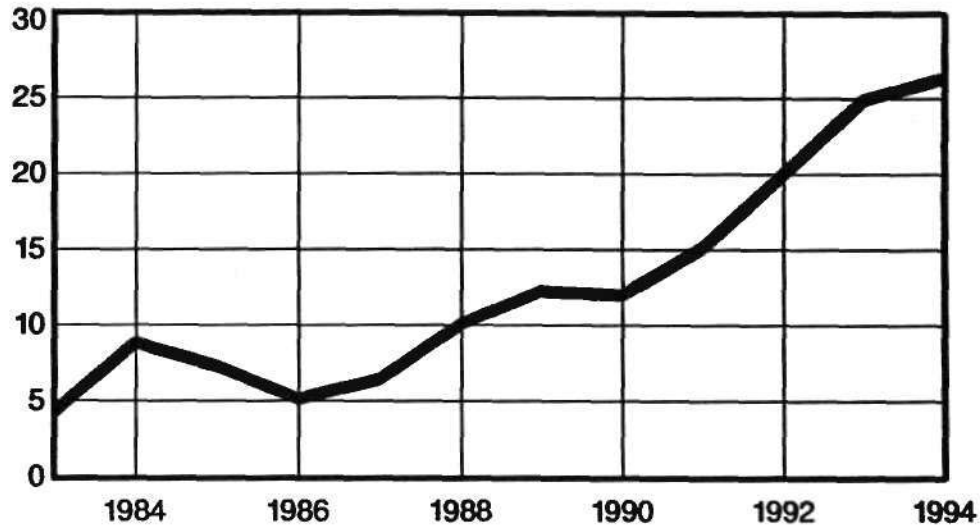
AGENDA

- Line geometries
- 200mm manufacturing
- New fabs
- Cost of a fab
- Capital spending

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

WORLDWIDE CAPITAL SPENDING FORECAST

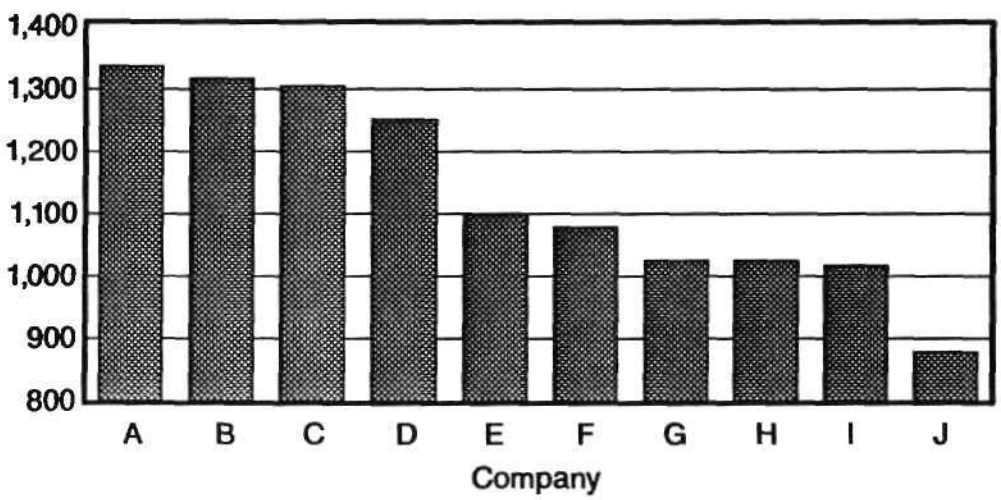
Billions of Dollars



Source: Dataquest

ESTIMATED TOP 10 SEMICONDUCTOR CAPITAL SPENDING, 1994

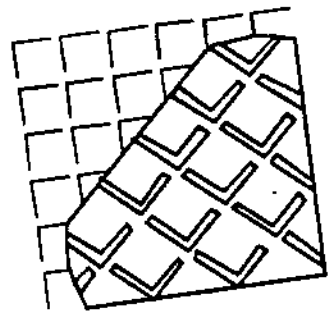
Millions of Dollars



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

Dataquest's Ninth Annual
SEMICON/West Seminar
Status 1990
May 23, 1990



Some Key Performance Measures of the Semiconductor Equipment Industry

Joseph Grenier

Semiconductor Equipment and Materials Service
Dataquest Incorporated

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

- Three key performance measures of the semiconductor equipment industry
- Status of the industry

THREE KEY PERFORMANCE MEASURES

- Operating income
- R&D expenditures
- Sales per employee

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

OPERATING INCOME

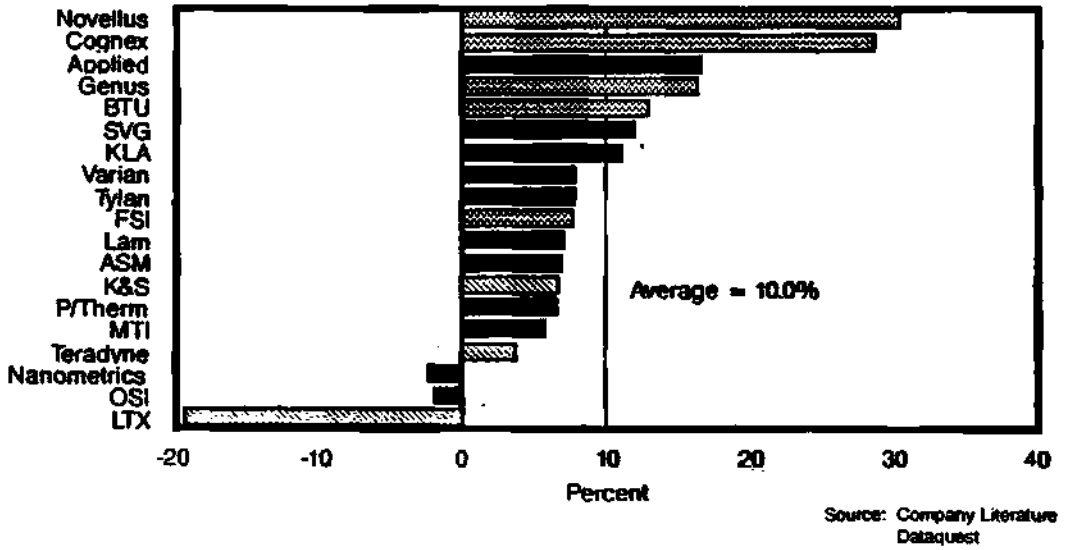
Net sales
- Cost of sales
- SG&A expense
- R&D expenditures

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

Net income

OPERATING INCOME AS PERCENT OF SALES

Fiscal 1989

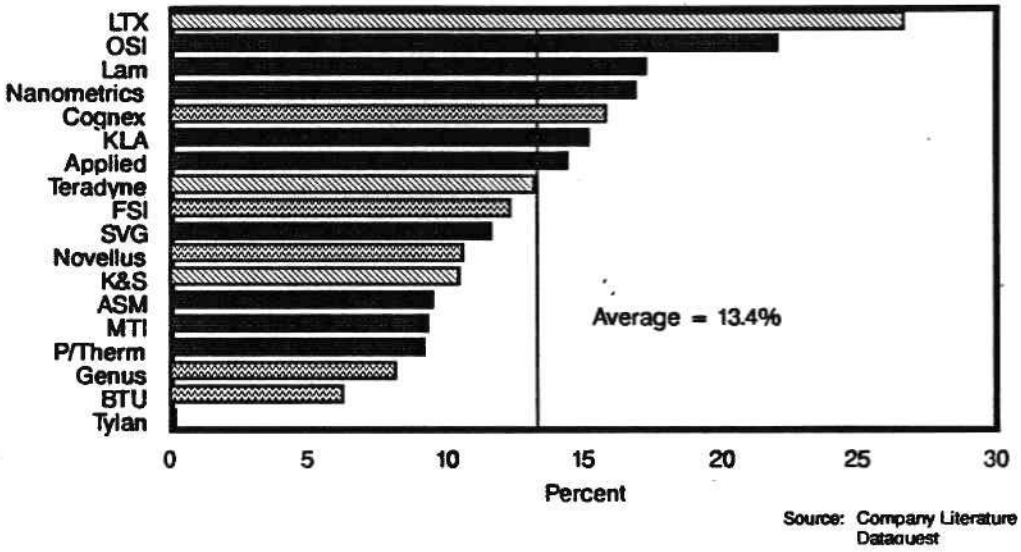


Source: Company Literature
Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

R&D EXPENDITURES AS PERCENT OF SALES

Fiscal 1989



Source: Company Literature
Dataquest

OPERATING INCOME PLUS R&D

A Pool of Funds

Net sales
- Cost of sales
- SG&A expense
- R&D expenditures

Operating income

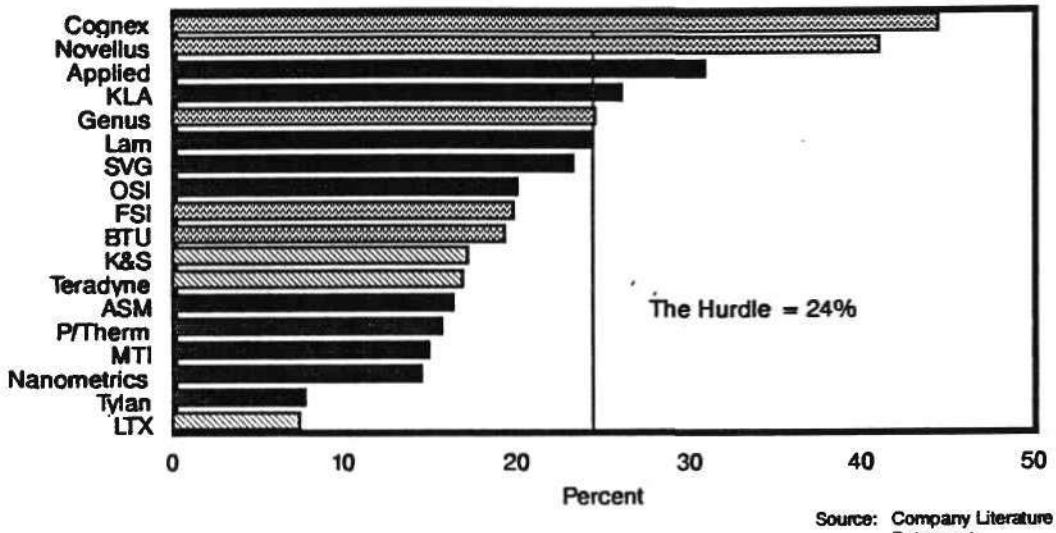
Operating Income + R&D Expenditures
Equals
A Pool of Funds that Can Be Traded Off

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

OPERATING INCOME PLUS R&D EXPENDITURES AS PERCENT OF SALES

Fiscal 1989

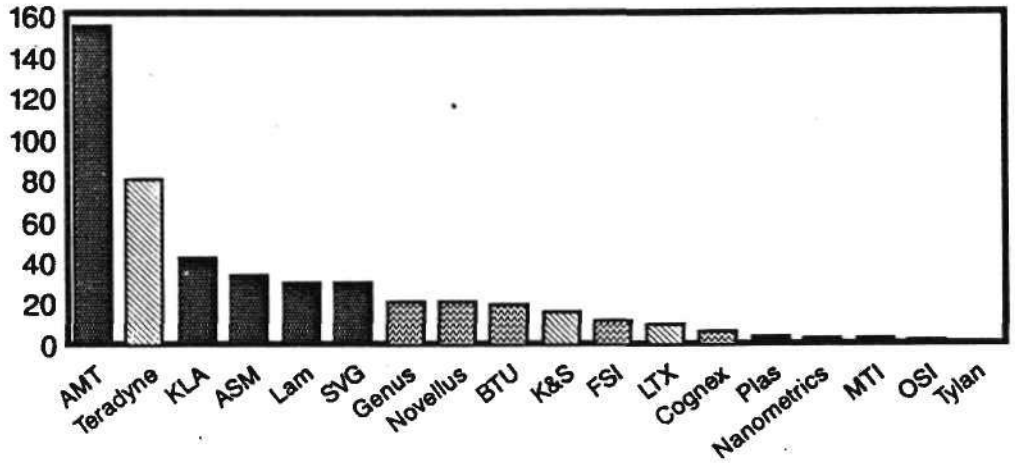


Source: Company Literature
Dataquest

OPERATING INCOME PLUS R&D EXPENDITURES

Fiscal 1989

Millions of Dollars

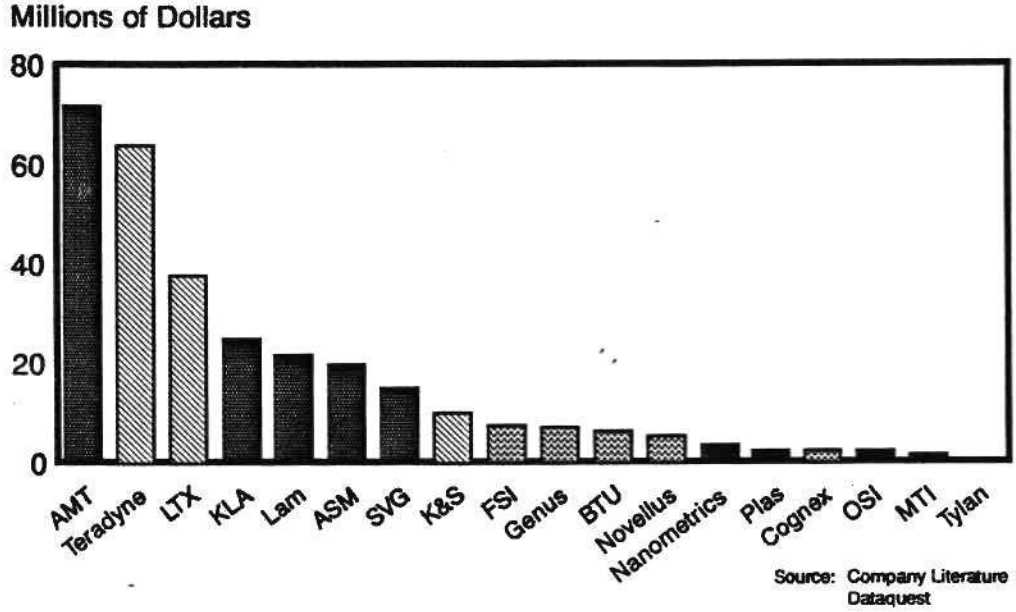


Source: Company Literature
Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

R&D EXPENDITURES

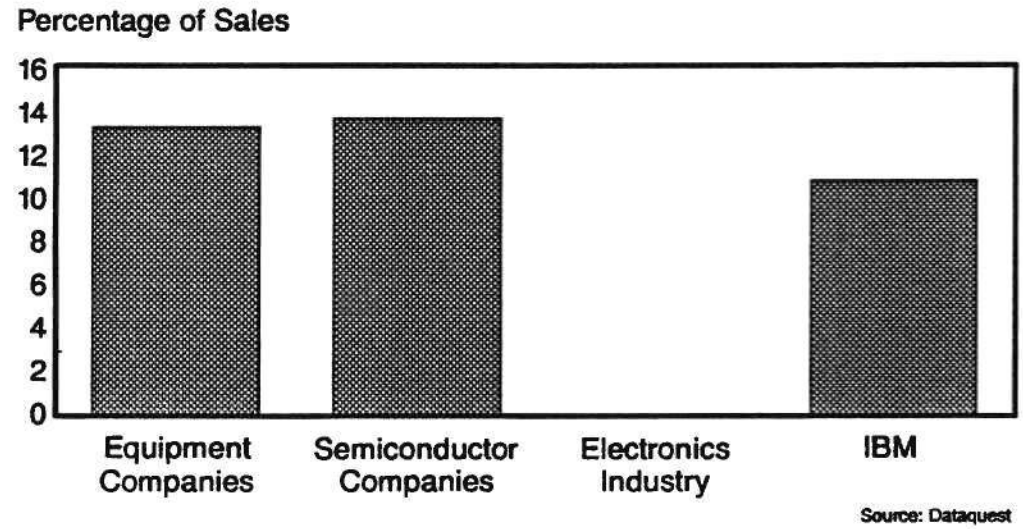
Fiscal 1989



Source: Company Literature
Dataquest

HOW DO EQUIPMENT COMPANIES STACK UP?

1989 R&D Expenditures – U.S. Companies

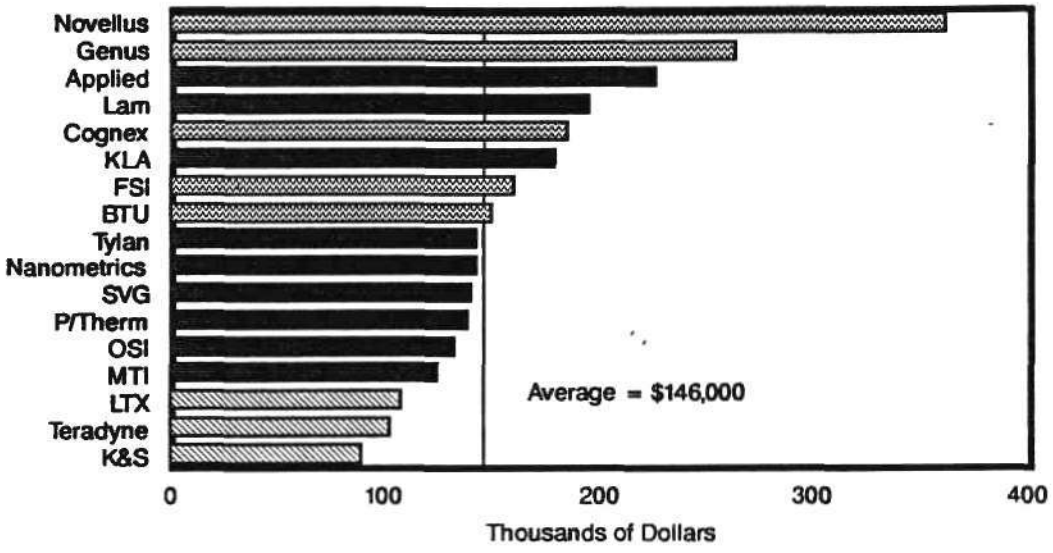


Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

SALES PER EMPLOYEE

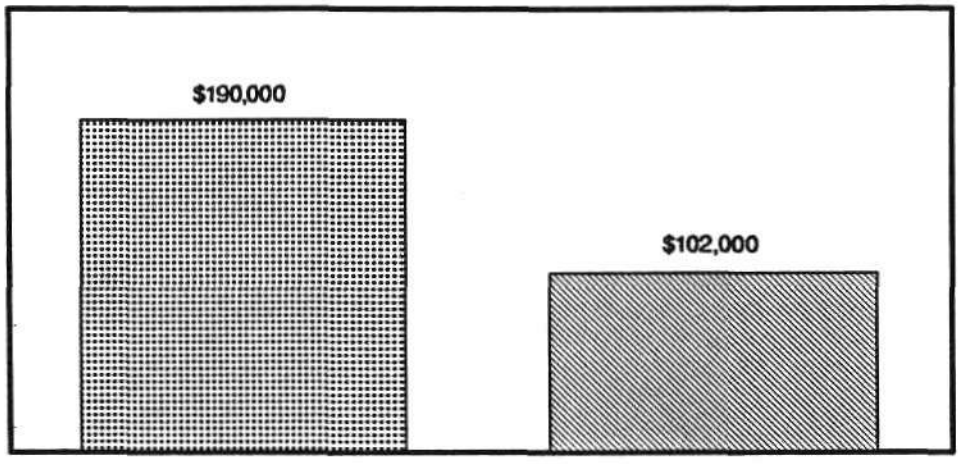
Fiscal 1989



Source: Company Literature
Dataquest

FRONT-END VS. BACK-END COMPANIES

1989 Sales Per Employee – U.S. Companies

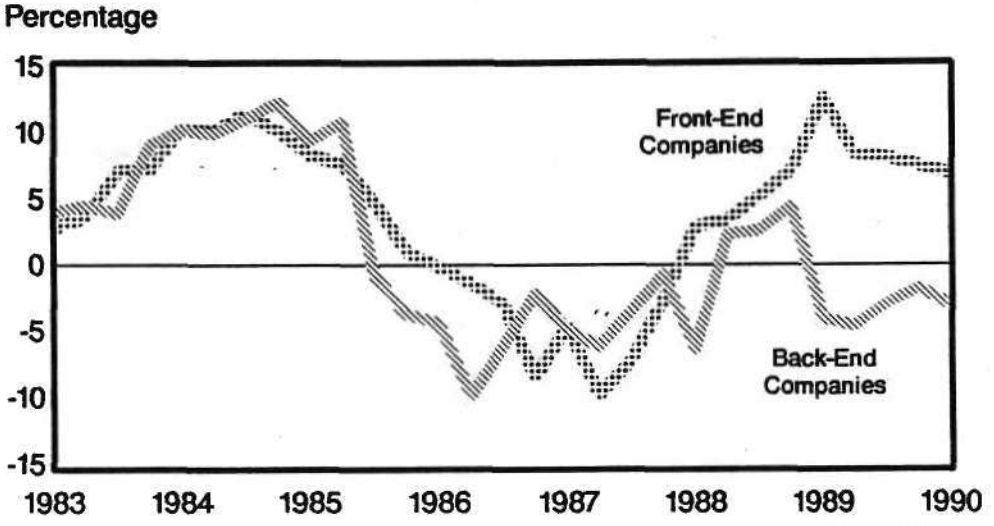


Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

NET INCOME AS PERCENT OF SALES

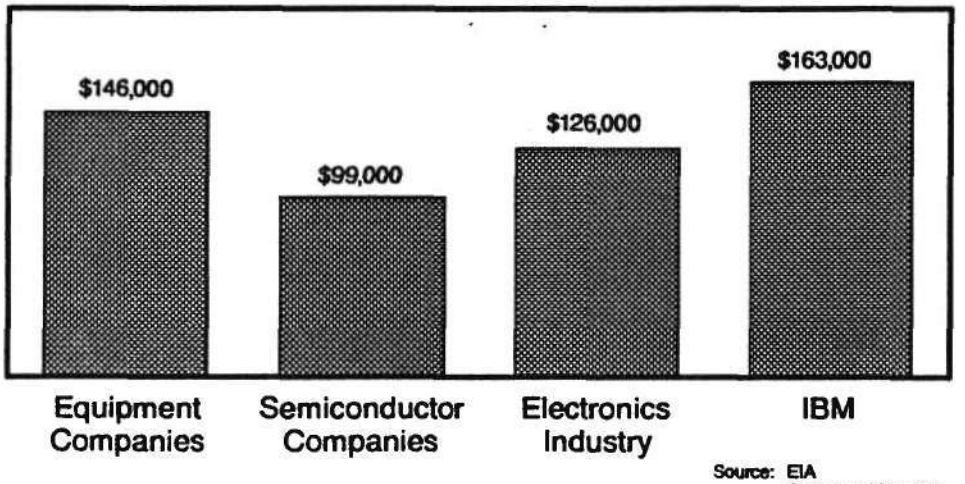
Front-End vs. Back-End
U.S. Equipment Companies



Source: Dataquest

HOW DO EQUIPMENT COMPANIES STACK UP?

1989 Sales Per Employee – U.S. Companies

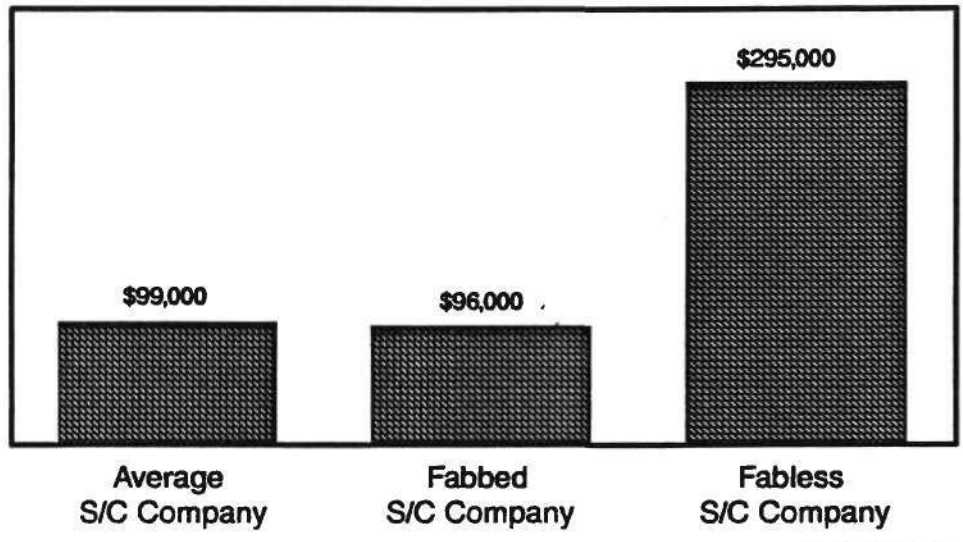


Source: EIA
Company Literature
Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

THE FABULOUS FABLESS

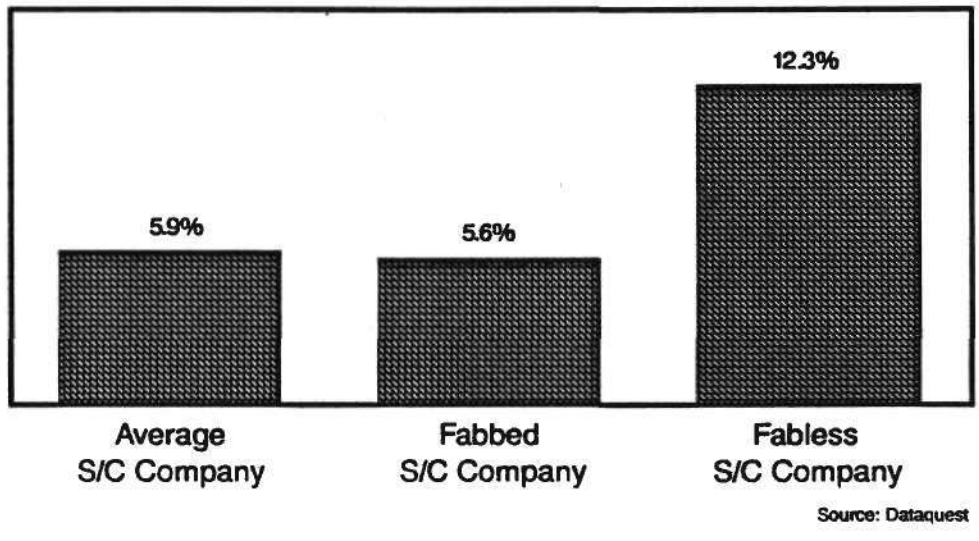
1989 Sales Per Employee – U.S. Semiconductor Companies



Source: Dataquest

THE FABULOUS FABLESS

1989 Net Income as Percent of Sales – U.S. Semiconductor Companies

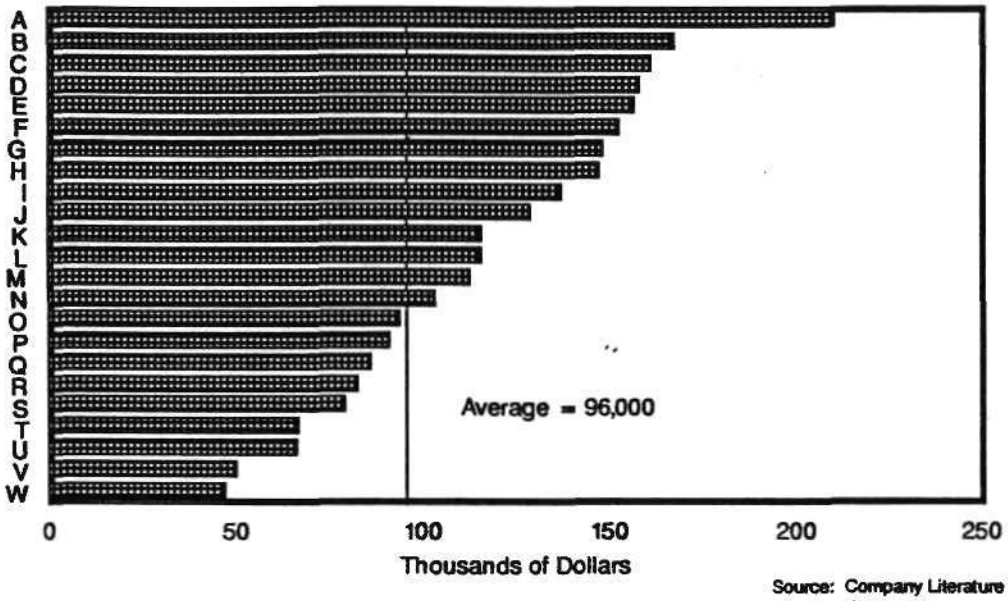


Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

1989 SALES PER EMPLOYEE

U.S. Semiconductor Companies with Fabs



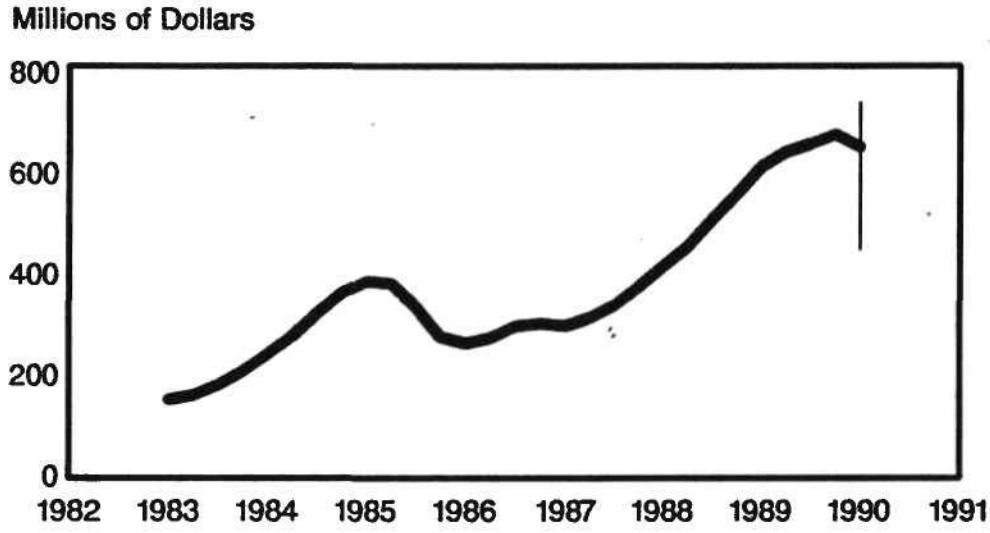
Source: Company Literature
Dataquest

Status of the Industry

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

EQUIPMENT COMPANY SALES TRENDS

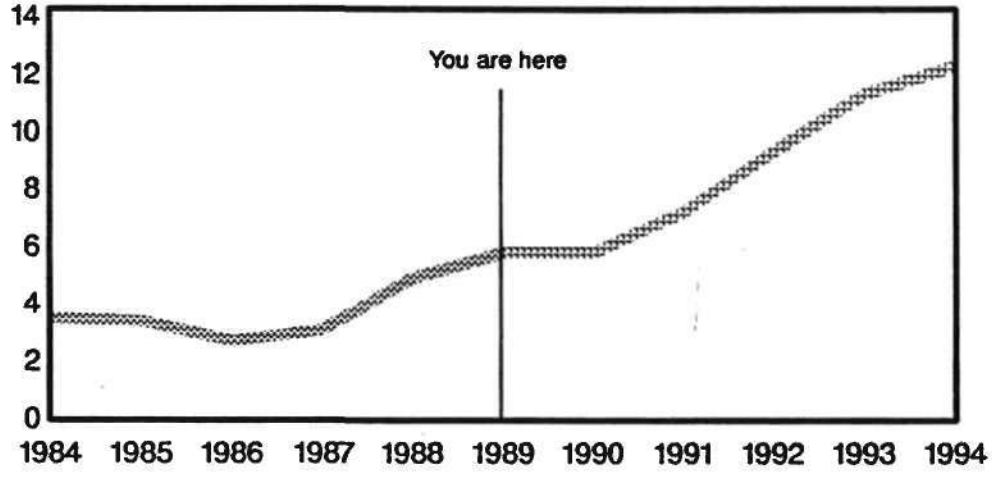
Sales by Quarter



Source: Dataquest

ESTIMATED WAFER FAB EQUIPMENT MARKET

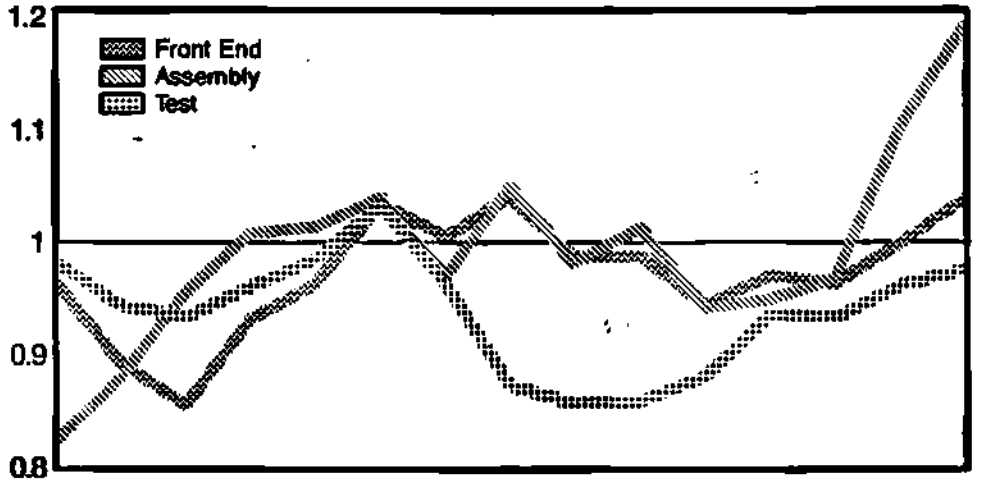
Worldwide



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

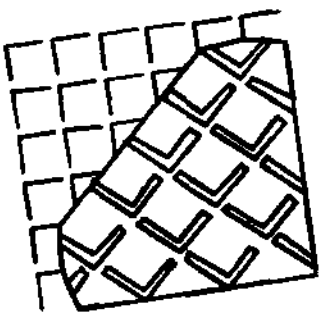
SEMICONDUCTOR EQUIPMENT BOOK-TO-BILL RATIO



Source: SEMI

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

Dataquest's Ninth Annual
SEMICON/West Seminar
Status 1990
May 23, 1990



Wafer Fab Equipment Trends in the 1990s

Krishna Shankar

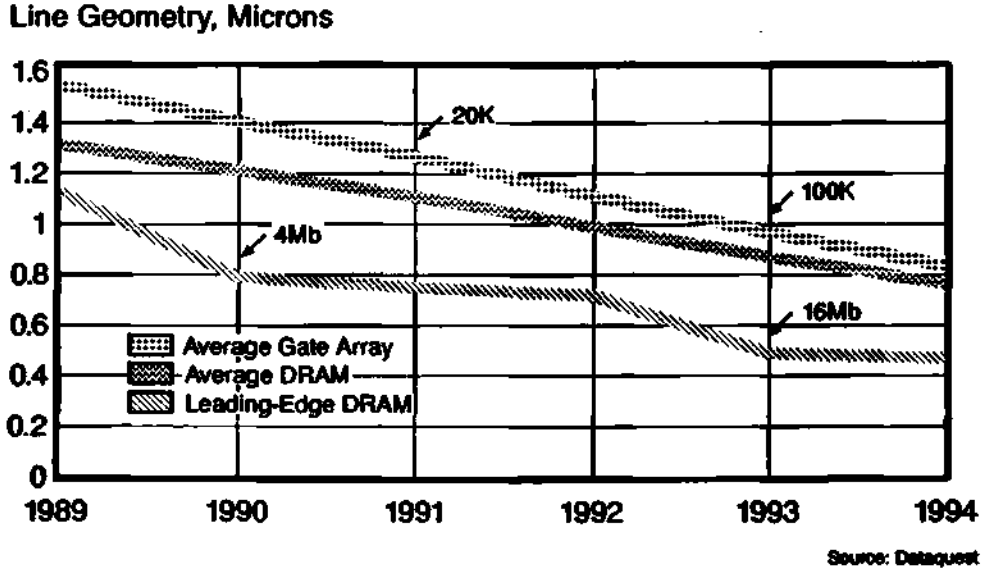
Semiconductor Equipment and Materials Service
Dataquest Incorporated

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

- Forces driving the fab equipment market in the 1990s
- Fab equipment market and technology trends
- Integrated processing market trends
- Future scenarios for fab equipment configuration
- Conclusions

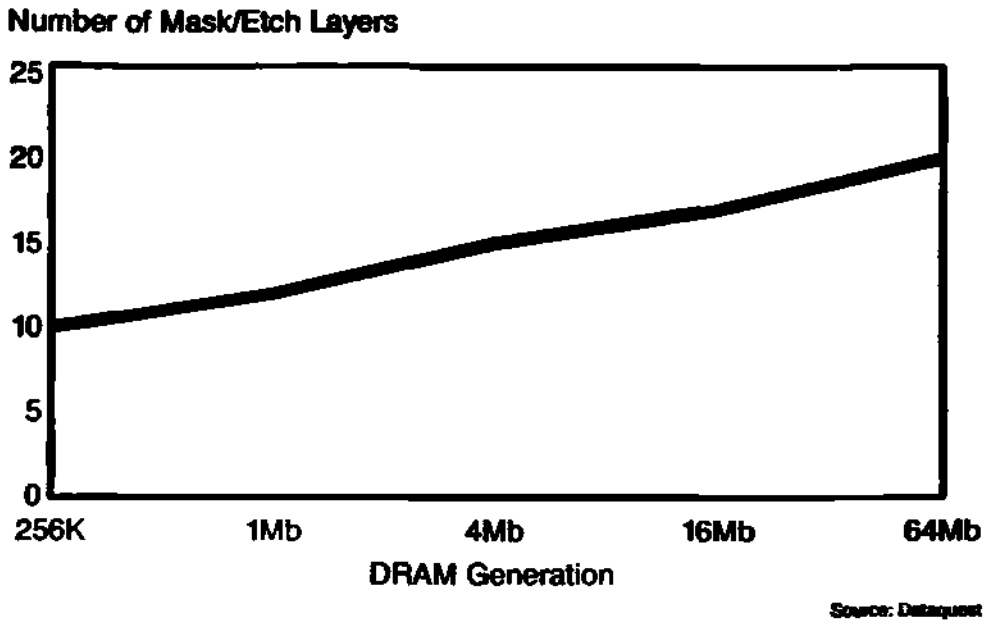
CONVERGING TECHNOLOGIES: ASIC AND DRAM LINE GEOMETRIES



Source: Dataquest

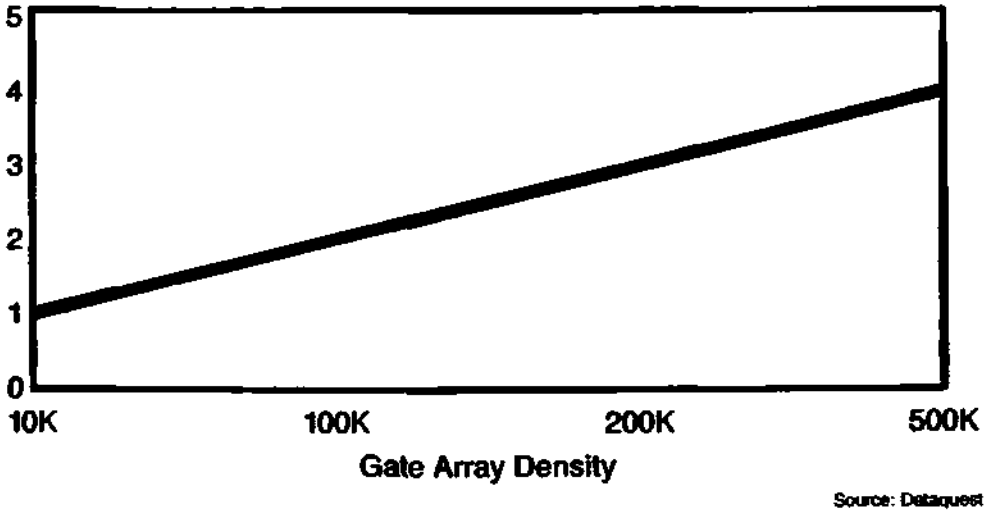
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

DRAMATIC INCREASE IN MASK/ETCH LAYERS



Source: Dataquest

ASIC FABS DRIVE INTERCONNECT TECHNOLOGY



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

MICROPROCESSORS AS TECHNOLOGY DRIVERS

Chip Feature	1989	1990
Transistor Count	283,000	580,000
Technology	1.4µ CMOS	0.95µ CMOS
Clock Speed	32 MHz	61 MHz
Instruction Execution	29 mips peak	58 mips peak

Source: ISSCC 1990

16Mb DRAM AS TECHNOLOGY DRIVER

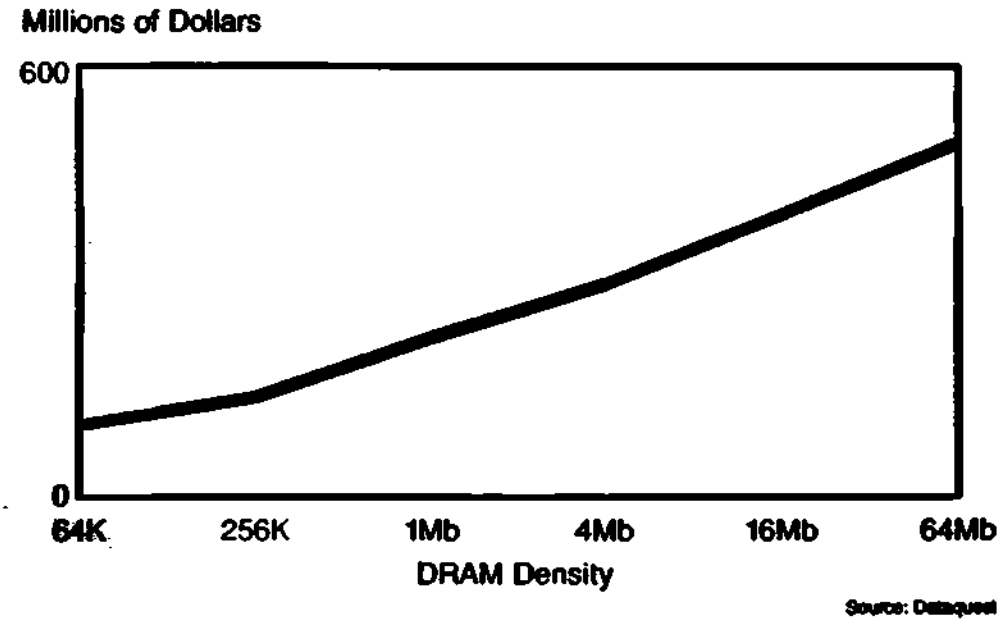
IBM at the Leading Edge

Feature	Comment
• 0.5-micron CMOS technology	• Uses deep trench capacitor
• Deep UV lithography	• Step-and-scan tool
• Excimer laser lithography	• 245nm excimer laser stepper
• 0.15-micron shallow junctions	• Titanium silicide used
• Tungsten plugs	• Blanket tungsten etchback
• Lithography cluster	• Integrated track and steppers
• Diffusion cluster	• Integrated thermal processing
• Thin films cluster	• Integrated deposition/etch

Source: IBM

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

ESTIMATED COST OF A NEW DRAM FAB



Source: Dataquest

AGENDA

- Forces driving the fab equipment market in the 1990s
- Fab equipment market and technology trends
- Integrated processing market trends
- Future scenarios for fab equipment configuration
- Conclusions

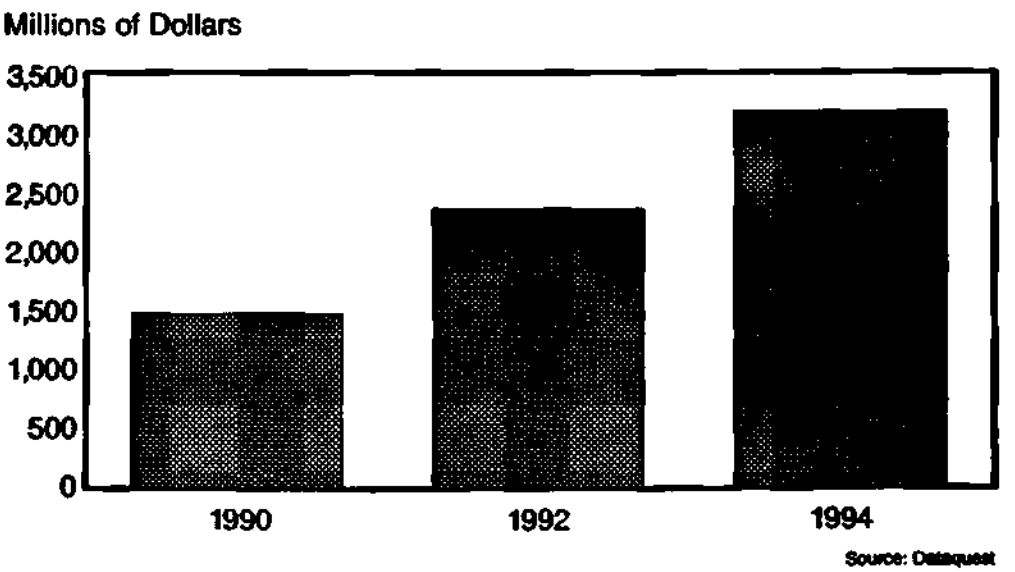
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

FAB EQUIPMENT MARKET AND TECHNOLOGY TRENDS

Engines Driving Submicron Processes

- Lithography management
- Thin films management

LITHOGRAPHY MARKET TRENDS FOR THE 1990s



Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

LITHOGRAPHY

Trends for the 1990s

- Interest reemerging in mix-and-match
  - 5:1 steppers with projection aligners
  - 5:1 steppers with 1:1 steppers
- Future mix-and-match strategy
  - I-line with e-beam
  - Where does this leave excimer laser and x-ray aligners?
- Two compact SORs soon to see first "light"
- New e-beam machines being introduced

Source: Dataquest

STEPPER TRENDS FOR THE 1990s

Keep Your Eye on I-Line

- G-line may fade faster than expected
- A lot of activity in i-line
  - Japanese semiconductor manufacturers very interested in i-line
  - Stepper manufacturers introducing new systems
- I-line lens heating problem is solved
- I-line advantages
  - More depth of focus
  - More process latitude
  - Good for two generations of DRAMs

Source: Dataquest

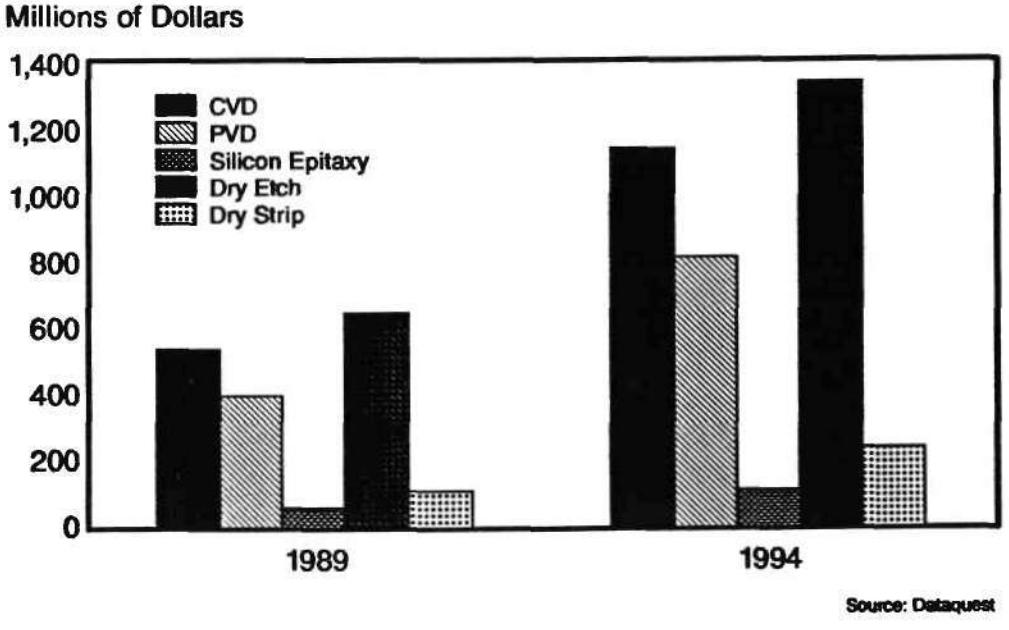
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

FAB EQUIPMENT MARKET AND TECHNOLOGY TRENDS

Engines Driving Submicron Processes

- Lithography management
- Thin films management

THIN FILMS MARKET TRENDS FOR THE 1990s



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

INTERCONNECT TRENDS FOR THE 1990s

- More than half the cost of submicron processes in the 1990s will be due to use of multilevel interconnect technology
- The choice of the optimum interconnect scheme, together with the appropriate processing equipment and materials, will be crucial to cost-effective submicron manufacturing

Source: Dataquest

CVD EQUIPMENT

Trends for the 1990s

- Development of cost-effective, production-worthy CVD processes
- Selective tungsten, aluminum, and copper for submicron processes
- ECR CVD for low-temperature, planarized dielectrics
- Integration of CVD into cluster tools

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PVD EQUIPMENT

Trends for the 1990s

- Incorporation of PVD with CVD into cluster tools
- Growth of sputtering equipment market with three- and four-level metallization
- Excimer reflow of sputtered aluminum?

Source: Dataquest

DRY ETCH EQUIPMENT

Trends for the 1990s

- High-selectivity, low ion damage equipment development
- Low-temperature etch processes for submicron processes
- In situ particle monitoring, plasma diagnostics
- Refinements to ECR and MERIE etch equipment

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

- Forces driving the fab equipment market in the 1990s
- Fab equipment market and technology trends
- Integrated processing market trends
- Future scenarios for fab equipment configuration
- Conclusions

THE PROBLEM

- Increasingly complex submicron processes are more sensitive to process-related defects
- Availability of reliable thin films deposition and etch equipment is a bottleneck in cost-effective submicron processing

Source: Dataquest

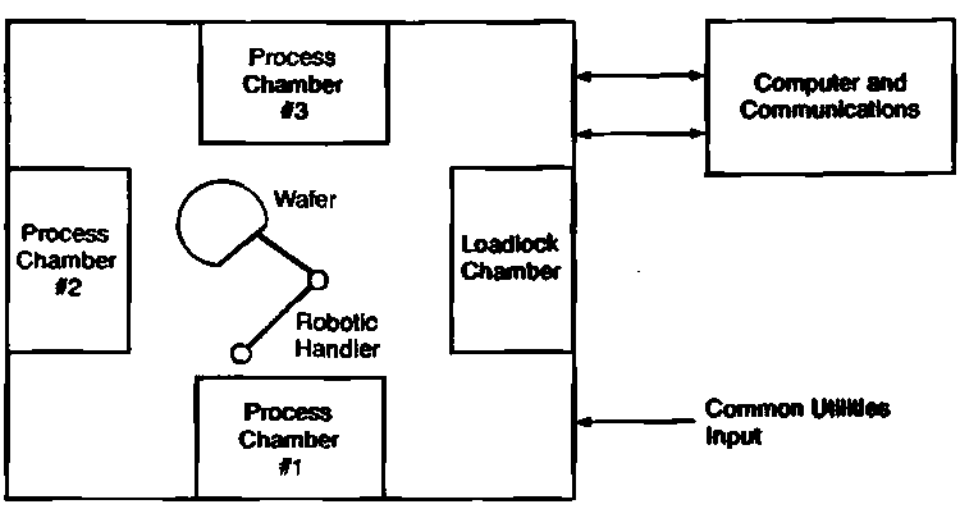
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

THE SOLUTION: INTEGRATED PROCESSING SYSTEMS -- THE WAVE OF THE '90s

- Advantages of integrated processing systems:
  - In situ film deposition and etch
  - Lower defects
  - Faster turnaround time
  - Ease of automation
- Today's rigid multichamber tools (RMTs) are precursors to tomorrow's flexible cluster tools (FCTs)
- FCTs will integrate areas such as dry clean, CVD, PVD, dry etch, RTP, and silicon epi

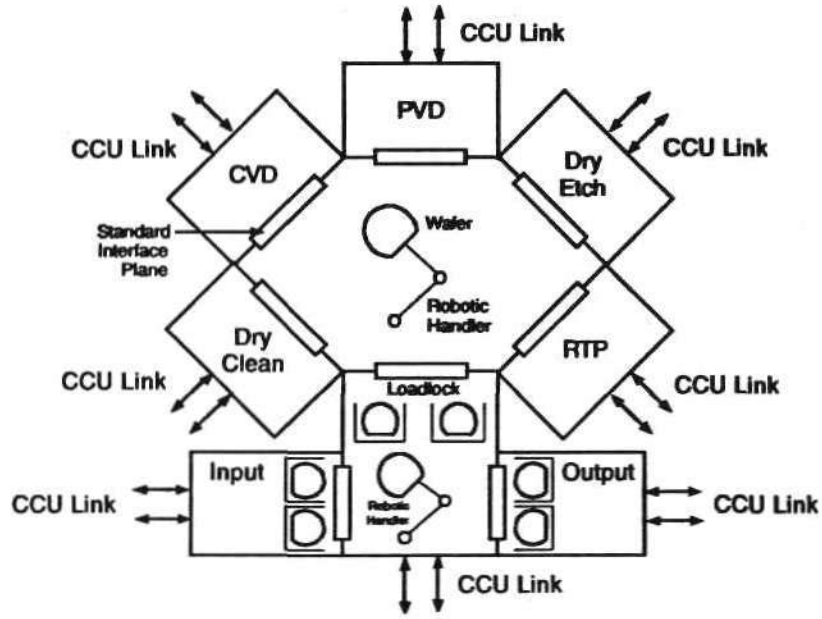
Source: Dataquest

SCHEMATIC OF A RIGID MULTICHAMBER TOOL



Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

SCHEMATIC OF A FLEXIBLE CLUSTER TOOL



INTEGRATED PROCESSING SYSTEMS

Some Future Market Scenarios

- New players: Wafer handling platform vendors, systems integrators, service companies?
- Synergistic partnership among equipment vendors
- Big, vertically integrated device companies will procure modules and assume ownership
- Emergence of "super" equipment vendors offering one-stop hardware, process, and service
- Timely, practical, worldwide standards fail to develop: The status quo prevails!

Source: Dataquest

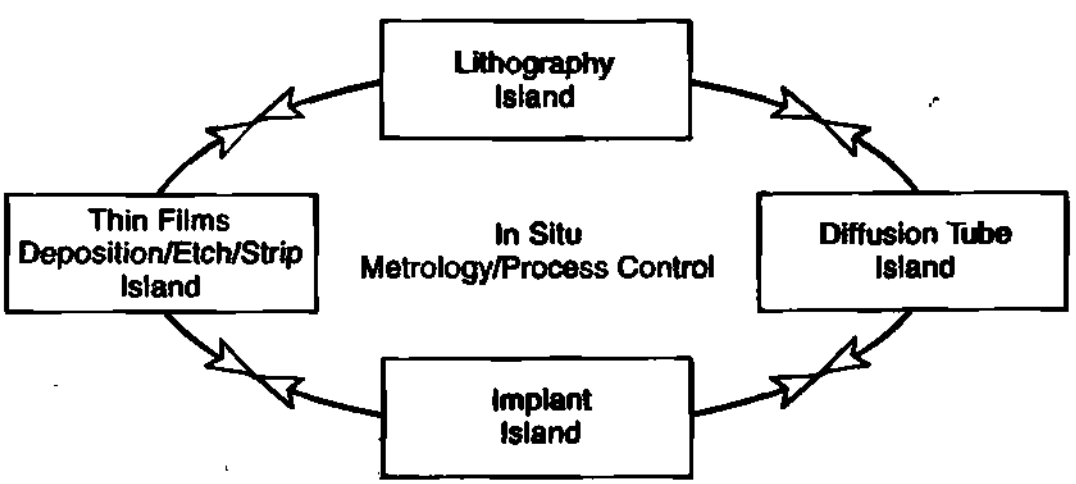
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

- Forces driving the fab equipment market in the 1990s
- Fab equipment market and technology trends
- Integrated processing market trends
- Future scenarios for fab equipment configuration
- Conclusions

FAB EQUIPMENT TRENDS FOR THE 1990s

Islands of Automation



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

- Forces driving the fab equipment market in the 1990s
- Fab equipment market and technology trends
- Integrated processing market trends
- Future scenarios for fab equipment configuration
- Conclusions

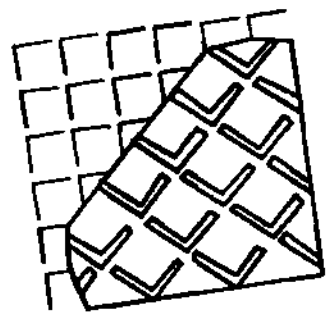
CONCLUSIONS

- Skyrocketing costs of submicron fabs
- Fab equipment industry in consolidation
- Lithography and interconnects drive technology
- Increasing process and equipment integration
- Fab equipment industry faces a momentous decade

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

Dataquest's Ninth Annual
SEMICON/West Seminar
Status 1990
May 23, 1990



Staying in the Materials Race through the '90s

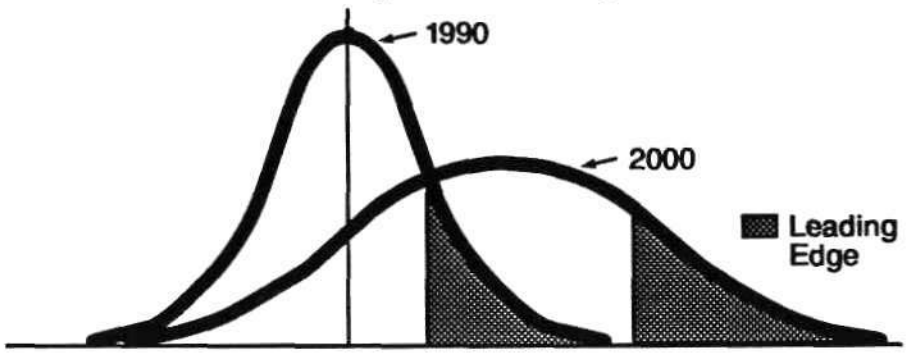
Mark FitzGerald

Semiconductor Equipment and Materials Service
Dataquest Incorporated

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

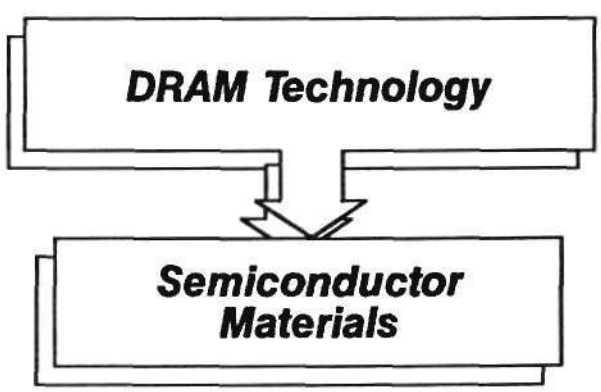
LEADING-EDGE TECHNOLOGY

Leading-edge technology today will be the middle of the pack in the year 2000



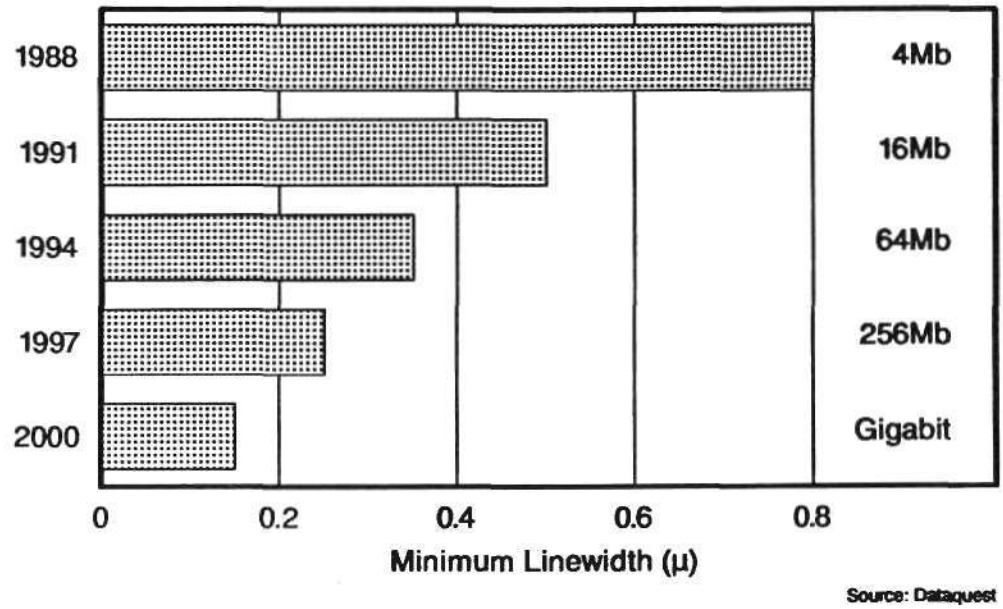
Source: Dataquest

SETTING THE PACE . . .

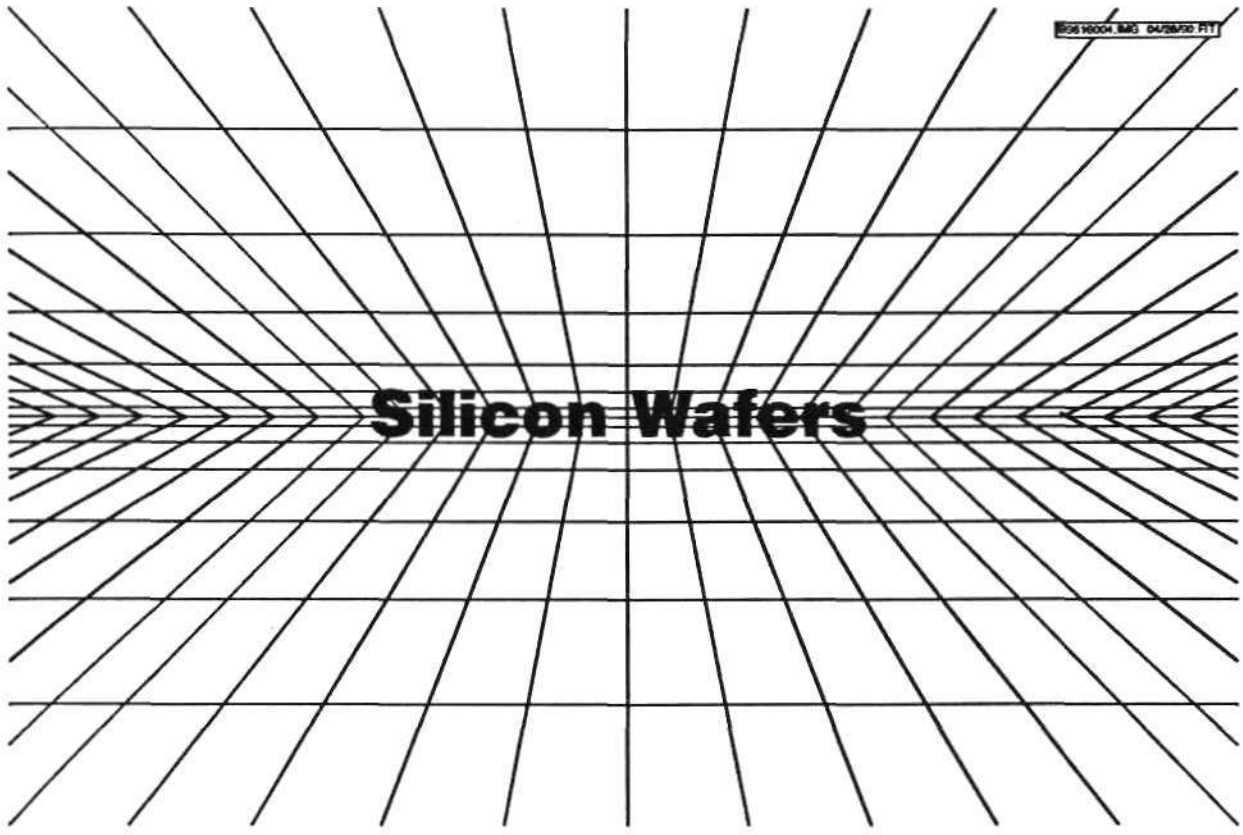


Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

THE MILESTONES



Source: Dataquest



Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

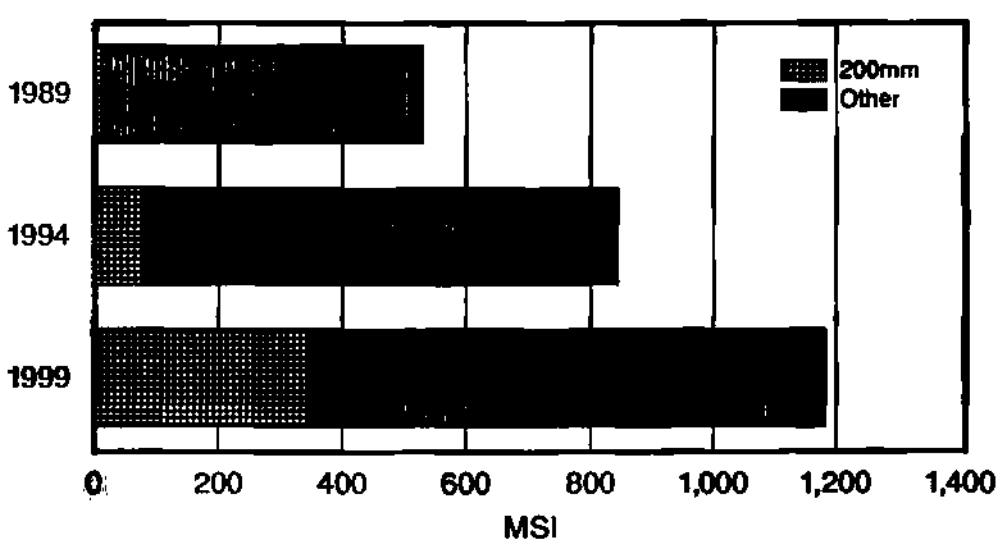
SILICON WAFER SIZE TRENDS

	1988 4Mb	1991 16Mb	1994 64Mb	1997 256Mb	2000 Gigabit
Wafer Size (mm)	150	200	200	200	250
Wafer Size (inches)	6	8	8	8	10

Source: Dataquest

SILICON WAFER SIZE DISTRIBUTION

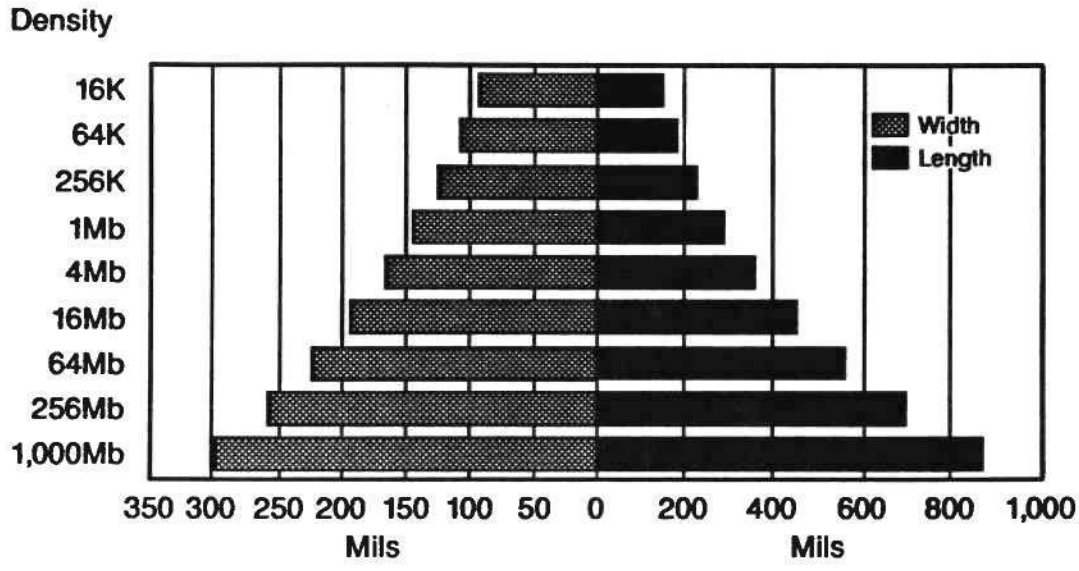
North America



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

DRAM DIE DIMENSIONS



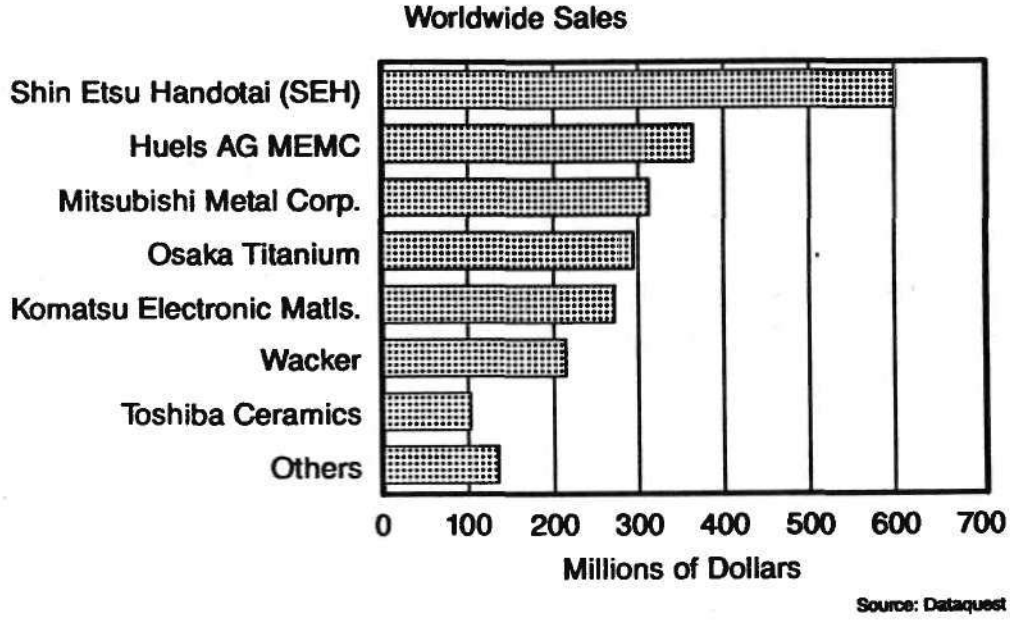
Source: ISSCC Technical Papers

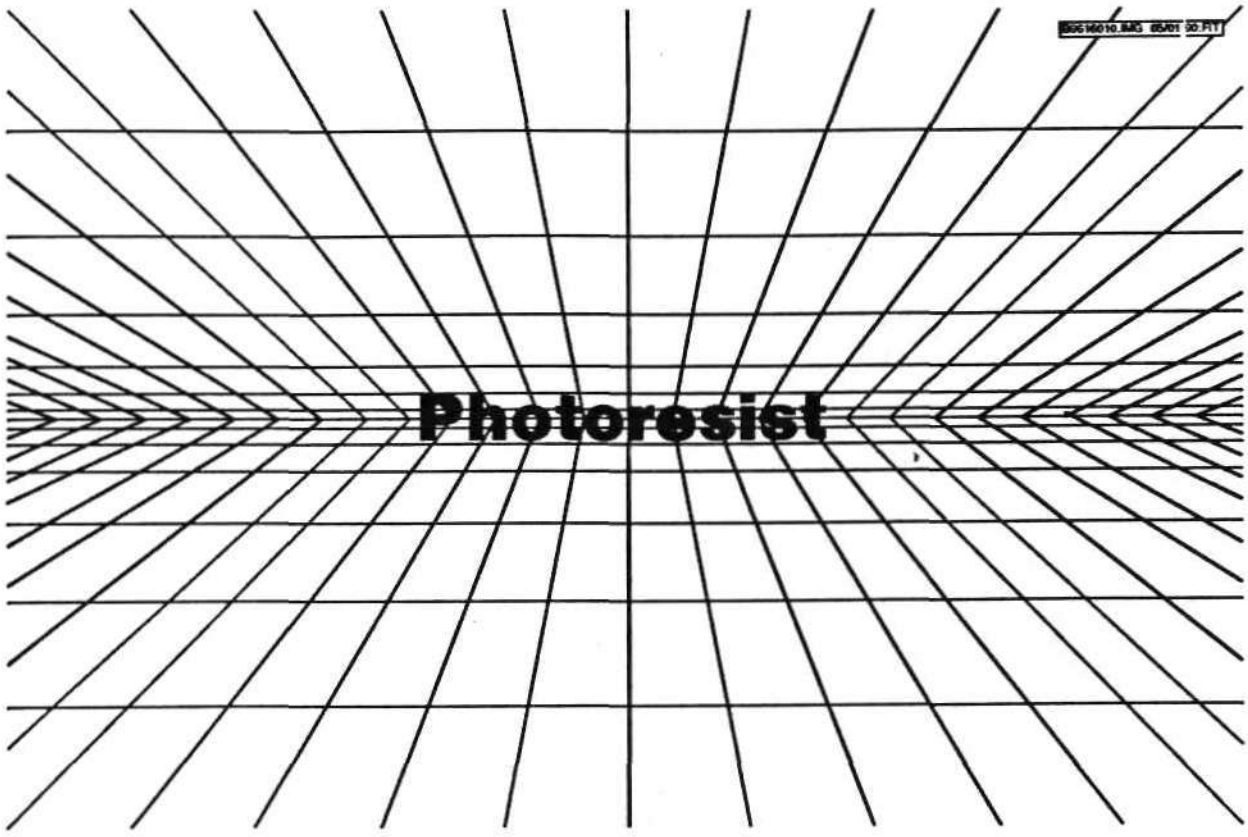
HURDLES FOR SILICON WAFER MANUFACTURERS

- Invest in 200mm wafer equipment
- Expand epitaxial wafer capacity (64Mb)
- Meet tighter specs: flatness, resistivity

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

THE COMPETITORS





Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PHOTORESIST TRENDS

	1988 4Mb	1991 16Mb	1994 64Mb	1997 256Mb	2000 Gigabit
Photoresist Type	G-line	G-line I-line	DUV	DUV X-ray	X-ray

Source: Dataquest

PUSH TO EXCIMER

- G-line – the technology of the 1980s
- G-line systems continue to improve
  - Alignment systems
  - High N.A. lenses
  - Wide-field lenses
- Prevailing g-line strategy
  - Push g-line to limits
  - Excimer laser steppers
  - I-line an interim technology

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PUSH TO I-LINE

- G-line may fade faster than expected
- A lot of activity in i-line
  - Japanese semiconductor manufacturers very interested in i-line
  - Stepper manufacturers introducing new systems
- I-line lens heating problem is solved
- I-line advantages
  - More depth of focus
  - More process latitude
  - Good for two generations of DRAMs

Source: Dataquest

X-RAY RESISTS

- Current market is insignificant
  - R&D evaluation
  - No production
- X-ray resist volume anticipated in 1995
  - 2 years after linewidth crosses 0.4 micron (1993)
  - 256Mb DRAMs

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

HURDLES FOR PHOTORESIST MANUFACTURERS

- Position company for change at excimer and the x-ray stepper introduction
- High degree of technical support
- Globalization

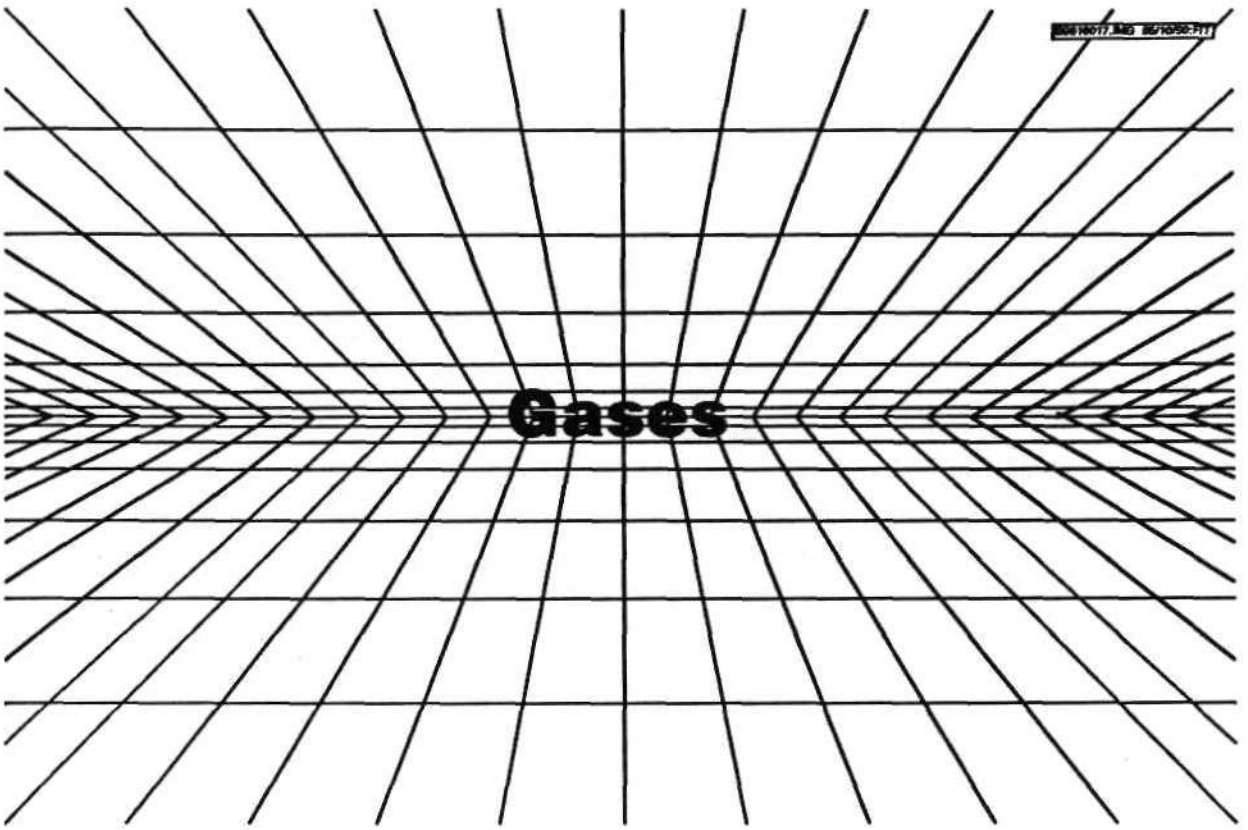
TOP 10 RESIST SUPPLIERS, 1988

(Estimated Revenue, Millions of Dollars)

Company	Worldwide	U.S.
1. Tokyo Ohka	$ 70	$ 7
2. Shipley	45	25
3. Hunt	36	17
4. Hoechst	15	10
5. KTI	14	9
6. JSR	9	0
7. Dynachem	6	5
8. Ciba-Geigy	5	1
9. Macdermid	3	3
10. Baker	2	2
Total	$205	$79

Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292



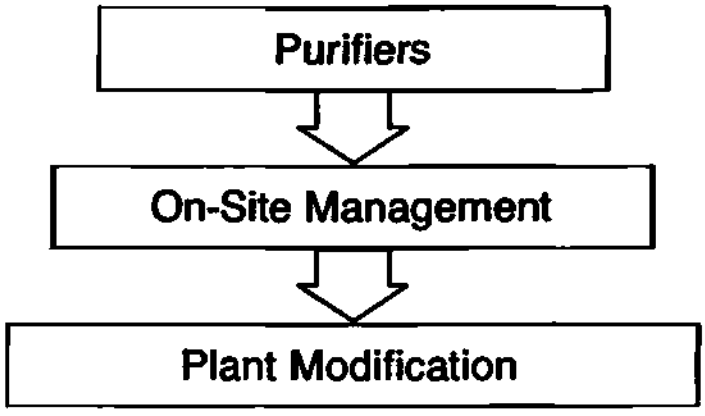
GASES TRENDS

	1988	1997	2000
Liquid Process	35%	10%	0
Gaseous Process	65%	90%	100%
Killing Defect Size (µm)	0.15	0.05	0.03

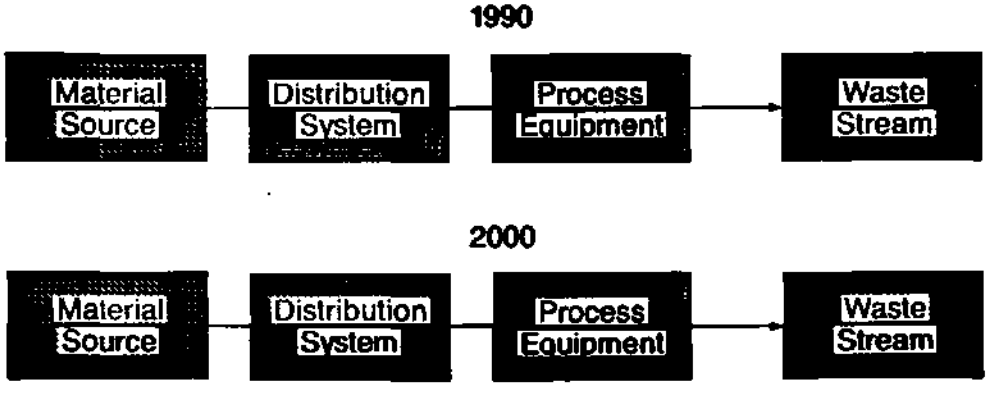
Source: Graydon Larrabee
Texas Instruments

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

THE MOVE TO HIGHER PURITY



VENDORS' RESPONSIBILITY FOR MAJOR SEGMENTS OF GAS SYSTEMS



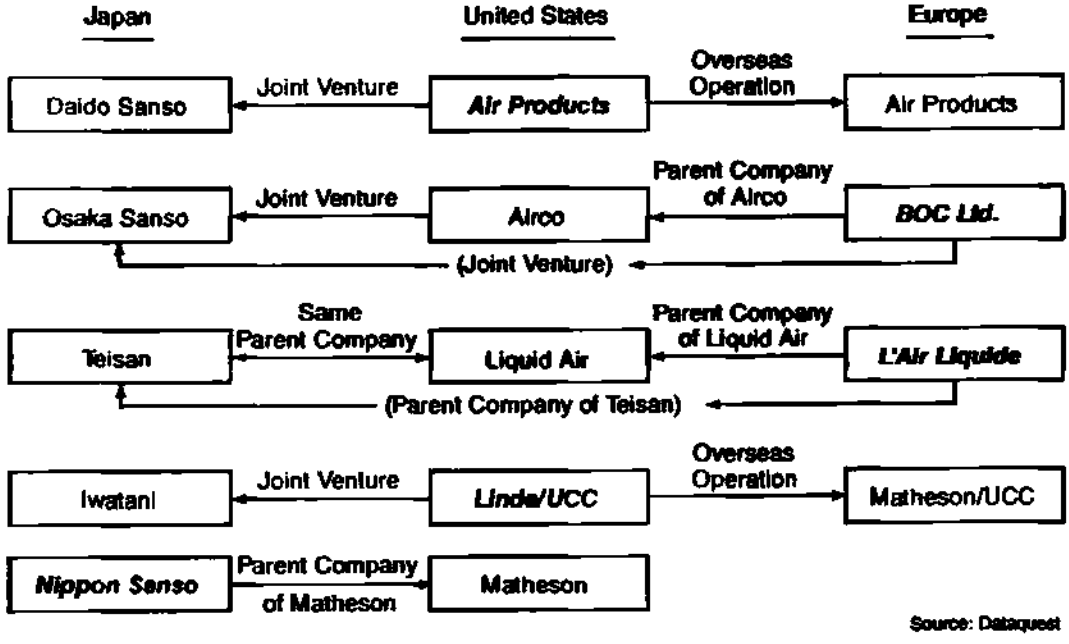
Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PLANTS PRODUCING HIGHER PURITY

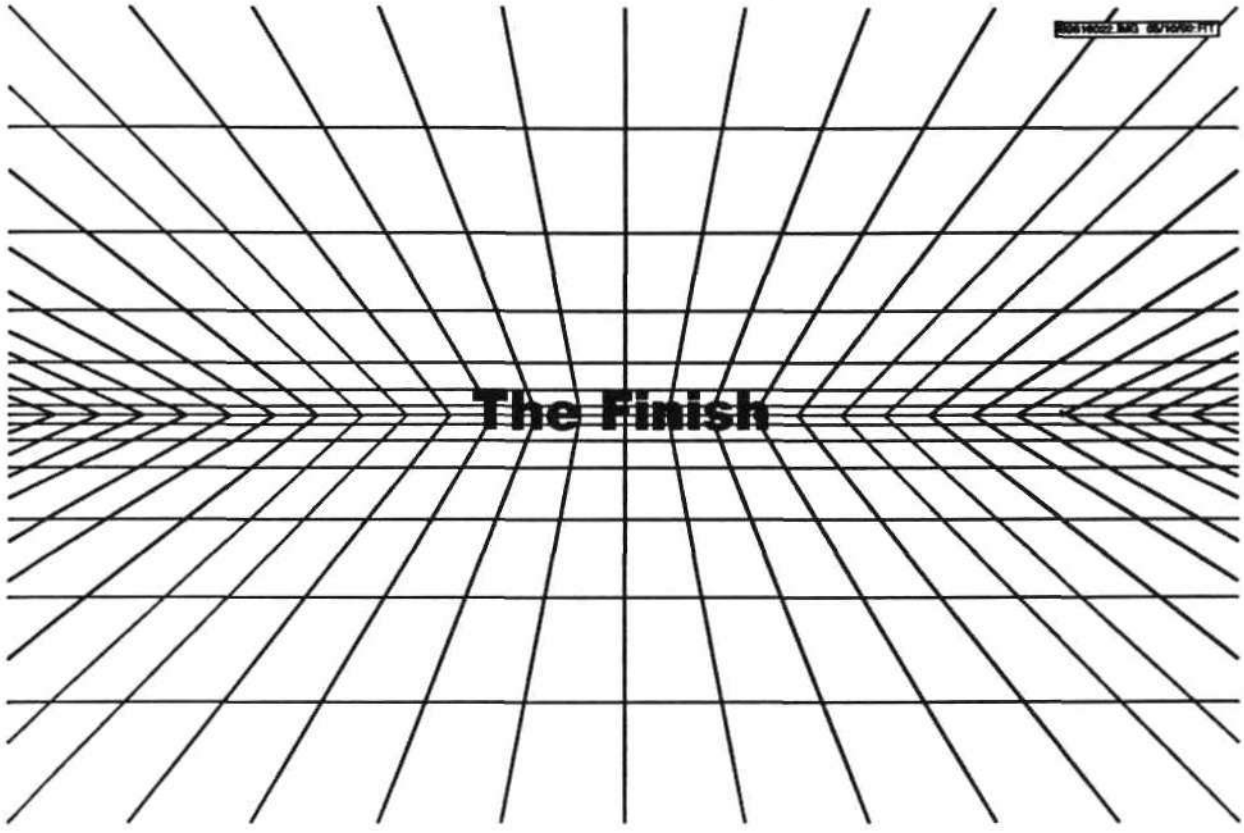
- Capital cost
- Operating cost
- Plant output reduced

GAS COMPANY INTERRELATIONSHIPS



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

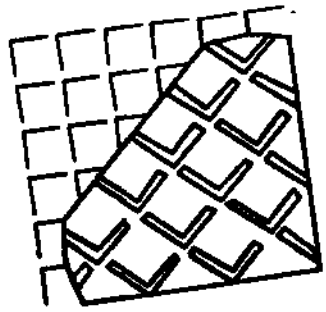


CONCLUSION

- Shift in technology
- Closer materials vendor-equipment-DRAM manufacturing relationship
- Large capital investment

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

Dataquest's 9th Annual
SEMICON/West Seminar
May 23, 1990



Trends in Packaging: The Drive toward High-Density Interconnect

Stan Bruederle
Vice President
Components Group Consulting
Dataquest Incorporated

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

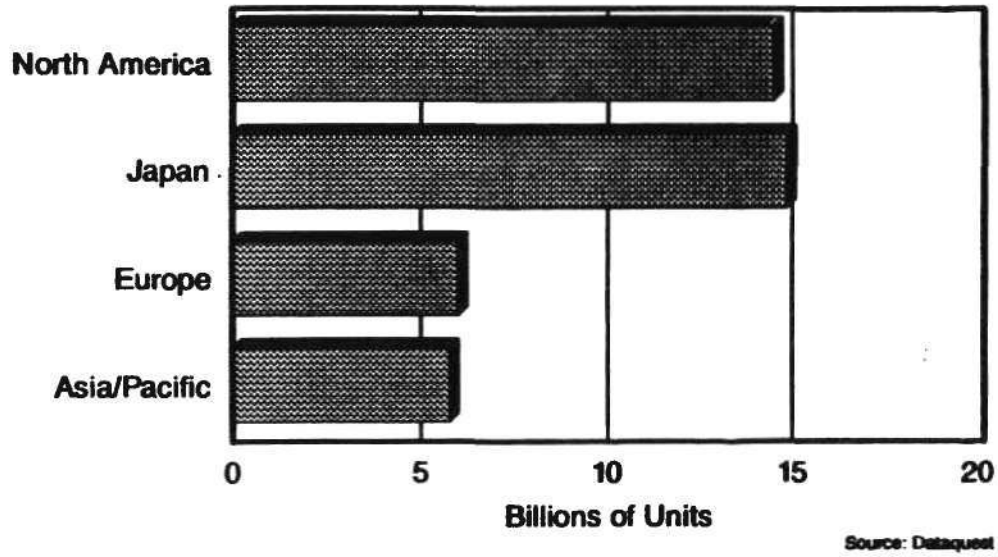
- Worldwide IC package market
- Emerging technologies analysis
- Applications demand analysis and forecast
- Strategic issues and opportunities
- Summary

AGENDA

- Worldwide IC package market

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

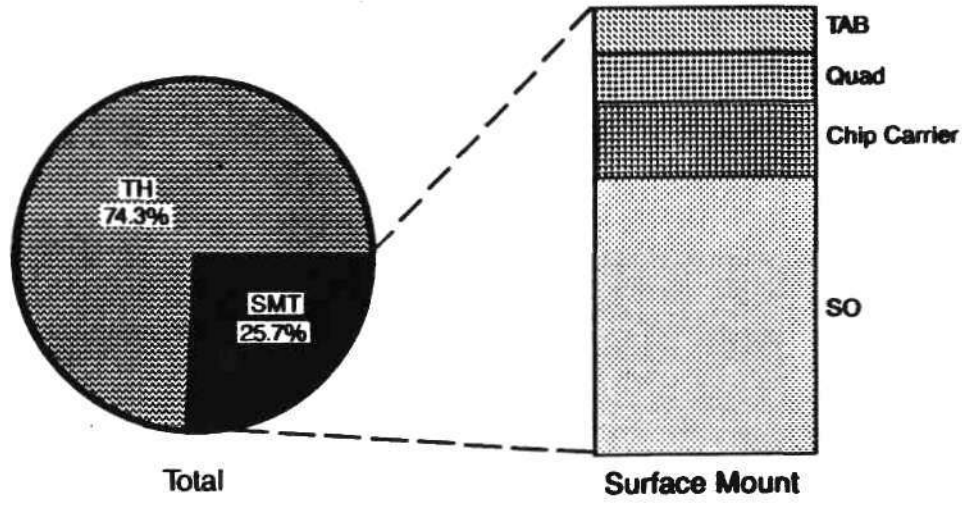
ESTIMATED 1989
WORLDWIDE PACKAGING TRENDS



Source: Dataquest

WORLDWIDE PACKAGE CONSUMPTION

1989 -- SMT versus TH



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

SURFACE-MOUNT TECHNOLOGY END-USE SEGMENTS -- 1989

	Japan	North America	Europe	ROW
End Use	Computer	Computer Automotive	Telecom	Consumer
Driving Force	Performance	Speed/Performance	Reliability	Small Size
% of ICs Consumed	39%	32%	17%	12%
Dominant SMT Approach	SO/Quad/TAB	SO/CC/TAB	SO/TAB	SO

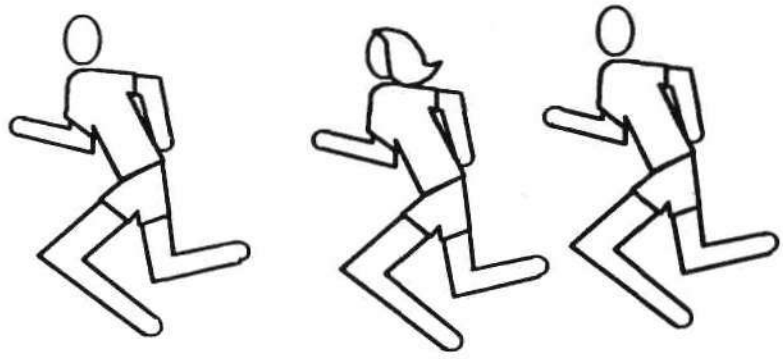
Source: Dataquest

AGENDA

- Worldwide IC package market
- Emerging technologies analysis

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

In the next decade, more performance strides will be made through improvements in semiconductor packaging than through semiconductor technology



Tomorrow, multichip modules will offer system-level cost savings AND significant performance improvements

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

MULTICHIP MODULE (MCM)

A collection of multiple die arranged in a thin-film multilayer interconnect structure that functions as a single integrated circuit, bridging the gap between printed circuit boards and wafer scale integration

AGENDA

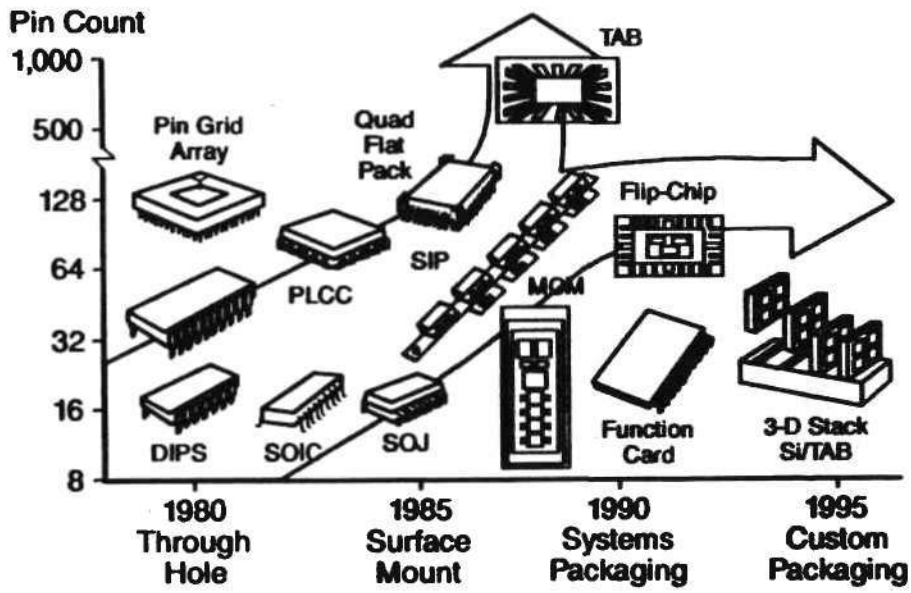
- Worldwide IC package market
- Emerging technologies analysis
- Applications demand analysis and forecast

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

MCM DRIVERS

- Supercomputers
- Laptop PCs
- Workstations
- Graphics terminals
- Storage devices
- Switching devices
- Optical communications
- Personal office equipment
- Portable communications
- Satellite communications

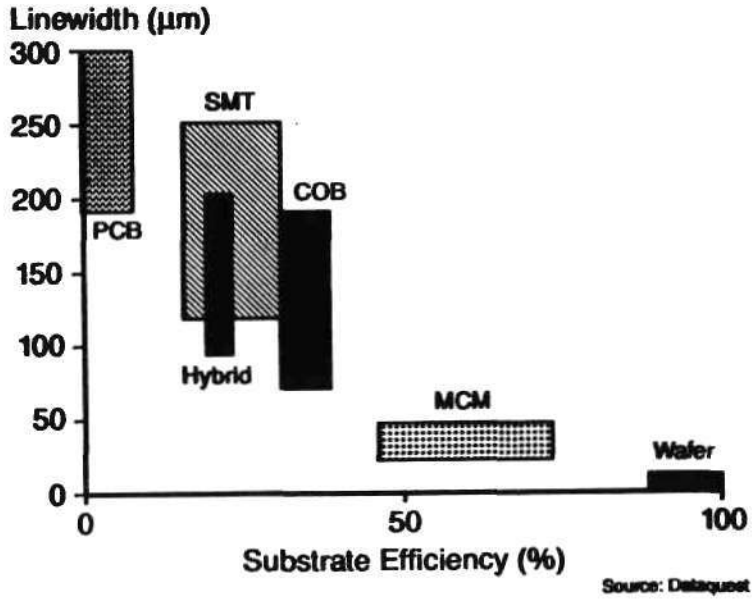
PACKAGING ROAD MAP



Source: Texas Instruments

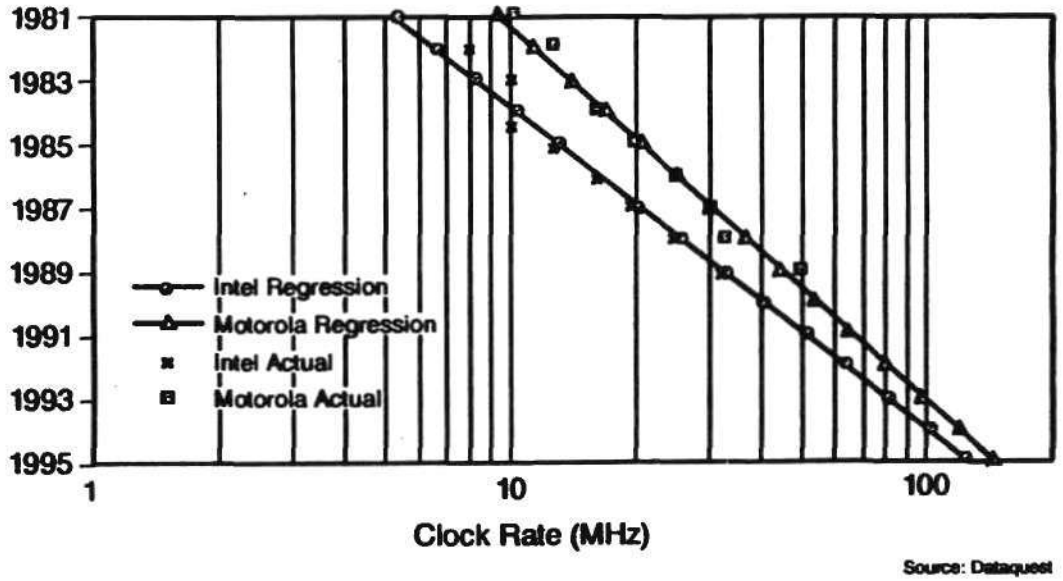
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PACKAGING EFFICIENCY AREA OF SILICON/PACKAGE



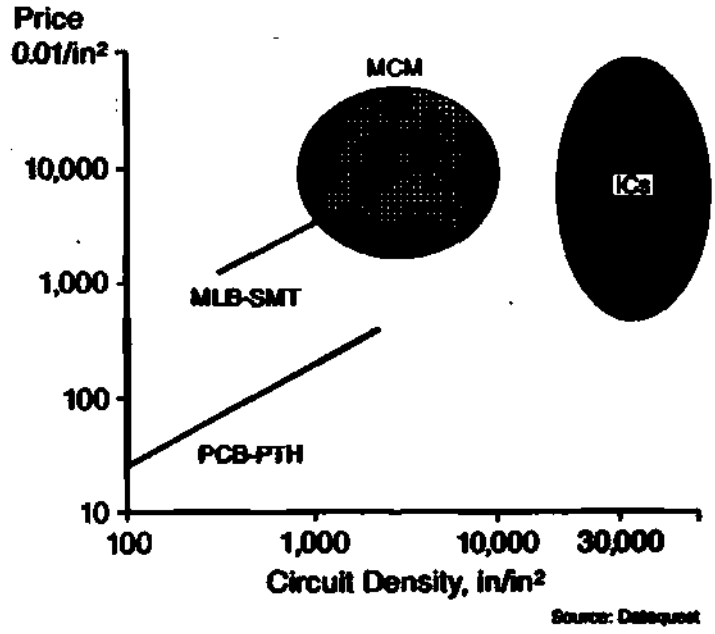
MICROPROCESSOR CLOCK RATES

Motorola and Intel



Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

INTERCONNECT TECHNOLOGIES



MULTICHIP MODULE ACTIVITY

Advanced Packaging Systems
Alcoa
British Aerospace
Holz Industries
Hughes Aircraft
ICI Array Technology
IDT
Kyocera
Mars Electronics
Midway
Mosaic
Multichip Technology
N + 1
Nara
N-Chip
Oki
Polycon
Polylithics
Raychem
Rogers
Silicon Connections
Thorn EMI
Unistructure

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

AGENDA

- Worldwide IC package market
- Emerging technologies analysis
- Applications demand analysis and forecast
- Strategic issues and opportunities

CRITICAL ISSUES

DESIGN REQUIREMENTS

- SIMULATION OF MULTICHIP DESIGNS
- TEST PROGRAM GENERATION
- COMPLETE SOFTWARE DESIGN VERIFICATION REQUIRED

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

CRITICAL ISSUES

MATERIALS REQUIREMENTS

- SUBSTRATE TECHNOLOGY
- INTERCONNECT TECHNOLOGY
- HEAT DISSIPATION REQUIREMENTS
- COST/PERFORMANCE TRADE-OFFS
- STANDARDS

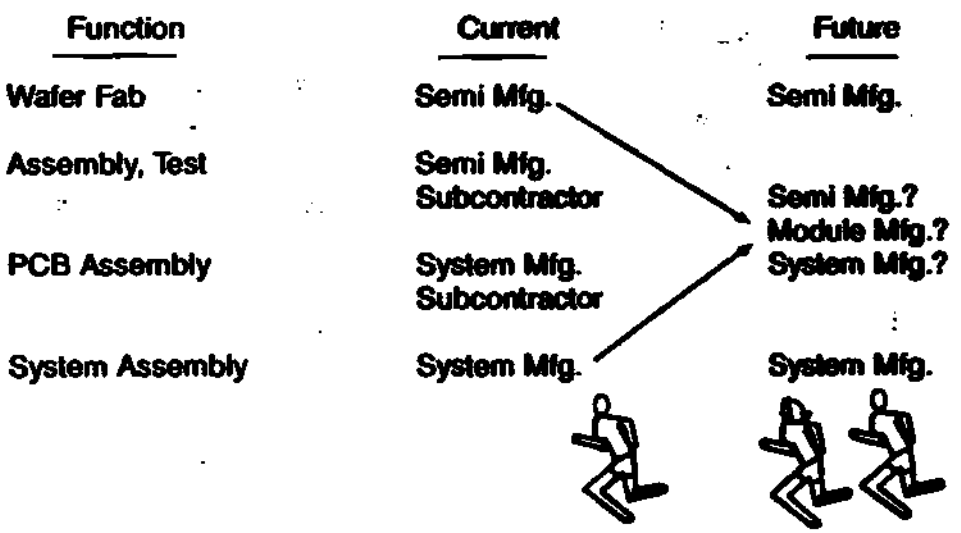
CRITICAL ISSUES

MANUFACTURING REQUIREMENTS

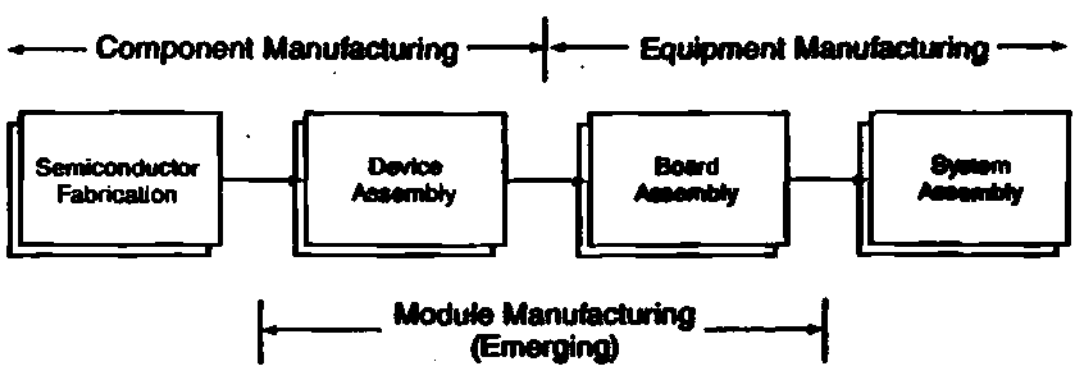
- CRITICAL DIMENSIONS/TOLERANCES
- FLEXIBLE MANUFACTURING
- MAKE/BUY ALTERNATIVE
- PPM QUALITY VS REWORK

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

MULTICHIP MODULES WILL CREATE A WHOLE NEW CLASS OF COMPANY



THE ELECTRONICS MANUFACTURING CHAIN



Source: Dataquest

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

MULTICHIP MODULES ARE COMING

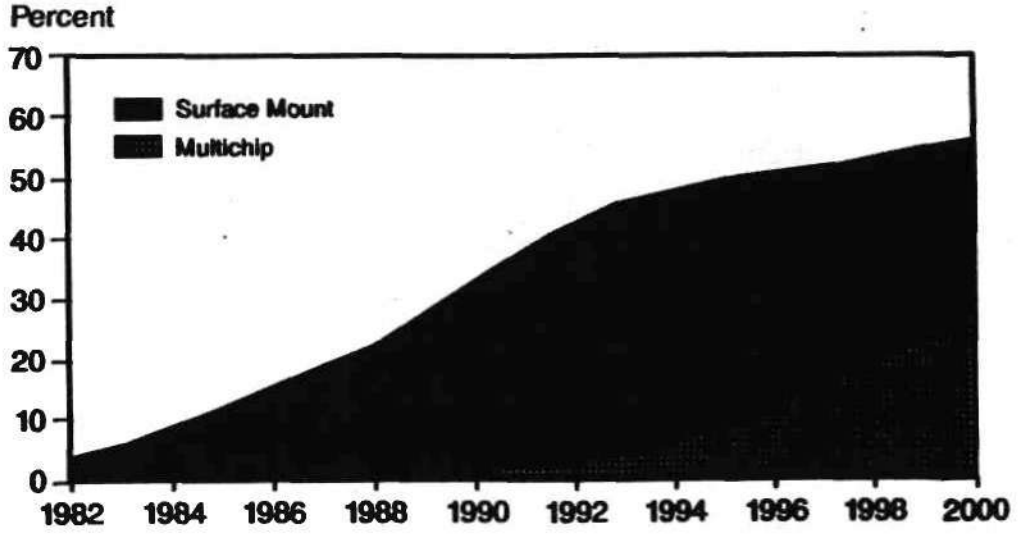
- Semiconductor clock rates will push above 50 MHz in near future
- Multichip modules provide means of taking advantage of these clock rates
- Price premiums in marketplace will support development of the technology
- Surface mount has prepared market to accept packaging innovations

MULTICHIP MODULES WILL CHANGE THE INDUSTRY

- Semiconductor and PCB assembly will be combined
- Leading semiconductor manufacturers will sell modules
- Opportunity will be created for module manufacturers
- System houses will license module technology
- Multichip module users will win in their markets

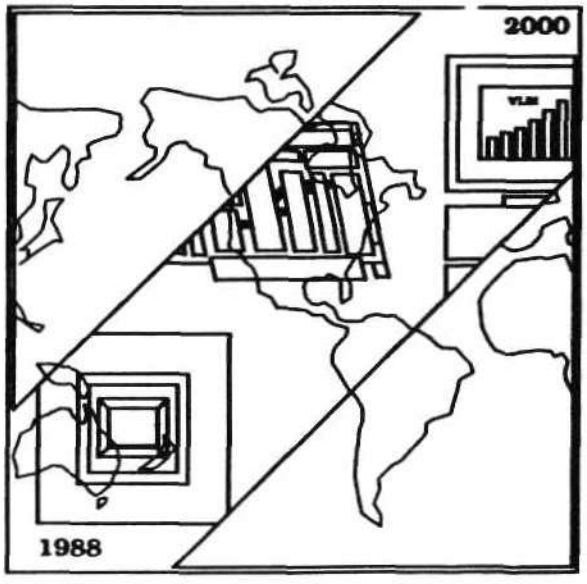
Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

PACKAGE MARKET SHARE



Source: Dataquest

Worldwide VLSI Packaging
Issues and Trends



A multiclient study examining existing and emerging VLSI packaging trends.

Dataquest Incorporated, a company of The Dun & Bradstreet Corporation
1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292