Nielsen Dataquest USER UPDATE

SUIS Code: Newsletters
No. 85-20

SEMICONDUCTOR INDUSTRY POISED
FOR MODERATE 1986 GROWTH: A BUYER OPPORTUNITY

Key indicators show that the worst of the current semiconductor recession is behind us and that the industry is building up steam for moderate growth in 1986. Price declines have slowed and in some cases risen (i.e., for 64K, 256K DRAMs) as production comes into balance with demand. Inventory corrections are nearing completion in the computer industry, and the telecommunications industry is expected to have inventory levels in line with shipments by the second quarter of 1986. These two actions constitute the main stimulus behind the anticipated 1986 recovery.

The industry did not drop as low as we forecast back in September. As production is sourced from new purchases rather than from inventory shelves, 1986 semiconductor shipments will increase at a steady 9.8 percent CAGR (see Table 1).

Low capacity utilization (< 60 percent) will allow for ready product availability in 1986 for those companies prepared for a business upturn. Among the factors determining readiness include semiconductor employment levels that dropped an average of 14.2 percent in 1985 in the United States and only averaged 5 percent in Japan. It remains to be seen whether companies with relatively high layoff percentages will be able to respond to large new demands in specific product areas.

The product areas to watch are:

- Gate arrays
- Microprocessors/micro peripherals
- Advanced Schottky logic
- Linear ICs
- Programmable logic

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Figures 1 and 2 provide insight into the imminent recovery, from the end-equipment perspective. These two charts cover the two largest domestic semiconductor user industries--computers and office equipment, and communications equipment. The computer and office equipment industry is expected to end 1985 at a 5 percent growth rate, while the communications industry will have grown by 10 percent in 1985.

The June inventory correction in the computer and office machine sector is nearly complete, based on surveys which indicate that some buyers are experiencing gradually lengthened lead times in certain products. DATAQUEST expects a similar inventory correction to occur in the communications industry in mid-1986.

DATAQUEST CONCLUSIONS

As capacity continues to be utilized, price decreases will slow considerably. DATAQUEST believes that semiconductor users should work closely with vendors on their long-term requirements now, in order to assure reliable supplies in 1986 and on through the recovery. The key areas to monitor are as follows:

- Price reductions will slow as production capacity becomes fully utilized.

- Lead times will remain steady and will not be affected by capacity usage until late 1986.

Mark Giudici

Table 1

ESTIMATED U.S. QUARTERLY SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

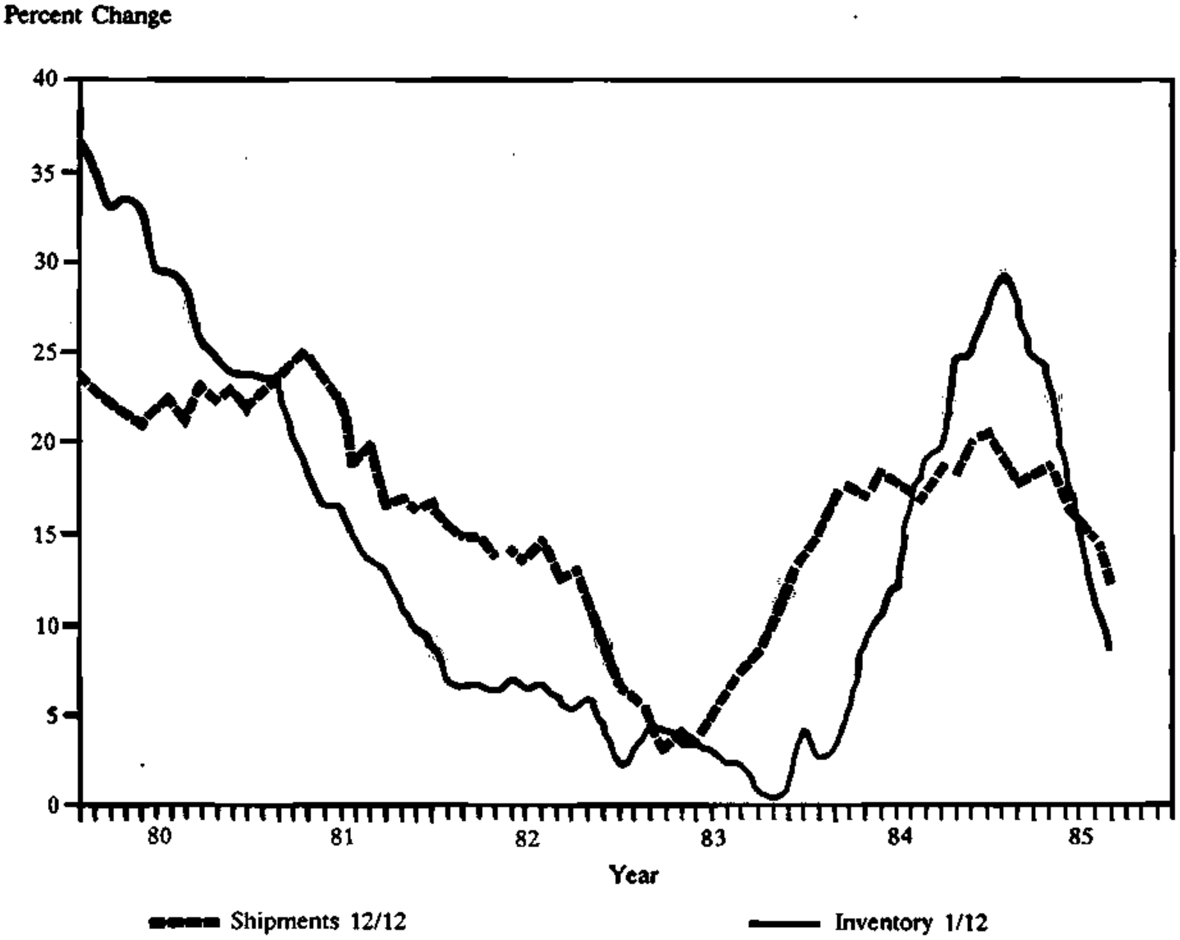
	1984	Q1	Q2	Q3	Q4	1985
Discrete	$ 2,229	$ 448	$ 430	$ 402	$ 412	$ 1,692
IC	11,104	2,328	2,068	1,819	1,744	7,959
Total	$13,333	$2,776	$2,498	$2,221	$2,156	$ 9,651
Percent Change	51.5%	(19.5%)	(10.0%)	(11.1%)	(2.9%)	(27.6%)

	1985	Q1	Q2	Q3	Q4	1986
Discrete	$ 1,692	$ 435	$ 471	$ 498	$ 542	$ 1,946
IC	7,959	1,820	2,057	2,226	2,548	8,651
Total	$ 9,651	$2,255	$2,528	$2,724	$3,090	$10,597
Percent Change	(27.6%)	4.6%	12.1%	7.8%	13.4%	9.8%

Source: DATAQUEST

Figure 1

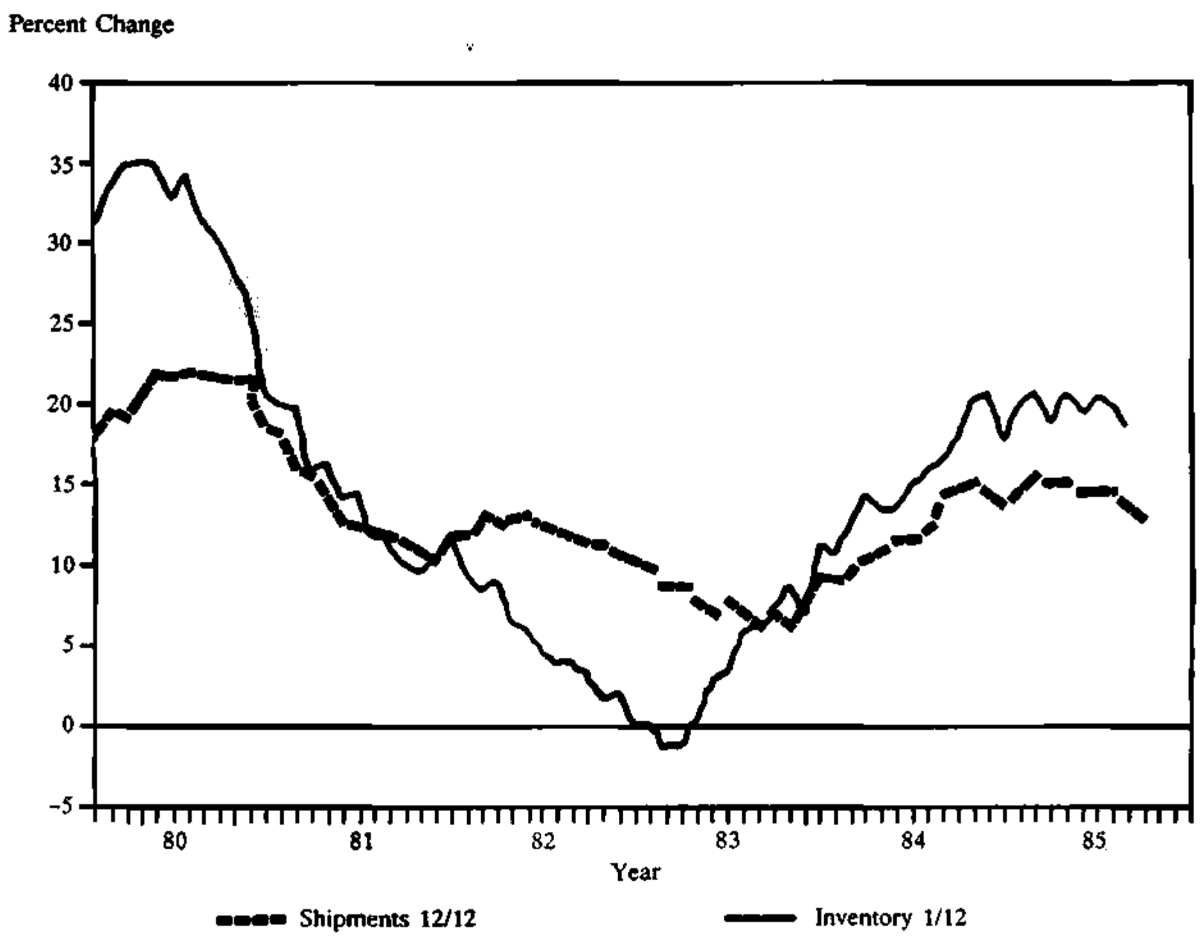
RATE OF CHANGE--OFFICE AND COMPUTING MACHINES



Source: DATAQUEST

Figure 2

RATE OF CHANGE--COMMUNICATIONS EQUIPMENT



Source: DATAQUEST

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CUTTING PC COMPONENT COUNTS AND COSTS: DESIGNING FOR SURVIVAL

SUMMARY

There has been a lot of recent lip service in the PC industry about cutting costs or being the low-cost producer in a particular product segment. Because of its immense size, buying power, and economies of scale, many people believe that IBM is the lowest-cost producer. Whether or not that is true is questionable; whether or not IBM has the lowest-cost design is not. The real key to component and manufacturing cost control is engineering, not economics.

By redesigning very low-cost motherboards (and, therefore, simpler, and cheaper manufacturing processes), companies such as Apple, Commodore, and Sinclair have managed to survive and grow with proprietary systems much more successfully than they would have if they continued with the original PET, Apple II+, and ZX-80 designs. The number of ICs in a C64, Apple IIc, and QL (three whole computers) is less than that of an IBM PC motherboard.

Elegant, streamlined designs benefit the bottom line directly by decreasing costs for:

- Parts inventory and handling (fewer parts)
- Casing, packaging, and shipping (smaller footprint, lower weight)
- Power supplies (lower power requirements)
- Assembly and other labor (fewer parts)

Such designs are also much more conducive to robotic assembly, automated factories, and just-in-time inventory procedures.

This newsletter takes a close look at the component count and costs of a typical "state-of-the-art" personal computer and explains how proper, advanced design can drastically change manufacturing costs.

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THE IBM PC AT: A VIEW INSIDE

Despite heated competition in a tough marketplace, the IBM PC AT and its look-alikes have weathered the 1985 storm rather well. In August, DATAQUEST's Semiconductor Application Markets analysts probed the IBM AT and analyzed the machine's IC content.

The AT that they examined contained 251 integrated circuits, amounting to an estimated cost of $457.24. We believe that this IC cost has dropped dramatically, by as much as 25 to 30 percent, since the AT was first announced. DATAQUEST derives estimated component content by contacting sales offices and distributors, comparing single-quantity prices, and assuming an average large-quantity discount. We supplement this information with the research and analysis of our semiconductor product analysts and pricing/trend information from our Semiconductor User Information Service.

DATAQUEST included three boards in the analysis. The main system board contained 125 components valued at $289.69. The display board contained 66 ICs valued at $35.02, and the disk controller board had 60 devices valued at $132.53. Table 1 reflects the overall AT IC content, by product area, quantity, and aggregate value. Table 2 lists the device manufacturers whose chips were prevalent on the boards.

Overall, there were 178 standard logic devices, 38 of which were from the ALS product family. The ALS devices were heavily concentrated on the main board but used less elsewhere in the system. We were also interested to note that ASIC devices accounted for just over 10 percent of the system IC cost. We believe that the AT is one of IBM's first uses of PLA devices to reduce logic component quantities in its PC family.

We believe that there is further opportunity to reduce the TTL "glue" devices that are still used throughout the system. We aggregated the device count and assumed averages of gates per package for both medium- and small-scale devices. We estimated 8 gates per small device and 25 gates per medium device. Accordingly, the 178 devices amounted to approximately 2,971 gates, which we evaluated at two- to five-tenths of a cent per gate, or approximately $7.43, i.e., the associated cost for gate arrays, compared to the combined logic device costs found on the system's three boards.

One caveat in this analysis is that it merely indicates the cost for the gates utilized, without accounting for the actual size (and cost) of the device(s) that would have to be implemented. The AT system logic that would be implemented on a gate array is pin intensive, requiring larger (more expensive) devices than a logic gate count would indicate. Low gate utilization combined with pin-intensive system partitioning would make a gate array solution substantially more expensive than the $7.43 figure indicates.

Table 1

ESTIMATED IC CONTENT
IBM PC AT

Main System Board	Quantity	Cost
Standard Logic		
Small Scale	36	
Medium Scale	36	
	72	$ 21.45
Micro Devices (80286-6 based)	9	91.14
Memory (predominantly 128K DRAMs "stack packs")	41	168.70
ASIC	3	8.40
Main System Board Total	125	$289.69
Display Board		
Standard Logic		
Small Scale	24	
Medium Scale	32	
	56	$ 14.85
CRT Controller	1	3.17
Memory (16K DRAMs)	8	12.00
ASIC	1	5.00
Display Board Total	66	$ 35.02
Disk Controller Board		
Standard Logic		
Small Scale	27	
Medium Scale	23	
	50	$ 12.40
Microperipherals	5	84.53
Memory (16K SRAMs)	2	2.80
ASIC	3	32.80
Disk Controller Board Total	60	$132.53
Total Estimated IC Content, IBM PC AT	251	$457.24

Source: DATAQUEST

Table 2

COMPONENT MANUFACTURERS
IBM PC AT

Main System Board	Manufacturer
Standard Logic	Texas Instruments Fairchild
Micros	Intel
Memory	Mostek Texas Instruments
ASIC	Monolithic Memories
Display Board	
Standard Logic	Texas Instruments Fairchild National Semiconductor
Micros	Motorola
Memory	Mostek
ASIC	IBM
Disk Controller Board	
Standard Logic	Texas Instruments
Micros	Western Digital Intel
Memory	Synertek
ASIC	Western Digital AMD

Source: DATAQUEST

DATAQUEST ANALYSIS

DATAQUEST believes that cost-effective gate array solutions are being developed. Chips and Technologies, a Milpitas-based start-up, is currently delivering a chip set for the PC AT and other 80286-based systems. The chip set integrates much of the TTL and some of the peripherals surrounding the system processor. Two other Silicon Valley firms, Faraday Electronics and Zymos Inc., are also working on similar chip sets for the IBM PC XT and its subsystems.

During the 1984 through 1987 great PC shakeout, manufacturers are facing increasingly intense competition and extremely sharp pricing. After the traditional reactive responses of layoffs, reorganizations, and revamped marketing strategies, PC firms must become proactive in their survival strategies. At that point, product manufacturing costs such as the component count and cost will come under much scrutiny. DATAQUEST expects that by the middle of 1986, several second- and third-tier PC manufacturers that are seeking to maintain their competitive edge will introduce chip set-based PC clones.

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Nielsen Dataquest
USER UPDATE

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FAST MOS STATIC RAMS

SUMMARY

Fast MOS static RAMs constitute the largest performance-optimized product market in the entire MOS memory portfolio. Having speeds comparable to most TTL RAMs and some of the slower ECL devices, fast MOS static RAMs are more and more often becoming the device of choice in many high-performance systems because of their high density, low power, or low cost. In addition, with device performance being the principal driving force in the chip circuit design and system application (more than price per bit, for example), fast MOS static RAMs are used in a unique set of applications at a relatively concentrated set of customers and well-defined set of systems.

As a result, the fast MOS static RAM market behavior is different from that of slow static RAMs, EPROMs, ROMs, and most dynamic RAMs. Product life cycles are prolonged, and healthy markets continue to exist for higher-speed, low-density devices long after the next generation becomes available. New high-performance CMOS technologies are adding momentum to the penetration of MOS in speed-optimized applications.

Shipments of fast MOS static RAMs from 21 participating vendors were estimated to have been $315 million during 1984. Table 1 shows the estimated market composition by density and technology of device. In 1984, the fast MOS static RAM market size exceeded that of bipolar RAMs (TTL and ECL combined) for the first time.

Fast MOS SRAMs constituted approximately 20 percent of the total MOS static RAM units shipped in 1984, accounted for 15 percent of the total MOS SRAM bits, and generated 28 percent of the total SRAM dollars.

This newsletter summarizes data collected through a survey that was followed by interviews with all major fast MOS static RAM manufacturers, as well as a number of prospective entrants to the market. The comments of 14 vendors and several users and industry observers were incorporated into the data summarized below.

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Table 1

ESTIMATED FAST MOS SRAM REVENUES
(Millions of Dollars)

Device	1984	1985
1K NMOS	$ 3	$ 2
1K CMOS	1	3
4K NMOS	47	36
4K CMOS	9	6
16K NMOS	191	163
16K CMOS	58	86
64K NMOS	2	9
64K CMOS	4	35
Total	$315	$340

Source: DATAQUEST
October 1985

Worldwide Regional Markets

The United States constitutes approximately 65 percent of the worldwide total available market (TAM), with a number of vendors selling close to 80 percent of their fast SRAMs into the U.S. market. Japan was 22 percent of the world market, Europe was 13 percent, and Rest of World (ROW) made up less than 1 percent of the worldwide TAM. More than half of Japan's 22 percent was used internally at three of the major Japanese suppliers--Fujitsu, Hitachi, and NEC.

Vendors' Market Shares

Japanese vendors, led by the three vertically integrated semiconductor-computer suppliers, had the largest market share in 1984, with 51 percent of the total revenues, followed by the European vendors (principally, Inmos Corp.) with 28 percent and U.S. vendors with 21 percent.

Speed Mix

The speed mix is still a strong function of device density. Fast 4K MOS SRAMs, introduced in 1977, average close to 35ns. Fast 16Ks, introduced in 1980/1981, averaged between 45ns and 55ns, with volumes of 35ns devices just beginning late in 1984. Fast 64Ks, which were introduced in 1984, were mostly 45ns and 55ns. Second-generation 16Ks using newer 64K technologies are expected to yield significantly to 25ns and 35ns in 1985 and 1986.

Architecture

Initially only x1 devices were available, but healthy markets now exist for 1Kx4, 4Kx4, and 2Kx8, and the outlook for 16Kx4 and 8Kx8, at the 64K density, is promising. About 30 to 35 percent of 4K revenues are generated by the 2148/2149/6148-type parts; about 25 percent of the 16K dollars are 4Kx4 or 2Kx8. However, as the 16K market matures, the 4Kx4 and 2Kx8 devices are expected to increase their shares significantly. In the mature 64K market, all three organizations (64Kx1, 16Kx4, and 8Kx8) should be represented in nearly equal proportions.

Technology

Scaled NMOS has traditionally been the mainstay technology of fast SRAMs, but is increasingly being challenged by CMOS. Hitachi's HiCMOS 6147 (4Kx1) and 6148 (1Kx4) followed pioneer Intel's 2147 into the market by about 18 months in 1977 to 1978. The technology is shifting rapidly, however, and NMOS may nearly be squeezed out of the 64K market. The CMOS devices are both 4Tx and 6Tx cells, and either P-well or twin-tub. Leading-edge devices, such as the emerging 64K densities, typically use 1.5 m design rules, and are mostly CMOS.

End Use--Equipment

In 1984, an estimated 50 percent of the fast MOS static RAM market was in EDP equipment, 2 percent was in consumer products, 20 percent was in communications, 11 percent was in industrial equipment, and 17 percent was in government and military.

End Use--Applications

In 1984, cache memory made up an estimated 33 percent of the fast static RAM market, main memory (principally for mainframes or supercomputers) made up 22 percent, buffer memory made up 17 percent, video applications made up 5 percent, MOS microprocessor-associated applications made up 2 percent, writable control store applications made up 19 percent, and 2 percent were made up by the other applications.

Package Mix

In 1984, an estimated 70 percent of units were shipped in plastic DIPs, 20 percent were in ceramic DIPs or CERDIP, 8 percent were in leaded or leadless chip carriers, and 2 percent were in flatpak or other packages At the 4K level, CERDIP was more strongly represented than 16K or 64K. Surface Mounted Devices (SMDs) may constitute up to 30 to 40 percent of packages by 1988, and fewer than 10 percent of packages are expected to be ceramic or CERDIP by that time.

Specialty Parts

Several manufacturers are looking at variants of the standard fast static RAM that can further enhance system performance. Examples on the market include innovative high-density packages, resettable RAMs for cache memories, dual-port RAMs for multiprocessor systems, and devices with separate input and output pins to enhance performance in systems using several high-speed devices.

Fast Static RAMs—Definitions

The static RAM market can be divided into two submarkets based not only on speed, but also to a large degree on application:

- The "fast" static RAM market is that portion of the market where the fastest device available can be used to improve the system performance. These systems may have bit-slice processors, standard logic, or gate arrays as the associated processor or logic.

- The "slow" static RAM market consists primarily of local store in MOS microprocessor-based applications. In these applications, the microprocessor usually limits the speed of the system; getting a faster part than is required by the MPU does not enhance system performance.

Therefore, for the purposes of this survey, we have used the following definition:

Fast 4K parts have access speeds of less than 70ns, and include the 2147, 2148, 2149, 6147, and 6148, or equivalents. Fast 16K and 64K static RAMs include all 16Kx1, 4Kx4, 64Kx1, and 16Kx4 devices, regardless of speed. All the devices are sub-100ns and almost all are sub-70ns. Also included as fast devices are those x8s that have access speeds of less than or equal to 55ns. This latter group now includes only Cypress, Motorola, and Toshiba, but several fast 8Kx8s are expected during 1985 or 1986.

MARKET BREAKDOWN, DISCUSSION, AND FORECAST

In each of the sections below, we have included a fuller discussion of the fast MOS SRAM market breakdown, describing expected shifts in market makeup for the coming years.

Market Characteristics

The applications of fast MOS SRAMs and the consequent market behavior differ from those of other MOS memory devices in a number of important respects:

- More big system usage; less low-end equipment; end equipment has longer life cycles
- Less price volatility than DRAMs, slow SRAMs, or EPROMs, but still steady price erosion (albeit more slowly)
- Device manufacturers' design emphasis skewed more toward speed improvement than density increases or cost reduction
- Steadier market at lower densities; new entrants may begin with fastest available part at a lower, older density
- Less motivation for systems makers to roll over to higher density devices; longer-lived markets for older products
- Market introduction of a given fast static RAM density may lag the slow part of the same density by 12 to 18 months
- Production ramp-up of fast SRAMs is gradual because of their systems applications--large systems with extended design cycles and in need of performance more than density

Market Growth

Fast SRAM units were about 20 percent of the total MOS static RAM units shipped in 1984, and made up 28 percent of the total SRAM dollars. DATAQUEST expects the percentage of revenues generated by fast parts shipped to continue to increase over the next several years, and perhaps reach as high as 40 to 45 percent of total SRAM revenues by 1988 or 1990. By 1990, the fast SRAM market is expected to be more than $920 million, with 64Ks and 256Ks being the principal contributors. The fast static RAM increase as a percentage of the total is expected to occur since CMOS DRAMs will be able to displace some of the slow CMOS static RAMs, and fast static RAMs are expected to encroach further on the bipolar RAM market, especially TTL RAMs.

By 1990, the percentage of units may rise to perhaps 30 to 35 percent of the SRAM total, and fast SRAM bits will be about 20 to 25 percent of total bits, up from 15 percent in 1984. These differences--revenues, units shipped, and bits--are because the life cycles of fast parts seem to be longer than those of slow parts, so the average bits per package are less. In addition, since the most desirable characteristic in this market is speed rather than high density, users will stay with a lower-density part longer than with a slow part. Thus, although fast parts are increasing as a percentage of units, the percentage of bits is not expected to increase as quickly.

Worldwide Regional Markets

Worldwide regional market estimates, as a percentage of the total world market, are shown below (note that a sale to a U.S. company is defined as U.S. consumption, regardless of the destination to which the part is shipped):

	1984	1985	1988
North America	65%	63%	57%
Japan	22	24	27
Europe	13	13	14
ROW	0	0	2
Total	100%	100%	100%

The U.S. percentage of the worldwide merchant TAM was 65 percent in 1984. This percentage is significantly larger than for overall MOS memory, which averages about 55 percent of the worldwide TAM in the United States. The primary reason for this difference is that fast static RAMs are high-performance parts, many of which go into large computers and are used by the U.S. military.

In 1984, Japan accounted for 22 percent of the worldwide merchant TAM, and Europe had 13 percent. These percentages are expected to shift over the next few years, with Japan increasing to 27 percent of the TAM by 1988, and the United States dropping to 57 percent.

North American Regional Markets

This was the one area of the survey where we were unable to get good data. Specific data on regional distribution was not obtained, since each vendor divides the United States into regions differently. We do know, however, that Minneapolis is one of the largest regional markets, as is the Northeast.

Vendors' Market Shares

As shown in Table 2, Inmos was the top supplier of fast static RAMs last year and, at $85 million, constituted the major portion of the European market share of 28 percent. Fujitsu, Hitachi, and Toshiba were the next three biggest suppliers, with $70 million, $41 million, and $22 million, respectively. They contributed to the Japanese market share of 51 percent. The U.S. suppliers had 21 percent of the market, with the leading suppliers being AMD, IDT, and Intel.

Table 2

LEADING SUPPLIERS OF FAST MOS SRAMS
(Millions of Dollars)

	1983	1984
Inmos	$ 34	$ 85
Fujitsu	41	70
Hitachi	38	41
Toshiba	4	22
Intel	22	20
IDT	7	18
AMD	12	17
Mitsubishi	4	14
NEC	10	12
Others	17	16
Total	$189	$315

Source: DATAQUEST
October 1985

Table 3 shows the range of production or announced fast SRAMs. Almost all of those of 16K density or below are in production; only a few of the 64Ks are.

Table 3

FAST SRAM PRODUCT OFFERINGS

Company	Density and Organization									
	1K		4K		16K			64K		
	1Kx1	256x4	4Kx1	1Kx4	16Kx1	4Kx4	2Kx8*	64Kx1	16Kx4	8Kx8**
AMD			N	N, N	N	C		C	C	C
Cypress		C	C	C			C	C	C	C
Fairchild								C	C	
Fujitsu			N	N, N	N, C	N		N, C	C	C
Harris					C					
Hitachi			C	C	C	C		C, BiC	C	
IDT					C	C	C	C	C	C
Inmos					N	N, C		C	C	
Intel	N		N	N, N	C	C		C		
Lattice						C		C	C	
Matra-Harris			C	C	C	C	C			
Mitsubishi					N	N				C
MOSel						C				
Motorola			C		N	C	N	C	C	C
NEC			N		N			C	C	
National			N	N						C
Oki Electric									C	
Ricoh						C				
STC			N	N	N	N				
Seiko								C	C	C
Sharp			N	N	C					C
Sony					C	C	C	C	C	C
Texas Inst.										
Toshiba						N	N	C	C	N
Visic (SRAM)								C	C	C
Vitelic					C	C	C	C	C	C
VLSI Tech.								C	C	

C = CMOS
N = NMOS
*Includes 2Kx9
**Includes 8Kx9
BiC = Bipolar/CMOS

Source: DATAQUEST
October 1985

Sales Channels

Distribution by sales channel for 1984, 1985, and 1988 are shown below:

	(Percent of Dollars)		
	1984	1985	1988
OEM/Direct	71%	69%	66%
Distribution	16	17	18
Internal	13	14	16
	100%	100%	100%

Distribution by sales channel is quite different for the U.S. and European manufacturers, compared to the vertically integrated Japanese vendors. The average of 1984 fast MOS static RAM internal consumption for U.S. companies was less than 1 percent of sales, while internal consumption for the top three Japanese vendors was 23 percent of sales.

The U.S. and European companies rely more heavily on direct sales and distribution, with 79 percent of fast static RAM revenues coming from OEM or direct sales and 21 percent from distribution, compared to 66 percent OEM sales and 11 percent distribution for the Japanese companies.

Speed Distribution

The actual 16K and 64K speed mix for 1984 and estimated mix expected for 1985 and 1988 are as follows:

- 16K Devices (Percent of Units)

	1984	1985	1988
≤25ns	0.0%	0.5%	3.0%
26-35ns	1.2	6.2	16.0
36-45ns	16.3	28.8	42.0
46-55ns	50.0	45.2	30.0
≥56ns	32.5	19.3	9.0
Total	100.0%	100.0%	100.0%

- 64K Devices (Percent of Units)

	1984	1985	1988
≤25ns	0.0%	0.4%	6.0%
26-35ns	1.3	6.0	26.0
36-45ns	25.3	42.1	43.0
46-55ns	46.2	39.5	18.0
≥56ns	27.2	12.0	7.0
Total	100.0%	100.0%	100.0%

For 4K SRAMs, the speed mix for 1984 was approximately 80 percent with less than or equal to 35ns (with a substantial portion of 25ns) and 20 percent with 45ns or slower.

Some vendors offer a 20ns, 30ns, 40ns, or 50ns split, as well, though it is not common. Products may be 10ns slower to guarantee operation over the full military temperature range.

Architecture

Historically, the x1 parts have been the first device introduced by any manufacturer, but this is changing. Although the 4Kx1, 16Kx1, and 64Kx1 were the first available on the market by nearly a year (versus the 1Kx4, 4Kx4/2Kx8, or 16Kx4/8Kx8), many vendors will offer 16Kx4 or 8Kx8 as their initial product introduction. This is because:

- The x4 and x8 markets are better developed than formerly.
- Later entrants to the market at a given density can be more timely if they start with a x4 or x8 device, which may be less competitive early in the product life cycle.
- A larger fraction of the fast market at each new generation is going into the alternative architectures.

Estimates of the fast SRAM market development by organization are provided in Table 4.

Table 4

ESTIMATED FAST MOS SRAM MARKET DEVELOPMENT BY ARCHITECTURE AND TECHNOLOGY (Millions of Units)

Organization	1983	1984	1985	1986	1987	1988	1989
4Kx1	11.7	10.8	7.4	5.6	3.5	2.5	1.5
1Kx4	5.1	6.2	4.1	3.2	2.0	1.5	1.0
16Kx1	7.8	21.2	25.0	40.0	52.0	33.0	23.0
4Kx4	3.3	13.2	23.0	36.0	45.0	30.0	20.0
2Kx8*	1.7	2.9	5.0	16.0	22.0	15.0	12.0
64Kx1	N/A	0.1	2.0	5.4	16.8	30.5	43.8
16Kx4	N/A	N/A	0.2	3.2	13.3	30.8	51.5
8Kx8*	N/A	N/A	0.1	3.1	11.9	25.5	39.7
256K (x1, x4, or x8)	N/A	N/A	N/A	0.2	1.2	10.5	21.5

Density	Percent CMOS						
	1983	1984	1985	1986	1987	1988	1989
4K	12%	16%	17%	11%	8%	5%	5%
16K	26%	22%	34%	39%	45%	69%	70%
64K	N/A	50%	79%	83%	88%	88%	93%
256K	N/A	N/A	N/A	100%	100%	100%	100%

*Includes 2Kx9 or 8Kx9, as appropriate.

Source: DATAQUEST
October 1985

Price Premium for Speed

Given the following 16K fast static RAM market speed distribution, which approximates the 1984 market mix for NMOS 16Kx1 devices, the following are estimates of the relative prices for various speeds:

	Percent of Total Units	Relative Price
≤35ns	0.5%	2.00
36-45ns	22.0	1.25
46-55ns	42.5	1.00
56-70ns	20.0	0.90
≥71ns	15.0	0.70
Total	100.0%	1.00

These price premiums give a general indication of pricing based on speed, but the market's supply-demand balance will affect this dramatically. Price is determined not only by the percentage of the market at a given speed, but also by the number of suppliers of that speed. Price premiums for the fastest speed part could range from 1.5 times to 5 times the average price, and at the slowest speeds some suppliers can find themselves practically giving away the parts.

Technology

NMOS parts still comprise about 80 percent of the market at 4K and 16K densities, but CMOS is expected to dominate the 64K market from 1985 forward. Only two NMOS 64Ks have been announced, while at least 22 CMOS 64Ks have either been announced or are in early production. This is an abrupt departure from the 16K density, where NMOS constituted 80 percent of the units shipped and 62 percent of the part types offered in 1984.

End Use--Markets

Actual fast MOS static RAM usage in end equipment in 1984 and the expected usage in 1985 and 1988 are as follows:

	(Percent of Dollars)		
	1984	1985	1988
EDP	50%	48%	44%
Consumer	2	2	4
Communications	20	22	20
Industrial	11	10	14
Government/Military	17	18	18
	100%	100%	100%

DATAQUEST defines EDP to include all computers and peripherals. Consumer includes radio, television, and other consumer electronics. Communications includes datacom and telephony applications, both central office and subscriber lines. Industrial includes automatic test equipment, medical, and instrumentation. The Government/Military market includes radar, sonar and related signal processing applications, for both commercial and military markets.

End Use--Applications

End use by application for 1984 and estimates for 1985 and 1988 are as follows:

	(Percent of Dollars)		
	1984	1985	1988
Cache Memory	33%	31%	27%
Main Memory	22	23	18
Buffer Memory	17	16	16
Video	5	7	15
MOS MPU	2	2	3
Writable Control Store	19	19	17
Other	2	2	4
	100%	100%	100%

Main memory for supercomputers may reach 50MB to 100MB, and will typically use the x1 organization. Several supercomputer makers have begun to offer fast MOS SRAM as an alternative to faster, more expensive, and more power-consuming ECL RAMs. Smaller configurations, such as cache memories (often up to 32KB to 64KB) may use a significant amount of the x4 as well as the x1. The other applications will often use considerable amounts of x4 and x8 because their total memory requirements are considerably smaller and the x1 organization in high density is too deep.

One of the fastest-growing areas for fast static RAMs is in video applications, where they may be used in conjunction with the newer video DRAMs that are beginning to appear from Texas Instruments, NEC, and several others.

There is also the potential for fast EEPROMs to replace fast static RAMs now used in conjunction with PROMs or floppy disks in writable control store applications. The initial penetration would be in the military market, but the commercial market could also use these in large computer systems.

Some of the rapidly growing application areas for high-speed MOS SRAMs include workstations, array processors, and a variety of signal and image processing applications such as facsimile, radar and sonar, and speech recognition. These calculation-intensive applications often use modest amounts of high-speed memory, and are expected to contribute to the growth of the x4 and x8 configuration relative to the traditional x1 configuration.

The percentage of cache memory applications is expected to decline, since cache is generally found in larger systems, which are not growing as fast as smaller applications of fast SRAMs. There may be some new growth in that area, however, as the manufacturers of smaller systems begin to feel market pressures and add cache memories in order to speed up their systems. DATAQUEST expects the use of a high-speed cache to percolate down to smaller and smaller computer systems over the coming years.

Package Mix

Actual fast MOS static RAM packages, as a percent of total units shipped in 1984, and estimated for 1985 and 1988, are as follows:

	1984	1985	1988
Plastic DIP	70%	71%	53%
Ceramic DIP or CERDIP	20	16	12
Ceramic LLCC	8	8	13
Plastic SMDs	0	3	20
Flatpak or Other (module, dice, etc.)	2	2	2
	100%	100%	100%

The percentage of ceramic or CERDIP packages in 1984 was about 25 percent due to:

- Present chip carriers are mostly leadless and ceramic.
- 4Ks continue to be shipped in volume, with a high fraction in ceramic DIPs or CERDIP.
- Several of the 16K vendors that had not shifted their package mix into plastic have done so in 1985.

The shift to plastic is apparent, however, even from 1984 to 1985, as the percentage of plastic DIPs increases with a shift from ceramic to plastic at the 16K and 64K level, and then the percentages of both plastic and ceramic DIPs drop by 1988 as chip carriers increase their share of the total.

Plastic surface mounted devices (SMDs) will become much more significant in the next few years, growing to about 20 percent of units by 1988. There are strong forces pushing for both small outline ICs (SOICs), specifically SOJs, and plastic leadless chip carriers (PLCCs). Flatpaks will not be a very significant package for fast static RAMs, with only 2 percent of units by 1988.

There is a wide variation among vendors, both in present and anticipated package mix, with CMOS suppliers more strongly into plastic packages, and U.S. suppliers having a higher fraction of CERDIP and ceramic DIPs.

Specialty Parts

The fast SRAM market offers many opportunities to diversify features from the basic multisourced commodity parts.

There is a lot of interest in dual-port static RAMs, to be used initially as a communication link between coprocessors. IDT has both a CMOS 1Kx8 and a 2Kx8 dual-port static RAM, and AT&T announced a 2Kx9 dual-port RAM at ISSCC in February of 1985. Synertek shipped an NMOS 1Kx8 (P/N SY21D1) during 1984, but has since licensed Signetics to produce it, as a part of Synertek's withdrawal from the market. Several other companies are developing dual-port static RAMs, and a number of applications are possible.

The dual-port RAM can be used to speed up a coprocessor system such as a PC with a main CPU processor and a second processor in a peripheral. Acting as a buffer, the dual-port RAM allows two processors to communicate at their own speeds. It also allows reading and writing from two different locations at the same time, as in electronic mailbox or workstation applications.

Another specialty SRAM is a resettable 4K RAM offered by AMD. This device can have all bits zeroed automatically with a control signal, making it a useful device for cache or scratchpad memories where there is no need to retain the data after the operation is concluded. Resettable RAMs allow the entire memory to be cleared before the following operation's data are moved into the cache.

IDT's P/Ns 71681 and 71682 feature separate data inputs and outputs that can be used to enhance system speed and reduce board space in multichip systems. This device comes in a 24-pin ceramic, 300-mil skinny DIP or chip carrier.

Toshiba offers a 2Kx9 modified version of its NMOS 2018 2Kx8 fast SRAM into several accounts. Although there has been talk of commercially available x9 devices for some time, this may be the first instance of a x9 SRAM offered in the merchant market. The 72K organization (8Kx9) is really a 64K device with a ninth bit amended to the byte-wide architecture purely for parity. In this case, it's the user's responsibility to implement the required hardware and software to detect and control the parity information.

The current supplier roster includes the following:

- AMD
- Fujitsu
- Hitachi
- Toshiba
- VISIC

All of these devices are CMOS fast SRAMs. The VISIC part is called an HRAM. The HRAM is a hierarchical RAM with special addressing modes to allow very fast access times: normal random addressing is 35nS; static column addressing is 25nS; Static Nibble Access Path (SNAP) mode addressing is 10nS. (HRAM and SNAP are registered trademarks of VISIC.) Presently, only Fujitsu is shipping its 81C79 part, but the demand comes primarily from the major EDP companies. Other vendors may introduce the 8Kx9 organization as well.

Finally, there is considerable opportunity for special value-added packages for dense SRAM configuration sold into military accounts. IDT, Harris Semiconductor, EDI, and others all serve this market with a variety of high-performance multichip modules. The applications in which these products are used place high value on improved system packing density and incremental system performance improvements.

256K SRAMs and Fast-Slow SRAMs

Sample quantities of monolithic 256K CMOS SRAMs will be available during 1985 from at least three to five suppliers. These devices, as described at ISSCC during 1984 and 1985, had typical access times in the 45ns to 70ns range. When production volumes are available, this should easily translate into 85ns to 120ns devices (maximum, not typical) over the full commercial temperature range. These devices, however, are probably targeted for high-speed MPU-based applications, and will be followed by speed-optimized 256Ks that may be as fast as the present fast 64Ks, either in the x1, x4, or x8 organization.

While there exists a rather clear distinction between "slow" and "fast" SRAMs (as described in the Definition, above), there has been a growing business in the midrange (70ns to 100ns) being served by low-power NMOS 4Kx4s (e.g., Inmos Corp.), as well as in the fast end of the slow 2Kx8 speed distribution, which may reach down to 85ns to 90ns (e.g., IDT and Matra-Harris Semiconductors).

LICENSING TRENDS

Numerous fast SRAM technology licensing and joint venture arrangements have been established. VLSI Technology Inc. (VTI) is used as a foundry for both Lattice's 16Kx4 part and VISIC's 64Kx1 HRAM with rights to produce both. Lattice has also signed others to manufacture their 16Kx4 in addition to a technology sale of their 64Kx1. Cypress has recently signed Matra-Harris Semiconductor of Nantes, France, to produce its CMOS SRAMs with an extendable marketing agreement for the Cypress products in Europe.

Sony is a major investor in Vitelic Inc. and will produce several of Vitelic's 16K and 64K devices. These parts will be sold through Sony's own sales channel. Marketing arrangements by both Inmos and Lattice with Japanese companies may also involve technology exchanges. Fairchild Camera & Instrument has also signed Goldstar of Korea to produce FCI's 64K SRAM.

The fast SRAM market is an attractive, growth memory market. The technology and designs to produce these components can often command a relatively high price from those manufacturers who wish to maintain that technology in their portfolios.

OUTLOOK

The fast static RAM market rides better over the ups and downs of the fluctuating markets than do the more commodity portions of the MOS memory market. As a result, fast static RAMs are expected to outperform the MOS memory market in 1986 by a wide margin.

Inmos, Fujitsu, Hitachi, and NEC are the principal suppliers to the largest, most highly visible parts of the fast SRAM market, namely EDP. But AMD and its progeny, IDT and Cypress Semiconductor, are very much contributors to the state-of-the-art and diversity of products that exist in the market. Because these three companies are applications and performance driven, they have all introduced innovative features and brought outstanding technologies to bear on the high-speed MOS SRAM market.

With the tremendous price pressure in dynamic RAMs, EPROMs, and the more commodity SRAMs, many vendors have pursued the stable market segments (such as fast static RAMs), yielding higher ASPs. Margins have become key to these suppliers as price pressures have increased in this product segment also.

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Nielsen Dataquest RESEARCH BULLETIN

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NINTH ANNUAL SIA FORECAST DINNER: FORECASTING THE RECOVERY

SUMMARY

The Semiconductor Industry Association's ninth annual forecast dinner was held amid a mood of optimism combined with deep concern for the future viability of the U.S. semiconductor industry.

The evening began with a roast of retiring SIA president Tom Hinkelman and was emceed by Charlie Sporck, president of National Semiconductor Corporation. The featured speakers were Dr. Gil Amelio, president of Rockwell International's semiconductor products division, and Dr. Bob Noyce, vice chairman of Intel Corporation.

Mr. Sporck compared the U.S. semiconductor industry to a football player who is bleeding from an injury in a game where the competition is not penalized for breaking the rules. Although the U.S. industry has managed to survive under these conditions, the bleeding has not stopped. He called for forced change through "forms of leverage that some may call protectionist."

FORECAST

Dr. Amelio presented the consensus forecast for 1985 through 1986, which was prepared by the World Semiconductor Trade Statistics (WSTS) forecast committee, comprising representatives from 30 semiconductor manufacturers worldwide.

The WSTS forecast calls for a worldwide consumption decline of 17 percent in 1985, followed by three years of growth: 18 percent in 1986, 23 percent in 1987, and 23 percent in 1988. Over the long term, Japan will be the fastest-growing market, gaining several points in world market share in 1985 and maintaining them through 1988. Dr. Amelio pointed out that NMOS and PMOS memory are still showing no sign of recovery, while analog ICs are doing well, particularly in Japan, where the consumer electronics market is still fairly strong. Bipolar digital ICs are also doing well, having maintained a book-to-bill ratio of 1.0 since May.

Dr. Amelio pointed to several causes of 1985's disastrous market decline:

- A slowdown in the OEM market, particularly computers, which account for 40 percent of the U.S. semiconductor market

- A huge semiconductor inventory at OEMs (estimated to have been between $2 billion and $2.5 billion)

He believes that end users (i.e., consumers and businesses) have slowed consumption because they want more innovative products. OEMs will continue to slim down their semiconductor inventories as part of better asset management, but eventually demand will firm, as will prices. Finally, new, innovative products will spur end-user demand.

U.S.-JAPAN TRADE

Dr. Noyce's topic was U.S.-Japan trade friction. While admitting that many unfair trade practices do exist on the part of the Japanese, he believes that unfair practices are not the sole cause of the U.S. industry's current dilemma. Prior to 1980, the United States enjoyed years of trade surplus. Since 1980, however, the U.S. trade deficit has escalated dramatically. U.S. manufacturers are no longer competitive in the world market, Americans are substituting foreign sources of goods and services for domestic sources, and thousands of formerly U.S. manufacturing jobs are being moved offshore.

Dr. Noyce stated that the high value of the U.S. dollar bears a direct relationship to the current U.S. savings and trade deficits. The implication of this is that if the U.S. savings rate increases to the point of becoming a savings surplus, the U.S. dollar will fall in value and the trade deficit will become a trade surplus. Approximately 65 percent of U.S. corporate profits go into savings, while only 4.5 percent of personal income is saved. If President Reagan's tax proposal is passed, shifting more of the tax burden onto corporations and off of individuals, the resulting decrease in corporate profits would lower the corporate savings rate, decrease net savings in the country, and increase import penetration by $22 billion.

Dr. Noyce concluded that the solution to the problem is in the hands of the United States, which must produce a surplus of goods to send overseas, rather than bringing in goods from other countries. This can be done by increasing personal and government savings.

DATAQUEST ANALYSIS

A dichotomy of opinion on the trade issue was clearly in evidence at the dinner. Although most attendees agreed that free trade is best in the long run, many called for short-term protectionist measures. Even those against any form of protectionism would probably agree with Mr. Sporck's often-repeated rallying cry: "Protectionism beats extinction any day."

Stan Bruederle
Patricia S. Cox

Nielsen Dataquest USER UPDATE

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SEMICONDUCTOR INDUSTRY UPDATE BUYER ALERT!
RESERVE YOUR CAPACITY NOW!

It's beginning to look like the end is near for the worst semiconductor recession ever.

- Users report that inventories are almost in line.
- Orders seem to have bottomed and are ready to start growing again.
- Brokers are buying up excess product at rock bottom prices, expecting to capitalize on a rising spot market in 1986.
- Discrete and linear demand have already started upward.
- Financial news from the semiconductor industry cannot get much worse (National expects to lose more than $40 million this quarter).
- A few purchasing managers are concerned about parts shortages in 1986.

Statistically, this recession (or should we say depression?) looks very much like the one that occurred in 1974 and 1975. That one was very steep and was followed by a strong resurgence in business.

NOW IS THE TIME TO MODIFY YOUR BUYING STRATEGIES

The operative strategy in 1985 has been to find ways to buy ICs in the United States at Far East prices. The time has come to reserve capacity with your vendors to assure availability of product as the semiconductor industry recovers in 1986.

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While both U.S. and Japanese manufacturers have built the facilities to produce the product required for 1986 and possibly 1987, DATAQUEST believes that reductions in force have left U.S. companies without the trained personnel to increase production as quickly as customer demand is expected to grow. Surveys of Japanese semiconductor manufacturers show that they have reduced production, but have also built inventories (maybe excessively) and kept a larger work force in place to respond to renewed industry growth. DATAQUEST believes that quarter-to-quarter growth in 1986 will be very strong and that U.S. semiconductor manufacturers, who have reduced their work force by as much as 30 percent, will quote rapidly lengthening lead times and have periodic shortages of product during the second half of 1986 unless customers begin reserving capacity now.

THE SHAPE OF THE RECOVERY

Estimated quarterly consumption for 1985 and 1986 is shown in Table 1. By the end of 1985, we expect to have experienced five successive quarters of steeply declining revenues. In 1986, after a modest first-quarter upswing, we expect to see three of the strongest quarterly growth rates since our recorded data began in 1966. You can compare with previous years by referring to the industry growth charts in the Market Analysis section of Volume I of your SUIS notebooks.

Table 1

ESTIMATED U.S. QUARTERLY SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1984	Q1	Q2	Q3	Q4	1985
Discrete	$ 2,229	$ 448	$ 430	$ 403	$ 407	$ 1,688
IC	11,104	2,328	2,068	1,675	1,386	7,457
Total	$13,333	$2,776	$2,498	$2,078	$1,793	$ 9,145
Percent Change	51.5%	(19.5%)	(10.0%)	(16.8%)	(13.7%)	(31.4%)

	1985	Q1	Q2	Q3	Q4	1986
Discrete	$ 1,688	$ 431	$ 465	$ 480	$ 510	$ 1,886
IC	7,457	1,436	1,824	2,184	2,712	8,156
Total	$ 9,145	$1,867	$2,289	$2,664	$3,222	$10,042
Percent Change	(31.4%)	4.1%	22.6%	16.4%	20.9%	9.8%

Source: DATAQUEST

Figures 1 and 2 provide insight into the expected recovery from the end equipment perspective. The shipment rate of change curves help anticipate industry growth trends. Computers and office equipment and communications equipment represent two of the largest commercial semiconductor consumers in the United States. Both sectors are expected to grow 10 percent or more in 1985. This indicates an underlying growth in demand for semiconductor devices in these industries, which we expect to continue into 1986.

Relative growth of inventories versus shipments provides a leading indicator of purchasing trends. Inventory growth in excess of shipment growth indicates inventory accumulation, which must be corrected by a period of inventory growth that is less than shipment growth. During the correction period, purchases of semiconductors drop below actual consumption levels, resulting in a decline in semiconductor industry revenues. Our surveys indicate that this correction has already occurred in the computer and office equipment industry and is expected to end by the fourth quarter. The computer industry is expected to start the recovery in the first quarter. Communications equipment manufacturers were still accumulating inventory at midyear. Our surveys of these companies indicate that they will begin their recovery cycle close to mid-1986. Once both sectors kick in, we expect strong semiconductor growth through 1986 and into 1987.

CONCLUSION

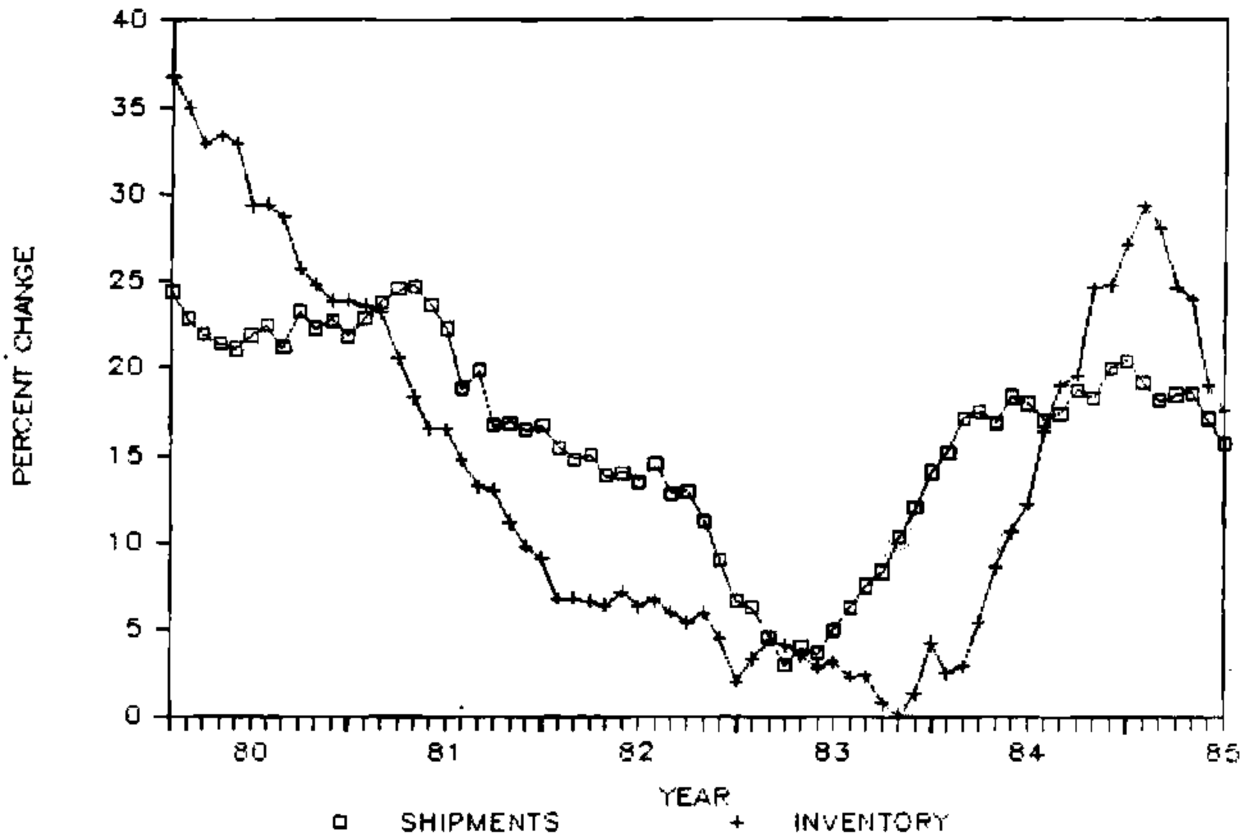
DATAQUEST believes that the effects of a sharp recovery in demand can be minimized if vendors and customers work together at this stage of the business cycle. Among the benefits for all concerned will be:

- Prices will be lower over the long haul.
- Lead times will remain shorter, enabling better control of inventories.
- Semiconductor companies will be able to plan ahead better, to anticipate and respond to growth in demand, and to control manufacturing costs better.

Stan Bruederle

Figure 1

OFFICE AND COMPUTING MACHINES
(Rate of Change)



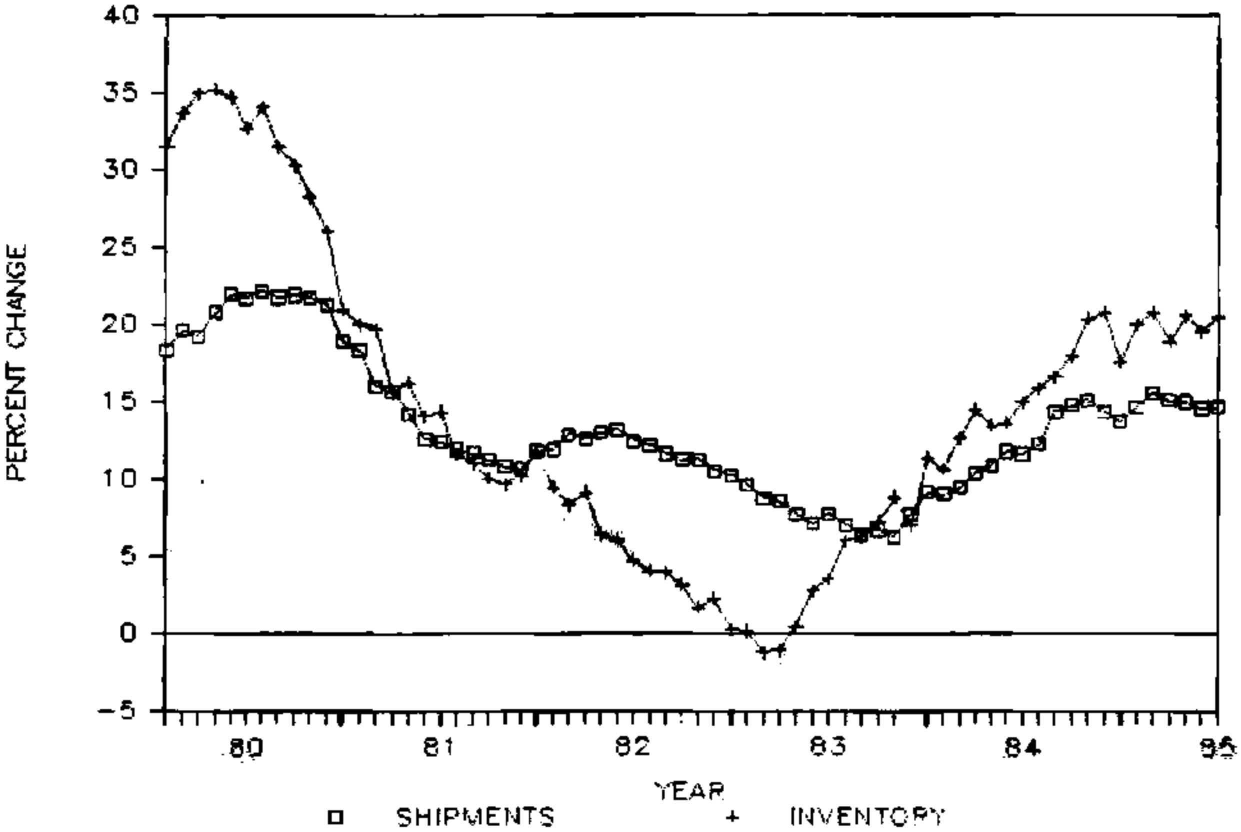
Last data: June 1985

Shipments = 12/12 Rate of Change
Inventory = 1/12 Rate of Change

Source: U.S. Department of Commerce
DATAQUEST

Figure 2

COMMUNICATIONS EQUIPMENT
(Rate of Change)



Last data: June 1985

Shipments = 12/12 Rate of Change
Inventory = 1/12 Rate of Change

Source: U.S. Department of Commerce
DATAQUEST

Nielsen Dataquest
USER UPDATE

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NEXT-GENERATION BELL 212A MODEM CHIPS COMMUNICATE AT NEW INTEGRATION LEVELS

Semiconductor manufacturers are breaking new ground in the area of 1,200 bit-per-second modem integrated circuits for the Bell 212A specification. For dial-up line applications, this appears to have become the most popular standard, surpassing the 300-bps specification. Users interested in implementing modem communications in their end products require an understanding of these chips.

PRODUCT DIRECTION

There is an established generation of products with which to design a modem facility. Now, however, we are witnessing the first of a newer, second generation of products that are much more capable than their predecessors. Specifically, these integrated circuits are designed to support the popular Bell 212A 1,200-bps specification and, possibly, even faster applications.

It is important to understand that the 212A specification calls for not only 1,200-bps full duplex communications, but also the ability to fall back to the 300-bps speed. As the data rate increases, more sophisticated design techniques are required in the filtering and equilization sections of the modem circuit to maintain reliable, accurate data transfers. As a result, some chip suppliers are designing with advanced techniques such as digital signal processing to achieve the required performance.

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APPLICATION INFLUENCES

Certain factors have abetted the development of these devices, as the following application list indicates:

- Standalone modems
- Personal computer enclosed modems
- Remote data entry terminals
- Facsimile equipment
- Low-end display terminals
- Portable computers
- Other portable equipment requiring integrated communications

TRENDS

Table 1 displays a matrix of suppliers and their products. A significant point is that there is a division of generations in these products. The mature devices are designs of a few years ago, while the next-generation components are virtually single-chip products derived from recent technological advancements. Since these are first offerings of second-generation parts, it is conceivable that future designs will reflect further evolutions in product philosophy. These could include characteristics such as:

- 2,400- to 9,600-bps speeds
- Increased use of DSP design
- Greater interface flexibility
- Standardization of functional pin-out

Some very definite trends are indicated in the newer component designs. These feature or technology trends imply product selection considerations of which users should be aware.

Table 1

PRODUCT MATRIX

Supplier	Part No.	Devices In Set	Process/ Package/ Pin Count	Required Voltages	Second Sources	Interface	UART	DTMF	Call Progress Detect	Bell 103 Fallback	Price	Comments
AMD	Am79C12	One	CMOS/ DIP-40/ PLCC-44	Pos 5	N/A	Micro bus	Yes	Yes	Yes	Yes	N/A	Built-in diag., handshakes; DSP arch
AMD	Am79C14	One	CMOS/ DIP-40/ PLCC-44	Pos 5	N/A	Micro bus	Yes	Yes	Yes	No	N/A	V.22bis (2,400 bps); supports 1,200 bps
Gould-AMI	S35212A S35213	Two	CMOS/ PDIP-24/ PDIP-28	Pos/neg 5	Mitel	Micro bus	No	No	Yes via 35212	Yes	$30 (10K pcs.)	S35212A in prod.; S35213 samples now
Exar	XR212AS (XR2120, XR2121, XR2122) XR2125	Four	CMOS/ DIP-22 DIP-22 DIP-28 DIP-14	Pos/neg 5 Pos/neg 5 Pos/neg 5 Pos 5	None at present	Serial	No	No	Yes	Yes	About $35 for set	Autodial via XRT5990 device; XR2125 is data buffer (additional
Fairchild	uA212A	One	LCCMOS CDIP-28		N/A	Control line	No	No	Yes	Yes	About $60 in volume	Complete modem: UA212 and microcon, plus DAA circuitry. Contains diagnostics (LALB, RDLB) also.
Intel	N/A	Two	CMOS DIP-24	Pos/neg 5	N/A	Uses 8096	On 8096	Yes	Yes	Yes	N/A	Set includes 8096 microcontroller and analog front-end part; supports V.22bis std.
Micropower	MP212A	Two	CMOS PDIP-28 PDIP-22/40	Pos/neg 5	None at present	Serial or micro bus	Yes	Yes	Yes	Yes	About $65 @ 1,000 pcs.	Includes: Bell & CCITT handshakes; diagnostics; two selectable equalizations.
National	N/A	One	CMOS	Pos 5	N/A	Direct to any micro	Yes	N/A	N/A	N/A	N/A	Datasheets available in September time frame
Rockwell	R2120S	Three	NMOS PDIP -40/28/40	Pos 5 Pos/neg 12	None	Serial or micro bus	No	Yes	Yes	Yes	About $50 in volume	Uses adaptive equalization; set will likely go to 2 devices
Silicon Systems	K212A	One	CMOS PDIP-22/28	Pos 12	N/A	Serial or micro bus	Yes	Yes	Yes	Yes	N/A	Full test modes; samples in early 4th quarter
Texas Instruments	TMS99542 TMS99532	Two	NMOS PDIP-28, 18	Pos/neg 5 Pos 12	None	Bit-line oriented	No	No	No	Yes	About $60 per set	Sampling 99542; TMS99531 does auto-dial/answer; Contains LALB

N/A = Not Available

Source: DATAQUEST

CMOS

Nine of the eleven devices shown in Table 1 are manufactured in CMOS. As with most of today's innovative semiconductors, a CMOS process makes the most sense from the point of view of both the supplier and the user. Better integration can be achieved with both linear and digital functions while maintaining a relatively lower power consumption.

Single Supply

Operation from a single voltage supply appears to be a feature the complete single-chip devices will have. This is more feasible with CMOS and creates a cost savings for the user since a less-complicated power supply is necessary.

Diagnostics

Local analog loop back (LALB) and remote digital loop back (RDLB) test modes are included in most of the more complex chips. This trend should continue, as functional integrity of the modem can be easily determined via these modes. It also simplifies the user's task at the design level since this is a built-in function requiring fewer additional components and providing a very necessary facility in such an end product.

Microprocessor Interface

Virtually all of the components are intended for direct use with a microcontroller or microprocessor. However, to simplify this interconnection, the newer-generation parts may have a direct bus interface or be selectable between interfaces. This can obviate the need for additional "glue" logic and, therefore, reduce the part count.

STANDARDS

From this examination of the next-generation products, there appear to be no specific standards in architecture, pin-out, or feature content. The only standard adhered to here is the Bell 212A specification if the devices are marketed as 212A-compatible. Features such as auto-dial, auto-answer, diagnostics, and handshakes may or may not be included. Since the previously mentioned product features are only trends at this point, the user must select a device that best fits the requirements of the given application.

SUPPLIERS

The current matrix is made up entirely of U.S. manufacturers--Japanese, European, and several U.S. suppliers are missing from the list. It is possible that because this has been a proprietary product area, these other companies will not enter the market until some standard becomes more visible in the use of these devices. Also, there are virtually no second sources at this time in either the existing or second-generation devices. Therefore, a selection is a single-source issue resulting in a very careful examination of the product and as importantly, the vendor.

Availability

Several of the products shown in Table 1 are in production now. Others, such as the AMD, Intel, and Silicon Systems parts, are close to being sampled now or before the year is out. Rockwell's three-chip set is available now but will probably go to two devices in the future. The overall trend will be for the majority of devices to be available between late 1985 and early 1986.

DATAQUEST expects more companies to bring products to market within the next one to two years. Suppliers such as Motorola, RCA, Harris, General Instrument, Signetics, and G.E.-Intersil are possible candidates for producing these types of devices. The broadening use of lower-cost communications in many end products, along with increased integration levels and requirement for higher speeds will result in a greater product selection.

DATAQUEST CONCLUSIONS

DATAQUEST believes that several of these modem devices are on the track to becoming the most popular. Products that include auto-dial, auto-answer, a miroprocessor bus, an on-chip UART, full call progress detection, diagnostics, and the handshakes, and which are implemented in cost-effective CMOS operating from a single voltage supply, will have the greatest edge. Suppliers such as AMD that are developing modem devices incorporating these features and emphasizing advanced design techniques such as DSP are likely to lead the way for the rest of the industry.

Brand A. Parks

Nielsen Dataquest USER UPDATE

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No. 85-14

WORLDWIDE INTEGRATED CIRCUIT PRICING: TO THE VICTOR GO THE SPOILS

Semiconductor users are reveling in historically low contract and spot-buy purchases as worldwide semiconductor prices continue to tumble. A precipitous decline in bookings (see Figure 1), and aggressive worldwide competition for market share has taken the steam out of logic and memory prices. Despite the users' wait-and-see attitudes and persistent spot buying activities, we expect that major semiconductor suppliers will implement various growth strategies in 1986. Table 1 lists the estimated contract and spot market prices for selected logic and memory ICs in Europe, Japan, and the United States during the second quarter of 1985.

The prices are a composite of data gathered from worldwide users, distributors, and manufacturers. Contract prices are for quantities of 500,000 units or greater for logic, and for quantities of 100,000 units or greater for memory. Spot market prices are based on any quantity.

PRICE TRENDS

Historically, average selling prices in Japan have fallen faster and remained lower than U.S. and European prices. Faced with a strong U.S. dollar, excess capacity, and weak demand, prices for Japanese manufactured goods dropped from 15 to 20 percent during the fourth quarter of 1984 and in the first half of 1985.

Logic

Overall, worldwide prices for the low-power Schottky products dropped 30 to 40 percent in the second quarter of 1985 from second quarter 1984 price levels. As the data indicate, spot prices for the 74LS gate and flip-flop products reached or fell below manufacturers' production cost levels in all markets.

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Japanese contract prices declined from 20 to 30 percent in the second quarter of 1985 from the previous year's second quarter, with substantial second quarter declines of 20 to 40 percent occurring in the United States and Europe. It should be noted that Japanese prices increased only 10 to 15 percent in the first half of 1984, while U.S. and European price increases exceeded 20 percent during that same time period. Prices for similar devices are considerably lower in Japan than in the United States and Europe. We expect Japanese prices to fall more slowly than the United States and Europe through the last half of 1985.

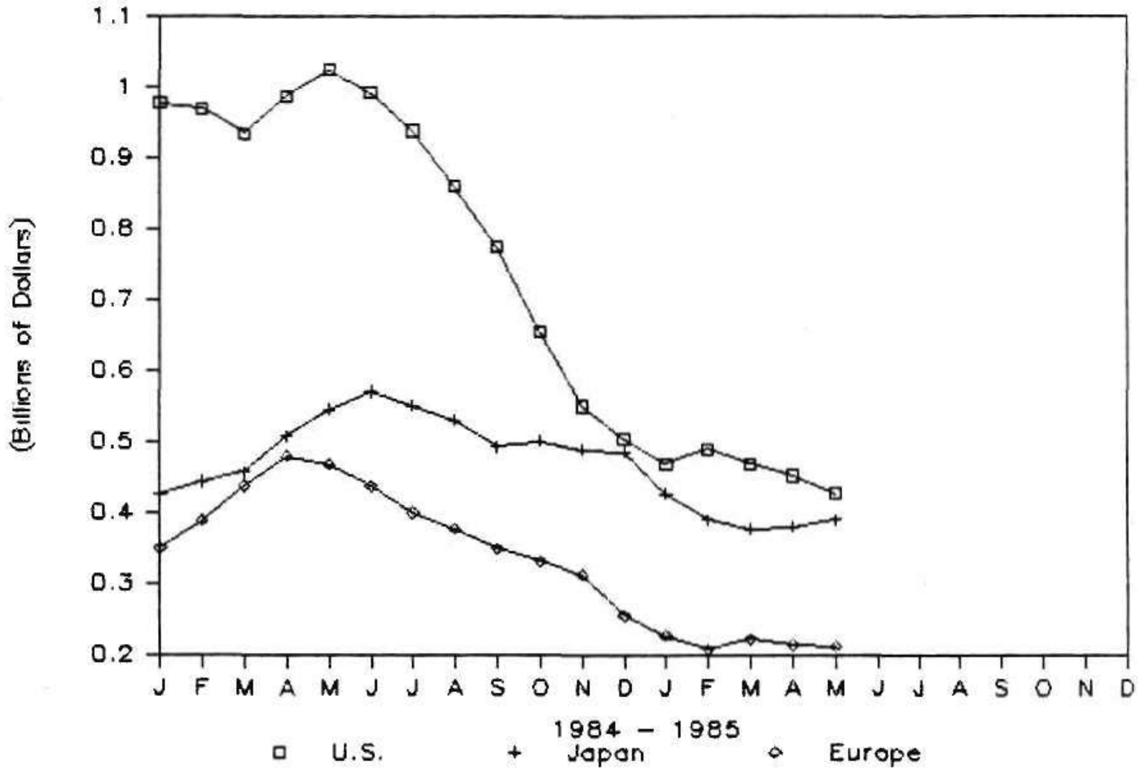
Memory

Excess capacity and weak demand has resulted in a fierce pricing war among Japanese, U.S., and European memory suppliers. Prompted by sub-$2.00 64K DRAM price announcements in the third quarter of 1984, prices of 64K DRAMs in Japan dropped from $2.00 in December 1984, to $1.19 during the first quarter of 1985. Contract prices for 64K DRAMs are projected to decline to $0.45 to $0.50 in Japan by the end of 1985, with U.S. and European prices trailing closely behind in the $0.60 to $0.80 range. We expect that fierce competition for high-density EPROM, SRAM, and DRAM market share between Japan and the U.S., coupled with strategic progress by Korean semiconductor companies, will drive memory prices down 25 to 35 percent by the first quarter of 1986.

Mary A. Olsson

Figure 1

WORLDWIDE SEMICONDUCTOR BOOKINGS
1984 through 1985



Source: DATAQUEST
August 1985

Table 1

WORLDWIDE PRICING--SECOND QUARTER 1985
(Prices in U.S. Dollars)

Product	United States Contract/Spot		Japan Contract/Spot		Europe Contract/Spot	
Logic						
74LS00	$0.14	$0.09	$0.09	$0.07	$0.13	$0.10
74LS74	$0.17	$0.13	$0.13	$0.10	$0.17	$0.16
74LS160	$0.30	$0.25	$0.23	$0.18	$0.35	$0.30
74LS244	$0.40	$0.35	$0.38	$0.35	$0.40	$0.35
74LS373	$0.38	$0.35	$0.36	$0.25	$0.40	$0.35
Memory						
64K DRAM (150ns)	$0.95	$0.60	$0.70	$0.40	$0.85	$0.50
256K DRAM (150ns)	$4.50	$3.60	$3.75	$3.00	$4.25	$3.40
16K SRAM (6116-3)	$1.75	$1.10	$0.95	$0.70	$1.50	$0.95
64K EPROM (2764-3)	$2.50	$2.00	$1.95	$1.25	$2.25	$1.90

Source: DATAQUEST
August 1985

Nielsen Dataquest

USER UPDATE

SUIS Code: Newsletters
No. 85-13

WESTERN EUROPEAN MARKET UPDATE--A YEAR OF CONSOLIDATION

SUMMARY

Following on from 1984's year of outstanding growth--43 percent in U.S. dollars--DATAQUEST believes that 1985 semiconductor shipments into Europe will exhibit only a small positive growth of around 2 percent, to reach $4,900 million. This contrasts with an approximate 11 percent worldwide decline from $28.7 billion to $25.5 billion. Taken together, the compound annual growth rate in shipments in Europe for 1983 through 1985 is estimated at a healthy 21 percent in dollars, or 34 percent in local currencies. The problems of 1985, we believe, are caused more by the excesses of 1984 than by any serious reduction in European end-user consumption--in short, the semiconductor industry shipped a substantial part of 1985's true demand, in 1984.

We anticipate 1985 to be a year of consolidation with a strong first quarter (down only 1 percent from the fourth quarter of 1984), but with a substantial second quarter decline of around 11 percent as the reductions in average selling prices (ASPs) and reduced booking levels start to affect product shipments.

In line with the traditionally flat third quarter, we do not expect any real strengthening in the market until the fourth quarter, when a positive quarter-on-quarter growth is projected. Overall, however, we believe that the fourth quarter of 1985 will be down some 7 percent from the previous year's fourth quarter.

Looking ahead, we anticipate a modest recovery in 1986, at around 16 percent in dollars, as ASPs remain under pressure. We estimate that total shipments will increase overall to $5,685 million in 1986, to reach $10.9 billion by 1990.

Table 1 lists DATAQUEST's estimates for Western European semiconductor shipments by major technology for 1983 through 1986 and for 1990. Figure 1 shows DATAQUEST's estimated quarterly shipments into Western Europe for 1984 through 1985. Shipments for 1985 and beyond are valued in constant dollars at average 1985 European exchange rates, January through April inclusive.

DATAQUEST ANALYSIS

Our scenario for Europe portrays a relatively more bouyant market than in the United States and other world regions. We believe that this is due to the following factors:

- PC phenomenon being predominantly U.S.-focused
- Less double and triple ordering in 1984
- More modest European OEM expectations
- Lower ASP excesses
- Sound, if modest, European economic GNP growth platform

This time, European natural conservatism worked in its favor. Europe did not reach the same extent of excesses that the United States did, and Europe currently appears to be realigning itself more quickly to the changing circumstances.

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Jean Page
Malcolm G. Penn
Adrian R. Tarr

Table 1

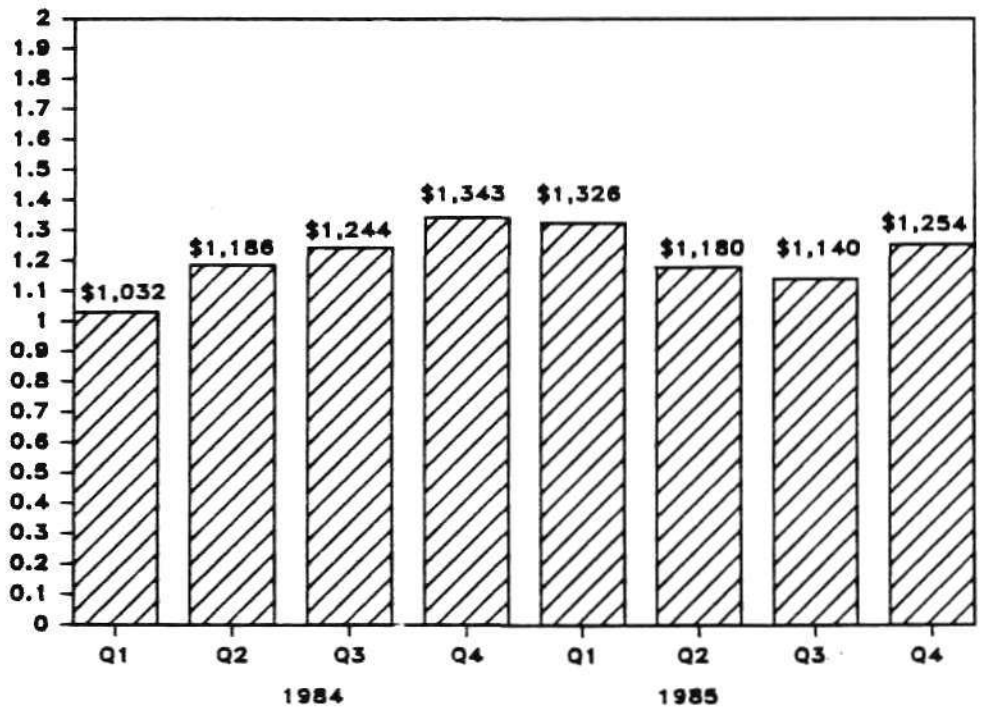
ESTIMATED EUROPEAN SEMICONDUCTOR SHIPMENTS, 1983-1990
(Millions of Dollars)

	1983	1984	1985	1986	1990
Total Semiconductor	$3,370	$4,805	$4,900	$5,685	$10,940
Integrated Circuits	$2,323	$3,634	$3,676	$4,379	$ 9,475
Bipolar Digital	483	724	716	829	1,451
MOS	1,227	2,092	2,038	2,502	6,315
Linear	613	818	922	1,048	1,709
Discretes	$ 866	$ 963	$ 996	$1,056	$ 1,105
Optoelectronics	$ 181	$ 208	$ 228	$ 250	$ 360
Exchange Rate (Base 1978 = 100)	143.8	162.5	178.4	178.4	178.4

Source: DATAQUEST

Figure 1

ESTIMATED EUROPEAN SEMICONDUCTOR QUARTERLY SHIPMENTS, 1984-1985
(Thousands of Dollars)



Source: DATAQUEST

Nielsen Dataquest USER UPDATE

SUIS Code: Newsletters
No. 85-12

SIGNETICS REORGANIZATION
A LOGICAL MOVE

Signetics announced a reorganization of its semiconductor divisions this week. The eight divisions that existed under the previous system were reorganized along product and process lines.

The new organization, which reduces the number of divisions to five, groups together similar products. Table 1 shows the relationship of the old divisions to the new. Table 2 shows the new organization chart.

The new organization puts products with common design, application, testing, and development support needs in one division. It also groups people who have the skills and training to develop, manufacture, and market those products successfully. The reorganization formalizes the following changes, which have been developing for some time:

- The Bipolar LSI Division had already taken responsibility for CMOS gate arrays in addition to its existing bipolar products.
- The Logic Division had already taken responsibility for CMOS logic as well as TTL and ECL bipolar logic.
- The Bipolar Memory Division had begun activity on CMOS programmable logic devices.
- The Linear LSI Division was already emphasizing CMOS technology rather than its existing bipolar technology for new product development.

The establishment of a dedicated EPROM development activity indicates that the company recognizes the need for this technology if it is to succeed in the memory market.

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The company has not yet announced how it plans to organize the fabrication facilities. Under the old organization, the fabs belonged to the individual divisions. However, since all the new divisions will be using a variety of processes, it makes sense for the fabs to be consolidated into a central operation. The ASIC division will have to address the problem of competing for resources to run a large number of codes in comparatively short runs with the requirements of large standard product manufacturing. In this service-oriented part of the market, it may make sense for the ASIC division to operate a separate final metallization line.

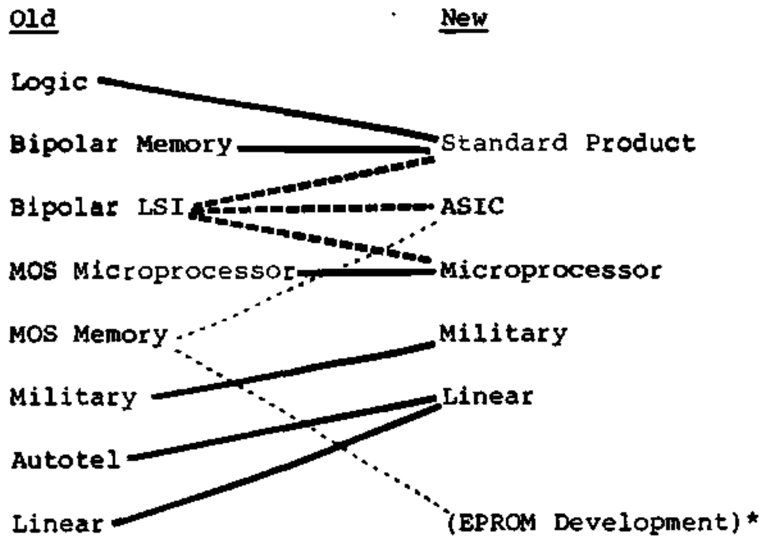
DATAQUEST ANALYSIS

Signetic's new organization creates a synergy of skills and capability within each division, which should enable the company to enhance its operations. In the advanced technology areas, particularly the field applications, support should be more cohesive, encouraging the development of complementary products within a division rather than across division lines.

Stan Bruederle
Jean Page

Table 1

SIGNETICS DIVISIONS

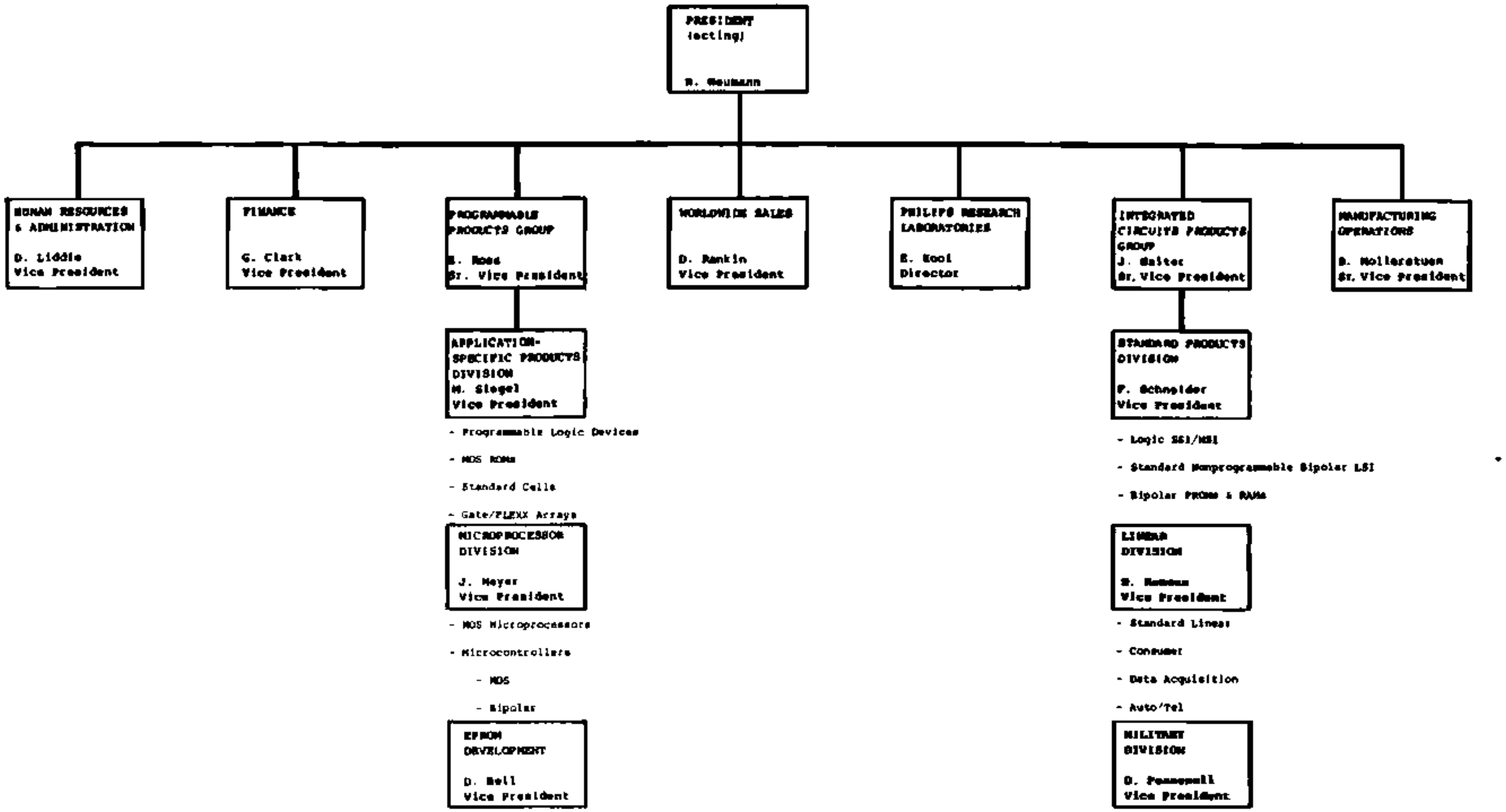


*The EPROM development group reports directly to the Senior VP of the Programmable Products Group

Source: Signetics

Table 2

SIGNETICS ORGANIZATION CHART



Source: Signetics

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No. 85-11

THE SEMICONDUCTOR START-UP BOOM CONTINUES

Despite the industry downturn, semiconductor start-ups are alive and well. As shown in Table 1, DATAQUEST's Japanese Semiconductor Industry Service has recorded 47 semiconductor start-ups since late 1983--a record for the industry. This figure tops the 29 start-up companies recorded for the same period covered by our last newsletter on this subject, "Asian Ties with U.S. Semiconductor Start-Ups," January 18, 1984. Twenty-eight of the start-ups are located in Silicon Valley. DATAQUEST believes that there are at least 10 more start-up companies that have not yet been publicly announced. We believe that the continuing boom in semiconductor start-ups reflects the emergence of new market niches in application-specific ICs (ASICs), CMOS memory and logic, gallium arsenide (GaAs), linear, digital signal processing (DSP), and silicon compilers.

A major development is the growing number of ties between Asian electronics companies and U.S. semiconductor start-ups. Some of the more notable alliances are as follows:

- Barvon Research--Licensing agreement with Ricoh
- China Micro--British-Chinese joint venture
- Ixys Corporation--Ricoh wafers
- Modular Semiconductor--Licensing of CMOS 256K DRAM and 16K SRAM to Ricoh
- Mosel--First round Taiwan investors
- NMB Semiconductor--Subsidiary of Minebea Co. (Tokyo ball bearing maker)
- Panatech Semiconductor--Sales and Marketing agreement with Ricoh
- Quasel--Joint venture with Taiwanese investors
- SID Microelectronica S.A.--Sales of Sharp products

- Unicorn Microelectronics--Funding from United Microelectronics of Taiwan

- Vitelic--Wafer fab contract with Taiwan's ERSO and ties with Sony and Kyocera

Jean Page
Sheridan Tatsuno

Table 1

SEMICONDUCTOR START-UPS
(1983-1985)

Company	Location	Product
Anadigics	Morristown, NJ	GaAs A/D converters
Array Logic	Melbourne, England	CMOS and bipolar ASICs
Barvon Research	Milpitas, CA	ASICs
Calmos	Kanata, Ontario	ASICs
Calogic	Fremont, CA	ASICs
Celeritek	San Jose, CA	GaAs FETs
China Micro	China	MOS ICs
Chips and Technologies	Milpitas, CA	ASICs
Cirrus Logic	Milpitas, CA	Silicon compiler
Crystal Semiconductor	Austin, TX	Telecom ICs
Custom Silicon	Lowell, MA	ASICs
Dallas Semiconductor	Dallas, TX	CMOS memories
Electronic Technology	Cedar Rapids, IA	ASICs
Inova Microelectronics	Campbell, CA	SRAMs
Integrated Logic Systems	Colorado Springs, CO	ASICs
Integrated Power Semiconductor	Santa Clara, CA; Livingston, Scotland	Linear
Isocom	Campbell, CA	GaAs coupler
Ixys Corporation	Santa Clara, CA	Power monolithics
Logic Devices	Sunnyvale, CA	CMOS multipliers
Micro MOS	Santa Clara, CA	EEPROMs
Microwave Technology	Fremont, CA	GaAs amplifiers
Modular Semiconductor	Santa Clara, CA	CMOS memories
Mosel	Sunnyvale, CA	EPROMs, SRAMs
NMB Semiconductor	Tokyo, Japan	CMOS memories
Pacific Monolithics	Sunnyvale, CA	GaAs Monolithic ICs
Panatech Semiconductor	Santa Clara, CA	CMOS memories
Performance Semiconductor	Sunnyvale, CA	CMOS SRAMs, MPUs
Pivot III-V Corp.	Unknown	GaAs digital ICs
Quasel	Santa Clara, CA	CMOS memories
Seattle Silicon	Bellevue, WA	Silicon compiler
Sensym	Sunnyvale, CA	Pressure sensors
SID Microelectronica S.A.	Sao Paulo, Brazil	MOS ICs
Sierra Semiconductor	Sunnyvale, CA	Reconfigurable MPUs
Silicon Design Labs	Liberty Corner, NJ	Silicon compiler
Silicon Macrosystems	Santa Clara, CA	Static ROMs
Teledyne Microwave	Mountain View, CA	DMOS discretes
Topaz Semiconductor	Santa Clara, CA	DMOS discretes
Triquint Semiconductor	Beaverton, OR	GaAs analog and digital
Unicorn Microelectronics	San Jose, CA	ASICs
Vatic Systems	Mesa, AZ	ASICs
VTC, Inc.	Eagan, MN	CMOS logic
VISIC	San Jose, CA	CMOS RAMs
Vitelic	San Jose, CA	CMOS memories
Vitesse Electronics	Camarillo, CA	GaAs digital ICs
Xilinx	San Jose, CA	CMOS logic arrays
Xtar Electronics	Elk Grove, IL	Graphics chips
Zoran	Sunnyvale, CA	DSP

Source: DATAQUEST

SUIS Code: Newsletters
No. 85-10

GENERAL INDUSTRY UPDATE

SUMMARY

The decline in U.S. semiconductor consumption, precipitated by major inventory corrections by semiconductor users and rapidly falling prices, has been deeper and lasted longer than expected. Declining demand for computers and office automation products in March and April of 1985 has exacerbated the situation, and reversed a trend toward increased bookings. DATAQUEST estimates that semiconductor consumption in the first quarter of 1985 was 19.5 percent lower than in the fourth quarter of 1984. We anticipate further declines in the second quarter of 1985, with a moderate recovery beginning in the third quarter.

We expect the U.S. economy to grow by a little more than 3 percent in 1985: less than half the growth rate of 1984.

The Semiconductor Industry Association (SIA) revised its March book-to-bill ratio to 0.80 to 1 for March, and announced a decline in April to 0.77 to 1. As Figure 1 shows, this represents a downturn in the ratio after a brief rally. Total bookings were down 7.5 percent from March. The depth of the decline of the book-to-bill ratio suggests that this recession could be as deep as that of 1975. However, we believe that the bottom of the trough has already been reached, and we can now expect the situation to improve.

ECONOMIC TRENDS

Although the index of leading indicators turned down in March, economists still expect the economy to continue to expand. The Federal Reserve Board acted to stimulate the economy and keep interest rates down by increasing the money supply. Unemployment levels remained unchanged in April at 7.3 percent.

The economic recovery is now in its third year, although its pace is considerably slower than that of the early stages.

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The trade deficit continues to be fueled by a strong dollar. The deficit for the first quarter of 1985 was $10.9 billion--up 17 percent from the $9.3 billion in the fourth quarter of 1984. No weakening of the dollar is expected until the U.S. budget deficit is cut and real interest rates decline in the United States.

The Federal budget deficit remains a problem. The Administration's projections probably underestimate future deficits, since they are based on the expectation of GNP growth rates of 4 percent per year through 1989. This would mean seven years of uninterrupted expansion. According to our estimates, the economy is expected to grow even more slowly in 1986 than in 1985, with GNP growth of only 2.9 percent.

DEMAND, SUPPLY, AND PRICES

The inventory problem has two components: over-buying in the 1984 upturn has left users with large inventories of components, and lower demand for their products has left them with large finished-goods inventories.

Semiconductor fabrication capacity increased 33 percent in the United States in 1984, and 31 percent in Japan. It will continue to increase throughout 1985 as capital commitments made in 1984 are met. This has resulted in strong price pressures, especially on commodity memory products. We estimate that semiconductor capacity is currently operating at a 60 percent utilization rate, and that price pressure will continue until the utilization rate reaches 80 percent. We estimate that the 80 percent rate of utilization will not be reached until 1987.

Japanese suppliers are especially prone to initiate price pressure because they operate at much higher debt to equity ratios than U.S. suppliers, and act to gain market share in order to service their debt.

The past two or three months have seen substantial layoffs at many semiconductor companies in response to the declining demand. We are already hearing semiconductor users expressing concern about the problems that this situation could cause as demand begins to increase. However, many manufacturers have resorted to shorter work weeks and mandatory vacations as a means of retaining a trained work force.

SEMICONDUCTOR INDUSTRY FORECAST

The continued softness in semiconductor orders, together with a weak market for computers and office automation products, has caused us to make a substantial downward revision in our forecast for 1985, as shown in Table 1. Year-to-year growth from 1983 to 1984 was a staggering 53.0 percent, and current buying patterns suggest that a high proportion of this growth was "borrowed" from 1985.

As Figure 2 shows, we estimate that semiconductor consumption in the United States declined 19.5 percent in the first quarter of 1985 compared with the last quarter of 1984. We expect this trend to continue into the second quarter, with consumption declining 10 percent compared with the first quarter. The third quarter should see the beginning of a modest upturn, with consumption increasing 2.5 percent compared with the second quarter. The fourth quarter of 1985 is expected to show an increase of 6.7 percent over the third quarter. The result of the sharp dèclines in the first and second quarters is that total U.S. semiconductor consumption in 1985 is expected to decline 20.4 percent in 1985 compared with 1984.

In the first quarter of 1986, we expect to see an increase in consumption of 4.5 percent over the fourth quarter of 1985. Total U.S. semiconductor consumption in 1986 is estimated to increase 20.5 percent over 1985, but even this growth will not raise consumption to the record levels of 1984.

Excess capacity, especially in the commodity areas such as DRAMs, will hamper the growth of the semiconductor market until demand catches up with supply (as it inevitably does). Price pressures will inhibit the growth of the market in dollar terms, even as unit shipments increase. We expect to see a modest return to growth in the third quarter of 1985, fueled mainly by increased demand for high-margin products.

Jean Page
Howard Bogert
Barbara Van

Table 1

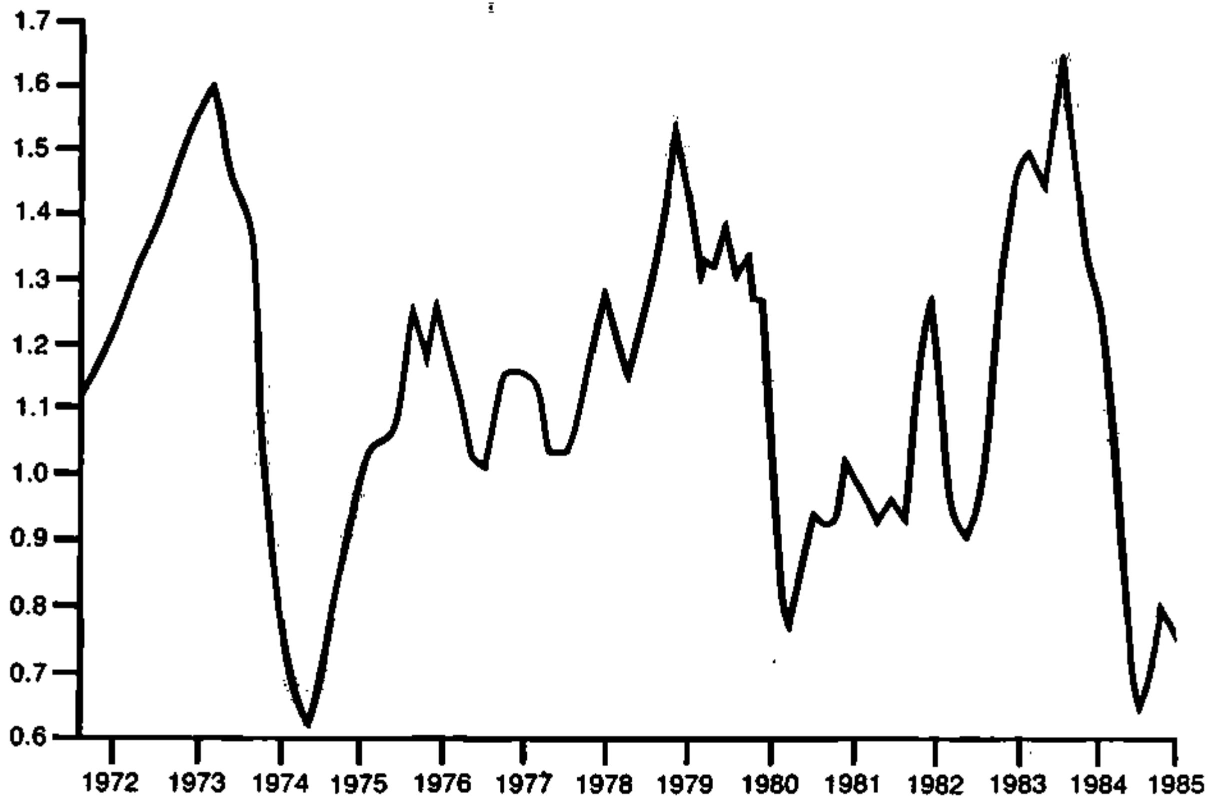
ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1984				
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Discrete	$ 475.0	$ 541.0	$ 564.0	$ 547.0	$ 2,127.0
IC	2,431.0	2,850.0	3,105.0	2,946.0	11,332.0
Total	$2,906.0	$3,391.0	$3,669.0	$3,493.0	$13,459.0
Quarter/Year Percent Change	9.9%	16.7%	8.2%	(4.8%)	53.0%
	1985				
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Discrete	$ 482.0	$ 434.0	$ 429.0	$ 447.0	$ 1,792.0
IC	2,331.0	2,098.0	2,166.0	2,322.0	8,917.0
Total	$2,813.0	$2,532.0	$2,595.0	$2,769.0	$10,709.0
Quarter/Year Percent Change	(19.5%)	(10.0%)	2.5%	6.7%	(20.4%)
	1986				
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Discrete	$ 485.0				$ 2,089.0
IC	2,409.0				10,819.0
Total	$2,894.0				$12,908.0
Quarter/Year Percent Change	4.5%				20.5%

Source: DATAQUEST
May 1985

Figure 1

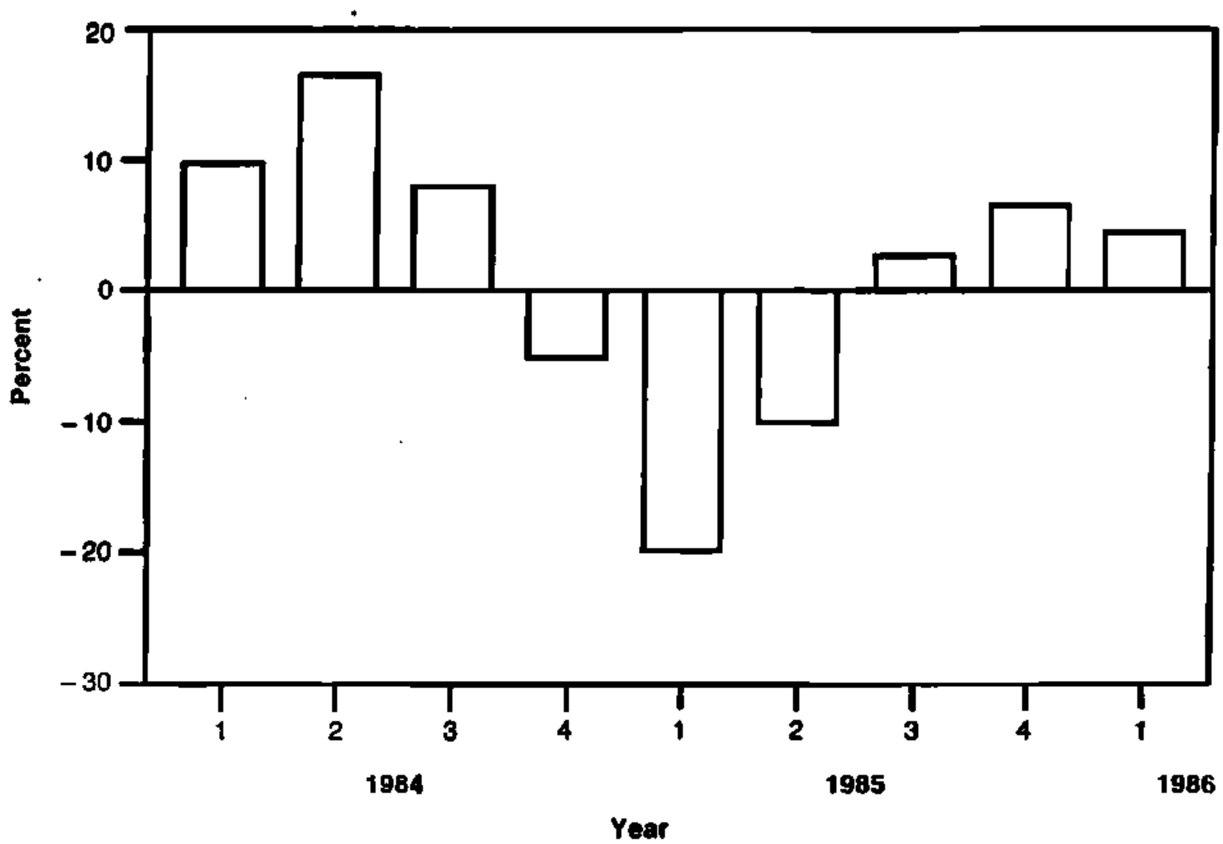
U.S. IC CONSUMPTION BOOK-TO-BILL RATIO
(Dollars)



Source: DATAQUEST

Figure 2

QUARTER-TO-QUARTER CHANGE IN U.S. SEMICONDUCTOR CONSUMPTION
(Dollars)



Source: DATAQUEST

Nielsen Dataquest
USER UPDATE

SUIS Code: Newsletters
No. 85-9

DYNAMIC RAM PRICES CONTINUE TO DROP: HOW LOW WILL THEY GO?

Since Micron Technology announced sub-$2.00 64K dynamic RAMs in early October, prices of the industry's most popular memory device have declined continuously. In the last two months, we have heard of companies dumping parts on the spot market for a penny a kilobit.

DATAQUEST believes that this is a short-term opportunity for users to save money. However, there are trade-offs to be considered. Some companies are avoiding spot market purchases to preserve their vendor relationships and to continue their quality improvement programs. Next-generation 256K DRAM prices are also decreasing rapidly, offering even lower-cost alternatives in the near future.

WHAT'S HAPPENING?

There are several reasons for the precipitous decrease in DRAM prices:

- Customer demand for 64K DRAMs slowed dramatically in the fourth quarter of 1984, as customers stopped orders to reduce inventories and adjust to slower demand for systems.
- There were record capacity additions in 1984, particularly by MOS memory manufacturers.
- 256K DRAMs have replaced 64K DRAMs in an increasing number of applications.

Shipments of 64K dynamic RAMs in the fourth quarter of 1984 were 9 percent greater than in the third quarter, as shown in Table 1. Indicators are that first quarter 1985 shipments were less than fourth quarter 1984 shipments.

This slowdown in 64K memory demand will be partly offset by the rapid increase in usage of 256K DRAMs. DATAQUEST expects 260 million 256Ks to be shipped in 1985. This is equivalent to another billion 64K DRAMs or twice the 1984 memory consumption, as shown by Figure 1. This growth is substantially less than the 2.65 times growth in memory consumption from 1983 to 1984.

CAPACITY ANALYSIS

A 27 percent increase in capacity will produce the estimated 1.28 billion 64K and 256K DRAMs forecast for 1985. Table 2 shows that semiconductor manufacturers will start the equivalent of 7.5 million 4-inch wafers in 1985 compared to the equivalent of 5.9 million 4-inch wafers in 1984. This represents the addition of roughly five new fab areas with a capacity of 360,000 4-inch equivalent wafer starts per year. DATAQUEST estimates that new capacity additions, plus conversion from 4-inch to 5- or 6-inch wafers, will increase capacity to produce the equivalent of 2.75 billion 64K DRAM units, versus consumption of 2 billion equivalent 64K DRAM units, or excess capacity of 750 million equivalent 64K DRAM units. This gap will diminish in 1986 and 1987 as the industry ramps from 260 million 256K DRAMs in 1985 to 740 million units in 1986 to 1.7 billion units in 1987. While there may be spot shortages during the next two to three years, we do not expect any prolonged shortages in the foreseeable future.

HOW WILL IT AFFECT YOU?

64K DRAM

The combination of decreasing demand and excess capacity have left some manufacturers with excess inventories, which they have chosen to sell at very low prices. We believe that spot market prices are presently below profitable levels. The cost model in Table 3 shows that the average variable cost of the 64K dynamic RAM in 1985 will be approximately $0.67. We estimate that manufacturers must sell this product for about 2 times that cost to make a profit. As a result, we believe that profitable prices were in the $1.50 to $1.60 range in the first quarter of 1985. We believe that manufacturers are quoting $1.10 at major accounts for delivery in the next two quarters. We expect prices will be $1.15 to $1.20 by the end of the year, then resume their downward trend. The 64K DRAM experience curve shown in Figure 2 supports this.

256K DRAM

As the price of the 64K DRAM has dropped, manufacturers have decreased prices of the 256K DRAM to encourage users to switch from 64Ks to 256Ks. As a result, we believe that companies are presently quoting prices in the $5.00 range. The 256K DRAM cost model shown in Table 4 indicates an average variable cost of $2.74 in 1985, indicating that manufacturers are operating with small or no margins at this point in the manufacturing cycle. Spot prices have been $4.00 or less.

Rapidly decreasing 256K DRAM prices is expected to result in very high shipment growth from 44 million units in 1984, to a forecast of 260 million units in 1985. This dramatic increase in production shipments causes the cost of the product to decrease at about the same rate as prices are projected to decrease as shown by the experience curve in Figure 3. According to the experience curve, we can expect average selling prices to be $4.50 to $5.00 by the end of 1985.

WHEN WILL PRICES REACH BOTTOM?

64K DRAMs

Our cost models and experience curves tell us that sub-$1.35 64K prices are presently below cost, but will be sustained until the last quarter of 1985 when we expect them to increase slightly. We believe that inventories, consumption, and production will come into balance and that there will be less aggressive activity in the spot market. Spot prices are expected to decrease at a slower rate.

256K DRAMs

We expect prices to remain near $5.00 for the balance of the year. By the end of the year, we believe that spot market prices will move back toward contract price levels. In 1986, prices are expected to continue to drop and reach $3.00 by the end of the year.

Table 5 summarizes expected behavior of average prices and spot market prices in 1985 and 1986.

THE BUYER'S DILEMMA: LONG-TERM RELATIONSHIP VERSUS SPOT MARKET SAVINGS

Many purchasing managers and operation executives have spent the last several years developing long-term relationships with their key vendors (which usually include memory suppliers). But now, spot prices have dropped well below long-term contract prices, and management is asking, "Why aren't we paying less than a dollar for our 64K DRAMs?"

DATAQUEST estimates that about 15 percent of the units being shipped are available at up to 55 percent less than the market price. Companies that can take advantage can reduce their purchased product cost for dynamic RAMs by as much as 8 percent if they buy 15 percent of their 64K DRAMs on the spot market. Users that want to take advantage of these opportunities should be aware of the following:

- Act now. Spot prices will return to higher, more profitable levels after mid-year.

- Be aware that the 256K DRAM is a lower-cost alternative only when it is less than five times the price of the 64K. DATAQUEST believes that sub-$1.00 64Ks will be the lower-cost solution through 1985 but not in 1986. You should plan to use 256Ks in 1986.

- Larger users generally appear to be sticking to their contracts rather than going for the spot market prices. They generally pay less than the average price in the tight market cycle while still getting relatively good delivery performance from their preferred vendors.

- Be prepared for a tightening 256K market and slower 64K and 256K price declines in 1986.

Stan Bruederle

Table 1

1984 AND 1985 64K DRAM QUARTERLY SHIPMENTS
(Millions of Units)

	1984				
	Q1	Q2	Q3	Q4	Year
Units	157.7	192.1	237.5	265.4	852.7
Percent Change	-	24.0%	18.1%	9.0%	129.1%

	1985*				
	Q1	Q2	Q3	Q4	Year
Units	235.0	240.0	258.0	295.0	1,028.0
Percent Change	(12.0%)	2.1%	7.5%	14.3%	19.4%

*Estimates

Source: DATAQUEST

Figure 1

DYNAMIC RAM SHIPMENTS
(Millions of Units)

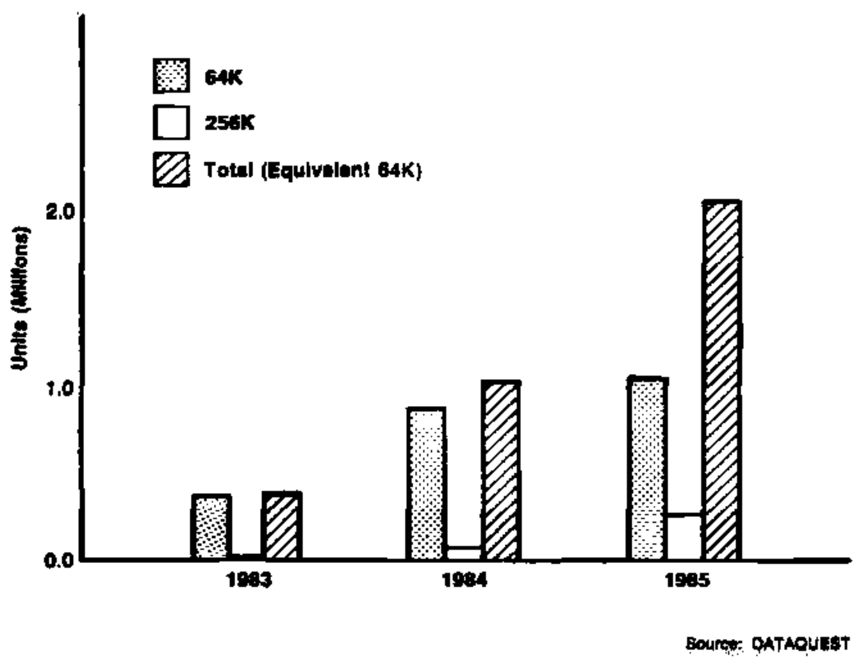


Table 2

DRAM CAPACITY ANALYSIS

	1984	1985
Unit Shipments (Millions)		
64K	852.7	1,028.0
256K	44.0	260.0
Shipments per 4-inch Wafer Start		
64K	195.0	258.0
256K	30.0	74.0
Wafer Starts (Millions)		
64K	4.4	4.0
256K	1.5	3.5
Total (Millions)	5.9	7.5

Source: DATAQUEST

Table 3

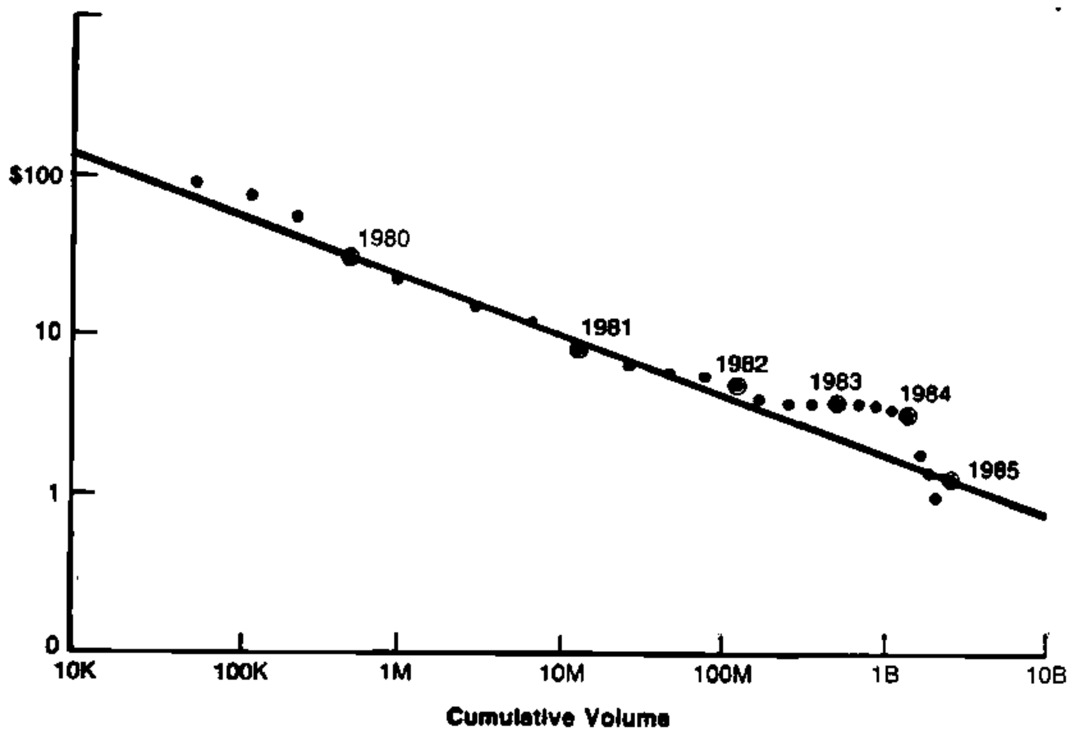
SEMICONDUCTOR COST MODEL
64K DYNAMIC RAM

	1984	1985	1986	1987
Wafer Sort				
Wafer size (inches diameter)	5	5	6	6
Processed wafer cost ($)	94	94	112	112
Die area (square mils)	31662	26912	22876	22876
Gross die per wafer	558	657	1112	1112
Processed wafer cost per gross die ($)	0.1680	0.1428	0.1007	0.1007
Wafer sort cost per gross die ($)	0.1500	0.1200	0.0900	0.0600
Cost per gross die at Wafer Sort ($)	0.3180	0.2628	0.1907	0.1607
Wafer sort yield (%)	71	78	81	81
Cost per sorted die ($)	0.4451	0.3348	0.2343	0.1974
Assembly				
Assembly cost per sorted die ($)	0.1500	0.1100	0.1100	0.1100
Assembly yield (%)	92	93	94	95
Cost per assembled die ($)	0.6474	0.4792	0.3672	0.3246
Final Test				
Test time per die (sec.)	6.50	6.50	3.20	3.20
Cost per hour of testing ($)	35	25	25	25
Test cost per die ($)	0.0632	0.0451	0.0222	0.0222
Final test yield (%)	88	89	90	91
Cost per final tested unit ($)	0.8115	0.5870	0.4317	0.3807
Mark, Pack, and Ship				
Cost @ 99% yield ($)	0.0800	0.0800	0.0800	0.0800
Total variable cost per net unit ($)	0.8915	0.6670	0.5117	0.4607

Source: DATAQUEST

Figure 2

64K DYNAMIC RAM EXPERIENCE CURVE



Source: DATAQUEST

Table 4

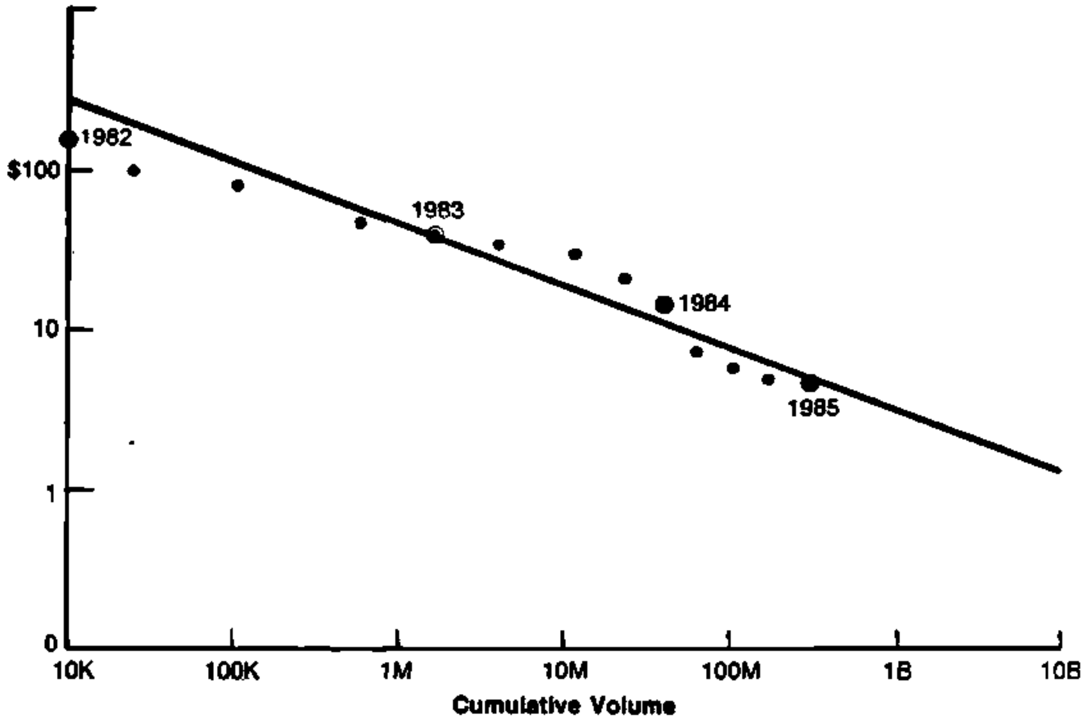
SEMICONDUCTOR COST MODEL
256K DYNAMIC RAM

	1984	1985	1986	1987
Wafer Sort				
Wafer size (inches diameter)	4	5	6	6
Processed wafer cost ($)	75	94	112	112
Die area (square mils)	54000	43200	34560	27648
Gross die per wafer	209	409	736	920
Processed wafer cost per gross die ($)	0.3581	0.2292	0.1521	0.1217
Wafer sort cost per gross die ($)	0.4000	0.3000	0.2000	0.2000
Cost per gross die at Wafer Sort ($)	0.7581	0.5292	0.3521	0.3217
Wafer sort yield (%)	24	39	53	65
Cost per sorted die ($)	3.1431	1.3545	0.6605	0.4918
Assembly				
Assembly cost per sorted die ($)	0.5000	0.2500	0.1200	0.1200
Assembly yield (%)	85	90	92	94
Cost per assembled die ($)	4.2860	1.7828	0.8502	0.6534
Final Test				
Test time per die (sec.)	90.00	30.00	15.00	10.00
Cost per hour of testing ($)	65	50	35	25
Test cost per die ($)	1.6250	0.4167	0.1458	0.0694
Final test yield (%)	75	85	87	90
Cost per final tested unit ($)	7.8813	2.5876	1.1489	0.8032
Mark, Pack, and Ship				
Cost @ 99% yield ($)	0.1500	0.1500	0.1500	0.1500
Total variable cost per net unit ($)	8.0313	2.7376	1.2989	0.9532

Source: DATAQUEST

Figure 3

256K DYNAMIC RAM EXPERIENCE CURVE



Source: DATAQUEST

Table 5

ESTIMATED AVERAGE SELLING PRICES (ASP) AND SPOT MARKET PRICES
FOR 64K AND 256K DYNAMIC RAMS

	Q1	Q2	Q3	Q4	1985	Q1	Q2	Q3	Q4	1986
64K DRAM										
ASP	1.70	1.40	1.10	1.15	1.30	1.15	1.10	1.10	1.05	1.10
SPOT	0.70	0.70	0.75	0.90	-	1.00	1.10	1.10	1.05	-
256K DRAM										
ASP	8.00	6.00	5.00	5.00	5.50	4.50	4.00	3.50	3.00	3.50
SPOT	4.00	4.00	4.25	4.50	-	4.50	4.25	4.00	3.50	-

Source: DATAQUEST

Nielsen Dataquest USER UPDATE

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No. 85-8

ARRAY LOGIC TARGETS QUICK-TURN LOW-VOLUME ASIC OPPORTUNITY

INTRODUCTION

A new U.K. company, Array Logic, has been set up to provide a unique application-specific integrated circuit (ASIC) design and short-run fabrication service. Backed by PA Technology and a consortium of merchant bankers, Array Logic is the culmination of an initial £4 million investment. The company is a spin-off from research done by PA Technology, the science and technology division of PA International. DATAQUEST believes that this is PA Technology's first attempt to leverage its own research into a new company in which it has an equity share (approximately 30 percent).

Array Logic aims to provide customers with quick access to working silicon and to offer, for the first time, the opportunity to design in silicon into prototype systems. Array Logic will apply direct-write E-beam technology to a range of ASIC architectures, processes, and materials, including CMOS and bipolar. Array Logic is aiming for around £10 million in revenues by 1987.

BACKGROUND

Array Logic, founded in 1984, is based in Melbourne, Cambridge, which has a high concentration of small science-based companies (see ESIS newsletter, "The Cambridge High-Tech Boom Town Phenomenon," dated 4 March 1985).

The £4 million initial funding of Array Logic included an investment package of a £2 million equity investment from Charterhouse Japhet Venture Fund, Midland Bank Equity, Morecrest Finance Ltd., Warburg Investment Management, and PA Technology. The new company also received a £450,000 grant from the U.K. Department of Trade and Industry via the MISPII scheme, a £800,000 loan from Samuel Montagu, and a £750,000 line of credit from ICFC.

The prime movers behind the company are Robert Whelan, managing director, formerly director of corporate business development at PA Technology, and John Catalano, technical director, formerly of General Electric. Others on Array Logic's management team include Peter Benton, special advisor on telecommunications to the European Commission and former deputy chairman of British Telecom, as chairman and Mike Lloyd, formerly of Texas Instruments, as marketing manager.

Array Logic's design environment is already in operation, with ASIC manufacturing to begin in the second quarter of 1985. The new company has already struck deals with Ferranti and Plessey to source their bipolar and CMOS arrays, respectively. DATAQUEST expects Array Logic to announce additional European and U.S. ASIC vendors shortly.

PRODUCTS

Array Logic will design and manufacture prototype and small volume ASIC devices. This will provide customers with quick access to working silicon parts and thus offer the opportunity to design silicon straight into prototype systems.

Array Logic makes fast turnaround possible by its investment in direct write on wafer E-beam processes and by integrating design, prototype, and testing under one roof. Array Logic has a fully integrated facility comprising:

- A design environment based on dedicated workstations and Digital Equipment VAX general-purpose systems
- Advanced E-beam and optical lithographic systems
- A process system encompassing metallization, organic and inorganic dielectric, and both wet and dry etch capabilities
- A test facility capable of testing both digital and analog semicustom circuits

Design implementation of the products is done using the vendor's ASIC software run by Array Logic on its own simulators. Thus, any device designed in conjunction with Array Logic can go directly into volume production by the original ASIC vendor, since the product is already proven.

Array Logic's prototyping service falls into two main categories--design and prototyping, and prototyping only. Designs are undertaken with the sole purpose of supplying prototype ICs--this distinction sets it apart from an ordinary design center. DATAQUEST believes that Array Logic is more than able to follow ASIC technology developments over the next three to five years without a substantial increase in investment. Presently, Array Logic's technical capability (i.e., array and feature size) is constrained more by the prime ASIC vendor rather than by Array Logic's capability.

Gate arrays are available in bipolar (ECL), MOS (CMOS), and linear technologies using single- and double-layer metallization for 3-inch, 100mm, and 125mm wafer sizes.

Planned enhancements to Array Logic's service will make cell arrays and even full custom prototypes a possibility. DATAQUEST believes that Array Logic plans to expand its marketing activity to the United States shortly.

It was announced recently that Array Logic is an approved company under the U.K. Department of Trade and Industry MAPCON Scheme. Companies using Array Logic to investigate the feasibility of using ASICs will now be able to qualify for a grant assistance toward such studies.

DATAQUEST ANALYSIS

The current industry move to ASICs has really only impacted the mature product environment. Most present applications are restricted either to relative high-volume applications (i.e., consumer and computer end-use areas) or to applications where design security and/or performance supremacy are prerequisites (i.e., telecommunications and government/military end use). Until now, the low-volume end of the market has been in direct conflict and contradiction with customized silicon, except where this could be accommodated by programmable devices such as programmable logic arrays. Most ASIC suppliers, whether mainstream semiconductor manufacturers or specialist companies, so far have been unable or uninterested in addressing the low-volume, quick-turnaround, low-cost ASIC requirement.

DATAQUEST believes that from the user's perspective, this lack of support represents a major disincentive to adopt ASIC system solutions. The time delays, additional engineering and development costs, and risks associated with either having to redesign the standard IC prototype system (when proven) to incorporate ASICs, or to develop the prototype in ASICs up front (with the added design uncertainties) can be profound.

We believe that Array Logic's approach provides a viable solution to just this problem. Given that the data base used to direct write on the silicon wafer is the same as that used to generate a mask, the subsequent transition to volume production should also be relatively smooth and risk free.

From the volume manufacturer's point of view, Array Logic provides an ideal opportunity to access the prospective user at the early development stage without the associated manufacturing logistic and cost problems. DATAQUEST believes that Array Logic will provide a valuable service to the European and world electronics companies and the ASIC market. The ASIC vendors gain by having easy access to prototypes and small quantity runs--the users gain by having easy access to small volume ASIC solutions.

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Nielsen Dataquest USER UPDATE

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THE OTP PLASTIC EPROM MISSION: THE MARKET STRIVES FOR A LAUNCH

The plastic one-time-programmable (OTP) EPROM market now has roughly four years under its belt. As a low-cost alternative to ceramic ultraviolet EPROMs, OTPs have not as yet made a signicant market impact. Contrary to the 47 million unit shipment level predicted for 1984, OTP shipments reached only about 5 million units. While most of the manufacturers appear to have overcome the original obstacles of testing and passivation, certain factors such as declining EPROM pricing, the exit of suppliers from the market, and poor customer acceptance have contributed to the slow growth of OTPs.

Despite these factors, DATAQUEST still believes that plastic OTPs will become predominant, with about 90 percent of the EPROM market by 1989. Suppliers will introduce new OTP products in the 128-Kbyte and higher densities between third quarter 1985 and second quarter 1986. Surface-mount packaging technology will also be a factor in the future growth of these products.

THE FACTORS AND THEIR EFFECTS

EPROM Price Erosion

Overall faltering demand helped reduce the price difference between ceramic EPROMs and plastic OTPs. A 5 to 15 percent price delta reduced the attractiveness of OTPs over CERDIP devices. Customers who do not require reprogrammability desire the more cost-effective OTP. Once the price separation reaches the 25 to 35 percent range, plastic EPROMs should become viable nonvolatile memory contenders. Our cost models indicate about a 35 to 40 percent assembly difference that supports the projected resale pricing given a supplier who performs all assembly internally (i.e., not via a contractor). Table 1 gives our forecast of the average selling prices for ceramic EPROMs, plastic OTPs, and mask ROMs.

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Supplier Offerings

One year ago, four primary OTP manufacturers were shipping products. They were:

- AMD
- Hitachi
- Intel
- NEC

Since then, the vendor field has narrowed to two main suppliers--Intel and NEC. AMD and Hitachi withdrew from the market when either technical difficulties arose or their products were perceived as not being competitive. We expect AMD to introduce two 12.5-volt programmable 64-Kbit and 128-Kbit OTPs with perfected packaging later this year and that it will offer a 256-Kbit part in the same series some time after that. In the earlier stage of the OTP market, AMD aggressively competed with the leader, Intel. DATAQUEST believes that AMD's new products will be even more competitive, as the company appears to have solved its technical problems by stressing quality manufacturing.

Hitachi's 64-Kbit OTP of last year was offered in a 300ns speed, which was slower than the EPROM/ROM cycle time of 250ns minimum it needed to meet. Hitachi is expected to introduce a new NMOS 128-Kbit OTP from its Tokyo facility by the third quarter of this year. Coupled with its EPROM and EEPROM products, the new OTP should give Hitachi one of the broadest nonvolatile memory selections on the market.

Future offerings will include 128-Kbit and 256-Kbit devices in NMOS and eventually CMOS. Intel currently has the broadest OTP range with densities from 32 Kbits to 128 Kbits. Intel's 256-Kbit and 512-Kbit ceramic EPROMs are expected to be offered in plastic within a year.

NEC currently has 64-Kbit and 128-Kbit NMOS OTPs and is expected to introduce a 256-Kbit device about mid-1985.

Oki Semiconductor offers a set of 64-Kbit and 128-Kbit windowed plastic EPROMS at prices between those of OTPs and ceramic EPROMs. DATAQUEST believes that Oki will not offer an OTP device in the future. The company apparently feels that users who desire reprogrammability but want the lower-cost benefit of the plastic package will pay for this midrange device.

Future Participants

DATAQUEST believes that because of the low 1984 EPROM shipment levels, companies like Texas Instruments, Mitsubishi, and Motorola will not quickly enter the OTP market. Most suppliers are adopting a wait-and-see attitude. Therefore, we do not expect further participants until the market is more fully developed. DATAQUEST anticipates that once OTP EPROMs become widely accepted, Texas Instruments, Mitsubishi, Fujitsu, and other major suppliers will need to begin offering plastic OTPs to maintain their competitive positions in the marketplace. Table 2 provides our estimate of 1984 EPROM shipments.

Customer Acceptance

Most users are reluctant to continue using OTPs or to even evaluate them at this time. The earlier technical difficulties coupled with the narrowing price gap between OTPs and ceramic EPROMs has caused customers to stay with ceramic EPROMs or design in EEPROMs for further code flexibility. Although plastic OTPs generally offer better package uniformity for automated manufacturing, several potentially major users we have surveyed are not implementing automated assembly for products incorporating OTPs. DATAQUEST believes that the attractive cost of OTPs is still the primary reason for using them. Further narrowing of the price gap between OTPs and mask ROMs will increase the incentive to use plastic OTPs in the much larger volume applications.

PRODUCT/TECHNOLOGY TRENDS

Densities

DATAQUEST expects OTPs to evolve with ceramic EPROM density levels. This year should see the introduction of 128-Kbit (revised versions) and 256-Kbit NMOS devices by the fourth quarter and into 1986. A desirable strategy would be for the manufacturer to take an EPROM die and package it in either plastic or CERDIP with little interstage processing.

Surface-Mount Packaging

Most suppliers realize the importance of this technology to today's systems designers. A number of companies are presently committed to offer OTPs and other EPROM devices in surface-mount and small-outline packages. Companies are expected to introduce these devices during 1986. DATAQUEST believes that production surface-mount EPROM devices will be predominantly plastic OTPs. This will enhance the development of the OTP market since this packaging technology will be widely used during the late 1980s.

DATAQUEST CONCLUSIONS

While plastic OTP EPROMs have staggered this last year in gaining a market hold because of decreasing ceramic EPROM prices and product withdrawals, DATAQUEST believes that this is a viable technology with very good potential. Users should consider their future product requirements in a one- to two-year time frame because within this time, OTP technology should be established. We recommend that users design next-generation systems with the higher-density devices in more cost-effective packaging.

Brand A. Parks

Table 1

ESTIMATED ROM, EPROM AVERAGE SELLING PRICES*

	1985	1986	1987	1988	1989
32-Kbit Ceramic EPROM	$ 2.75	$ 2.75	$3.00	N/A	N/A
32-Kbit Plastic EPROM	$ 2.25	$ 1.75	$1.75	N/A	N/A
32-Kbit ROM	$ 1.20	$ 1.50	N/A	N/A	N/A
64-Kbit Ceramic EPROM	$ 3.25	$ 3.00	$3.00	$ 3.25	$3.50
64-Kbit Plastic EPROM	$ 2.50	$ 2.00	$1.80	$ 2.00	$2.25
64-Kbit ROM	$ 1.60	$ 1.40	$1.50	$ 1.55	$1.60
128-Kbit Ceramic EPROM	$ 5.00	$ 3.50	$3.00	$ 3.00	$3.00
128-Kbit Plastic EPROM	$ 4.25	$ 3.25	$1.75	$ 1.65	$1.50
128-Kbit ROM	$ 2.25	$ 1.85	$1.75	$ 1.65	$1.60
256-Kbit Ceramic EPROM	$12.00	$ 5.50	$4.00	$ 3.25	$3.25
256-Kbit Plastic EPROM	$10.00	$ 4.50	$3.25	$ 2.50	$2.00
256-Kbit ROM	$ 3.10	$ 2.50	$2.10	$ 1.90	$1.75
512-Kbit Ceramic EPROM	$40.00	$15.00	$7.50	$ 5.50	$4.50
512-Kbit Plastic EPROM	N/A	$10.00	$5.00	$ 3.75	$2.35
512-Kbit ROM	$ 8.50	$ 6.00	$4.00	$ 4.20	$3.25

N/A = Not Available
*Prices are for NMOS devices.

Source: DATAQUEST
May 1985

Table 2

ESTIMATED 1984 EPROM SHIPMENTS
(Thousands of Units)

	32-Kbit	64-Kbit	128-Kbit	256-Kbit
AMD	8,000	5,700	3,350	600
Thomson	1,200	0	0	0
Fujitsu	7,000	11,300	3,125	195
Hitachi	7,200	23,050	8,150	0
Intel	7,600	8,000	7,000	1,250
Mitsubishi	3,050	21,400	4,160	5
Mostek	0	0	0	0
Motorola	0	2,900	0	0
National	3,850	0	0	0
NEC	4,700	4,300	1,780	5
Oki	400	1,900	0	0
Ricoh	150	125	0	0
Rockwell	75	70	0	0
Seeq	8	3,950	1,650	5
SGS-Ates	2,150	1,150	0	0
Signetics	0	30	0	0
Texas Instruments	13,200	10,200	85	0
Toshiba	525	2,900	1,800	190
Total	59,108	96,975	31,100	2,250

Source: DATAQUEST
May 1985

Nielsen Dataquest USER UPDATE

SUIS Code: Newsletters
No. 85-6

THE GENERATION GAP-- AN UPDATE ON 32-BIT MICROPROCESSORS

SUMMARY

The 32-bit generation of microprocessors is now emerging. Three devices are already on the market, and there are more to come. The decision to move to a new generation of semiconductor devices is complex, and timing can be critical to the company making that decision. This newsletter gives an update on the 32-bit microprocessor, its applications, and its current and future manufacturers.

INTRODUCTION

Users look to the 32-bit microprocessor to provide increased speed and functional enhancements. Engineering and CAD workstations represent the most visible market segment to adopt the 32-bit MPU. Other important design-ins are in robotics, computer-aided manufacturing, and telecommunications.

DATAQUEST anticipates three phases in the adoption of the 32-bit microprocessor:

1. The replacement of 16-bit devices by 32-bit devices will be the first phase as new versions of existing systems are designed. We see this occurring initially with engineering workstations as growing systems complexity demands greater performance from the microprocessor. The important issue in this phase will be upward compatibility. The Motorola 68020 and the National 32032 are expected to be important players here because many of the existing workstations have been designed with the 16-bit predecessors to these 32-bit MPUs. In both cases, the conversion to the new MPU can easily be accomplished. This phase is already beginning.

2. In the second phase of the market development, we will see the use of 32-bit microprocessors in minicomputers and small business systems. Designers will use these products to improve the cost/performance ratio of their machines. A significant factor in this market will be the captive manufacturers of 32-bit devices, such as Data General, Digital Equipment Corporation, Hewlett-Packard, and NCR. The potential exists for any of these companies to offer its devices on the merchant market. NCR's entry into the merchant market marks the beginning of this phase.

3. The third phase of the development of the 32-bit market will occur when the devices are well understood and accepted and become the basic design elements of many microprocessor-based systems. Rapid growth in consumption of 8-bit and 16-bit microprocessors occurred about five years after they were first introduced. We expect 32-bit microprocessors to follow the same trend, with rapid growth beginning in 1989.

MICROPROCESSOR PRODUCT ACCEPTANCE

If 32-bit microprocessors follow the trends we have observed, they will exhibit slow to moderate growth in the first two or three years after introduction, followed by a period of extremely rapid growth in the fourth and fifth years. There are, however, arguments for either faster or slower growth than this experience suggests.

The arguments for slower acceptance revolve to some extent around the fact that the full capabilities of existing 16-bit devices have not yet been exploited. Another argument is that there are more design alternatives than ever before. Many systems designs are being done with multiple 8- or 16-bit microprocessors.

With the evolution of application-specific ICs, we are seeing the development of intelligent microperipherals. A number of coprocessors for 16-bit devices are also coming to the market. All these devices make the design of higher-performance systems possible without resorting to the use of a 32-bit microprocessor.

Faster acceptance of the 32-bit microprocessor could come about simply because the market is much larger than it was when the 8-bit and 16-bit devices were introduced. Some 32-bit microprocessors offer upward compatibility with existing 16-bit devices, making the transition from a 16- to 32-bit device much easier than previous generation switches.

The 32-bit device will appeal to manufacturers of minicomputers and superminicomputers as a means of reducing cost. These manufacturers will not have the same commitment to previous generations of microprocessors as microcomputer manufacturers, so they may accept the devices more readily, thus accelerating the rate of acceptance.

MANUFACTURERS--PRESENT

Motorola

The Motorola 68020 was introduced in the third quarter of 1984. The company is now ramping up to full production. The 12MHz version will be in volume production by mid-1985 and the 16MHz version in the Fall. Motorola has entered into a second-source agreement with Thomson-CSF, contingent upon certain technology exchange agreements. If these agreements are met, Thomson-CSF is expected to start production of the 68020 by the end of 1985. Hitachi, Rockwell International, and Signetics also second-source Motorola's 16-bit devices and may be regarded as potential second sources for the 32-bit family.

National Semiconductor Corporation

National Semiconductor Corporation is currently the leading supplier of 32-bit MPUs with its 32032. The device has been in production for more than a year. Texas Instruments, which is second-sourcing the family, is expected to start sampling around mid-1985.

NCR Corporation

NCR is offering its 32-bit chip set, originally developed for internal use, on the merchant market. The device, which features external microcode, can emulate existing microcomputers. Honeywell, Inc., has signed an agreement with NCR to use the NCR/32 chip set for a future small- to medium-scale computer system.

MANUFACTURERS--FUTURE

This section of the newsletter will cover the announced plans of future participants in the 32-bit microprocessor market. Table 1 lists those companies believed to be currently involved in 32-bit microprocessor development.

Advanced Micro Devices

The Advanced Micro Devices (AMD) 29300 family of bipolar devices includes the Am29323 Multiprecision Multiplier, the Am29325 Floating Point Processor, the Am29332 16-bit Micro-Interruptible Sequencer, the Am29332 32-bit Arithmetic Logic Unit, and the Am29334 Four-Port Dual-Access Register File. Each device can function alone or act as a building block for a 32-bit system. The products are intended for use in high-performance applications, for intelligent peripherals control, and in digital-signal and array processors. The 29325 arithmetic unit will be sampling within two months, and all five devices will be sampled by the end of 1985.

AT&T Technologies

AT&T's WE32100 is a CMOS microprocessor originally developed for in-house use. The company recently announced commercial availability of the family. The WE32100 is now in production, together with the WE32101 memory management unit and the WE32105 system interface unit. The 32106 math acceleration unit is now being sampled, and the 32103 DRAM access controller and the 32104 DMA controller will complete the chip-set early next year.

Hitachi Ltd.

Hitachi Ltd. announced the development of a CMOS 32-bit microprocessor at the end of 1984. Sample quantities are expected at the end of 1986, with full production beginning in mid-1987. The device is expected to be upwardly compatible with Motorola's 68000 family. Hitachi had been regarded as a potential second source for the Motorola 68020 and it is not yet clear what effect the announcement of a proprietary 32-bit device will have on the situation.

Inmos

Inmos is in the final development stages of a family of devices based on its unique, high-performance architecture. The family includes both a 16-bit and a 32-bit transputer as well as some intelligent microperipherals. Inmos will begin sampling the first parts of this family by the end of 1985 or early 1986.

Intel

Intel announced early this month that it plans to ship samples of its 80386 32-bit microprocessor in about six months. The device will be offered in 12- and 16-MHz versions, and Intel will also offer a 32-MHz clock generator and a floating-point coprocessor chip.

NEC

NEC's V series family of microprocessors will include 32-bit devices. The V-60 is scheduled for introduction in 1986 and the V-70, described by NEC as a second-generation 32-bit device, is planned for 1987. NEC has licensed both Sony Corporation and Zilog, Inc., as second sources. NEC is also licensed as a second source for Zilog's Z80,000.

Zilog

The Zilog Z80,000 is now expected to be sampled by the end of 1985. NEC is a licensed second source for the part.

Other Manufacturers

Data General, Digital Equipment Corporation, and Hewlett-Packard have all introduced 32-bit microprocessors for internal use, but it is not yet known whether they will offer these devices on the merchant market. The other companies listed in Table 1 are believed to be developing 32-bit devices for the merchant market.

SELECTING A 32-BIT MICROPROCESSOR

As Table 1 shows, 17 companies already produce or are planning to produce 32-bit microprocessors. How do you pick a winner from such a range of alternatives? The market is still too young to predict who the big winners will be, but there are several points worth considering.

For the first time, the computing power of a minicomputer will be available in a microprocessor. This means that the 32-bit device can be approached from two directions: it can provide an upward migration path for current users of 16-bit devices, and it can offer a lower-cost option to manufacturers of mini- and superminicomputers. These two categories of users make different demands on 32-bit devices. Those taking the upward migration path are looking for upward compatibility from existing 16-bit devices so that they can continue to exploit the existing software base. Those taking the downward path from the minicomputer environment are more concerned with getting the architectural capabilities available with advanced technology. In the long term, this diversity could set the stage for a larger number of suppliers to enter the market.

There are two new factors in the 32-bit market that could change the market pattern. The first is the presence of the captive manufacturers. Captive manufacturers were ahead of the merchants in their development of the 32-bit device. There has been an increasing trend for captive semiconductor manufacturers to offer their products on the merchant market. NCR's device, the NCR/32, is the first of such products to be offered, but others could follow. Such a development could herald the growth of a 32-bit niche market for those users who are looking for minicomputer capability in a microprocessor. Captive manufacturers have the advantage of a protected internal market to help them weather the vicissitudes of market introduction. However, the ability of captive manufacturers to market their products effectively will obviously be an important factor in the growth of this niche market.

The second factor to be considered in the 32-bit market is the development of proprietary devices by Japanese companies. In previous generations, Japanese manufacturers have second-sourced U.S. products.

The most important issue to consider in selecting a 32-bit microprocessor is whether you really need the added capabilities that the device can offer. Have you fully exploited the 16-bit options available? If your application requires 32-bit capability, then the next areas of consideration are similar to those for any microprocessor:

- Does the device match your application?
- Will it be available in sufficient quantities when you need it?
- Are the appropriate microperipherals and coprocessors also available?
- Are there adequate development tools?
- Is there a viable second source?

The point of divergence that you reach when selecting a 32-bit device is the decision about which category of 32-bit devices you should be considering. Is upward compatibility an issue? If so, you should be considering those devices that offer a migration path from earlier generations. Are you looking for minicomputer-like architecture? Devices developed initially for captive use will fit into this category. National Semiconductor's 32032 offers a VAX-like architecture, and Fairchild is promising to take a minicomputer-like approach to its 32-bit offering. Japanese companies will also be entering the market with devices that are not upwardly compatible with existing products. There is yet another segment, represented by AMD's 29300 family and also, perhaps, by the Inmos transputer. These devices offer alternatives for high-performance applications that do not fit into either of the other categories.

The ultimate success of 32-bit microprocessors may rest on the rate at which the market develops. If market acceptance of the 32-bit device is delayed, the winners could be those companies that gained an early share of the market, those companies with upward compatibility to a substantial installed base of 16-bit devices, or those companies with protected internal markets. Early acceptance of the 32-bit devices, on the other hand, may permit market growth adequate to support a wider range of successful products than we have seen in any previous generation.

Future newsletters on the 32-bit microprocessor will examine the growth of the market and the development of new devices. This information will help you to implement a selection strategy that will satisfy your product's requirements.

Jean Page
Mel Thomsen

Table 1

COMPANIES INVOLVED IN 32-BIT MICROPROCESSOR DEVELOPMENT

Advanced Micro Devices (Bipolar)	Matsushita
AT&T Technologies	Motorola
Data General	National Semiconductor
Digital Equipment Corporation	NCR
Fairchild Semiconductor	NEC
Hewlett-Packard	Texas Instruments
Hitachi	Toshiba
Inmos	Zilog
Intel	

Source: DATAQUEST
May 1985

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INTERACTIVE SESSIONS AT DATAQUEST'S SEMICONDUCTOR PROCUREMENT CONFERENCE

INTRODUCTION

Most of the second day of DATAQUEST's Semiconductor Procurement Conference in Tucson, Arizona (February 11 through 13), was devoted to interactive sessions on these five topics:

- Memory
- Microprocessors
- Far East Suppliers
- Application-Specific ICs
- Packaging

This newsletter briefly discusses each session topic and the conclusions reached by the participants.

MEMORY

The Memory Forum was led by Lane Mason, Senior Industry Analyst, DATAQUEST. Forum participants, who represented both users and manufacturers of semiconductors, discussed three topics:

- Changing from 64K to 256K dynamic RAMs
- Factors determining the premium that users would be willing to pay for CMOS
- Evaluating and working with memory start-ups

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Participants agreed that two categories of reasons underlie the move from 64K to 256K dynamics RAM. The first category involves decisions based solely on price. These decisions are usually made when the 256K reaches a price of 5X the 64K service. The second category of reasons involves technical and engineering decisions. When space or design considerations are at issue, companies will pay much higher premiums.

Most of the companies represented at this forum anticipated seeing all new product designs using 256K devices, but no consensus was reached about the value of re-designing existing products.

Companies would not now consider qualifying a new 64K vendor that did not have the potential to move quickly to 256K devices.

MICROPROCESSORS

Mel Thomsen, Senior Industry Analyst, DATAQUEST, led the Microprocessor Selection Workshops. Participants at the workshops used material from Mr. Thomsen's speech, "Microprocessor Section: Picking a Winner," along with material presented in the workshops in discussion projects such as:

- Developing a checklist and timetable for microprocessor selection
- Listing the business and technical reasons for and against selecting a new microprocessor
- Developing a weighted vendor selection checklist for microprocessor products

Among the considerations the participants considered important were the following:

- It is important to consider the manufacturer's track record and history of reliability.
- When selecting a microprocessor vendor, you should give weight to existing business relationships.
- The process of selection must take into account factors relating to the past and future. Will the device be software compatible with existing products? What are your plans for future products? Are they compatible with the vendor's plans?
- Small companies have a special problem with vendor selection. They must ensure that their vendors have selected them and will support them in times of shortage.
- Although procurement should have some input, microprocessor selection is essentially an engineering-driven decision.

FAR EAST SUPPLIERS

The DATAQUEST perspective on Asian Suppliers was given by Patricia S. Cox, Research Analyst, DATAQUEST, and Gene Norrett, Vice President, DATAQUEST. The presentation covered the top 20 Japanese suppliers, Korean and Taiwanese suppliers, events in China, and Japanese design centers in the United States.

Much of the subsequent discussion was centered around price and availability of Japanese parts; the following comments were made:

- Current memory prices in Japan are more comparable to U.S. prices than they were.
- Some Japanese devices cannot be purchased in Europe although they are available in the United States and Japan.
- Japanese suppliers were seen as less willing to support the European market during times of high demand.

APPLICATION-SPECIFIC ICs

At the Application-Specific Product Workshop, participants were challenged to develop ASIC solutions for a series of case studies presented by Andy Prophet, Senior Industry Analyst, DATAQUEST. The case studies had life cycles ranging from 2 years to 10 years, and volume requirements ranging from 3,000 to 100,000 units. These studies sparked lively discussions, which produced an impressive variety of solutions. The problems addressed included:

- Identifying critical issues
- Interfacing with engineering
- Selecting vendors
- Selecting technology

Participants found it very useful to share ideas in the hypothetical framework of the case studies.

PACKAGING

Phil P. Marcoux, President, Educational Group, AWI, chaired a discussion of packaging issues. Mr. Marcoux's extensive experience and knowledge in the field of surface-mount technology was a valuable resource for those participants interested in the transition. Virtually all those present agreed on the necessity of considering innovative packaging technology for future products. Advantages of surface-mount technology were identified as follows:

- Semiconductor manufacturers have published data demonstrating the reliability of surface-mount products.
- Rework and removal of parts from boards is easier with surface-mount components than with through-hole components.
- Surface-mount assembly equipment is more readily available.
- Surface-mount test equipment is now available.

Concerns about surface-mount technology included the following:

- Limited availability and high price of parts in the recent past
- Lack of surface-mount package standards
- High outlay required for capital equipment
- Limited number of equipment suppliers in 1984

The groups concluded that tape-automated bonding and chip-on-board techniques would remain expensive until high unit volume becomes a reality.

CONCLUSION

The interactive sessions offered conference attendees an opportunity to take a more active role in the conference, and to share ideas and experiences with their peers. Many participants commented enthusiastically on the sessions, and we expect to offer similar opportunities for idea exchanges at next year's conference.

Jean Page

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CHANGES, CHALLENGES, COOPERATION--
DATAQUEST'S FIRST ANNUAL SEMICONDUCTOR PROCUREMENT CONFERENCE

INTRODUCTION

DATAQUEST's Semiconductor User Information Service held its first annual Semiconductor Procurement Conference in Tucson, Arizona, February 11 through 13. Among the 150 attendees were representatives of all functions in the semiconductor procurement cycle from manufacturers to distributors and users. The conference theme--"Changes, Challenges, and Cooperation"--was addressed from many different perspectives by the 18 speakers.

SUMMARY

On Monday morning, speakers from DATAQUEST's Semiconductor Industry Division gave a broad overview of the semiconductor industry, with specific attention paid to memories and microprocessors. Monday afternoon was devoted to application-specific integrated circuits. Each of the four speakers on Tuesday morning dealt with an aspect of change occurring in the semiconductor industry and in procurement practices. The second part of Tuesday's program was devoted to interactive sessions that gave participants a chance to share their views and experiences with their peers in the industry. Wednesday's program dealt with various aspects of procurement strategy from the viewpoint of both large and small companies.

CHANGES

In a dynamic industry such as semiconductors, change is a way of life, and making effective use of change is an important part of the procurement function. Some of the more rapidly changing areas covered in the presentations included surface-mount technology, application-specific devices, and the trend toward CMOS.

Phil P. Marcoux, President, Educational Division, AWI, discussed the trend toward surface-mount packaging. Mr. Marcoux emphasized the role of surface-mount products in cost reduction and performance improvement and concluded that "only by exploring and implementing cost and space-saving techniques, such as surface mounting technology, do the electronic product producers of the world become and remain leaders."

Application-specific devices and the growth of that market were addressed by a number of speakers. Marshall G. Cox, CEO and Chairman of the Board, Western Microtechnology, Inc., discussed the future role of distributors in semicustom VLSI. David A. Laws, Managing Director of PLP, Advanced Micro Devices, Inc., described programmable logic arrays as "custom ICs off the shelf" in his presentation "Semicustom Logic: The Field-Programmable Option."

The trend toward CMOS technology was covered by Jean Page, Industry Analyst, DATAQUEST, in her discussion "Procurement Patterns--Impact of CMOS." Since increased device density makes the use of CMOS technology essential, the trend toward CMOS is really a trend toward more complex and powerful devices.

Perhaps the most widely discussed change in today's semiconductor market--the rapid decline of commodity memory prices--was the focus of the presentation "Memory Prices: Returning to the Experience Curve" by Lane Mason, Senior Industry Analyst, DATAQUEST. Mr. Mason concluded that "three years of market growth and product evolution may be required to absorb suppliers' excesses and brake price declines."

CHALLENGES

The challenges facing today's semiconductor procurement decision maker were a recurring theme throughout the conference. James F. Riley, Senior Vice President, DATAQUEST, set the stage for the discussion with a series of questions raised in his presentation "Dealing with the New Business Climate." The questions covered such topics as strategic alliances, education and training, government relations, and quality. Richard T. Fedor, Corporate Purchasing Director, GTE Corporation, spoke of the challenge of procurement in the Far East. Stan Bruederle, Vice President, DATAQUEST, looked at the challenge of using forecasting tools to make sound purchasing decisions. Mel Thomsen, Senior Industry Analyst, DATAQUEST, gave some suggestions for picking the winners in the selection of microprocessors.

The challenge of keeping pace with technology was discussed by Robert H. Welch, President and CEO, Zitel. Jim Peachey, Vice President of Operations, Pyramid Technology Corporation, tackled the challenge of developing a purchasing strategy for a small high-growth company.

COOPERATION

A recurring theme in any discussion of semiconductor procurement has been the change from the adversarial relationship between vendor and supplier to a more cooperative attitude. The subject of cooperation was discussed in detail by Andy Prophet, Senior Industry Analyst, DATAQUEST, in his presentation "Application-Specific ICs: Cooperation in a Changing Environment." Ralph R. Russo, Materials Manager, Apple Computer, Inc., and Gary Flack, Manufacturing Consultant, Hewlett-Packard Company, both stressed the importance of user/vendor relationships in their presentations on just-in-time delivery systems. The flexibility of a start-up company in its relationships with customers was emphasized by Norm Miller, Executive Vice President, Micro Linear Corporation, when he addressed the rewards and risks of doing business with start-up companies.

DATAQUEST CONCLUSIONS

The conference was well received by the attendees. Apart from the formal presentations, participants had an opportunity to share ideas at the interactive sessions, which will be discussed in more detail in another newsletter. Those who attended the conference also commented on the value of meeting with their peers in the industry for informal discussions of mutual concerns.

Changes in technology, packaging, and methods of doing business were frequently discussed. The challenges of responding to the cyclicity of the industry, described by Frederick L. Zieber, Senior Vice President, DATAQUEST, in his presentation "Semiconductor Outlook: Feast or Famine," were accepted. The need for cooperation, both within a company and between companies, was recognized as a successful strategy for companies in today's marketplace.

Copies of the conference proceedings will be sent to all Semiconductor User Information Service binderholders in March. Additional copies of the proceedings are available for $250. DATAQUEST's second annual Semiconductor Procurement Conference will be held in Monterey, California, in February 1986.

Jean Page

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PRELIMINARY 1984 MARKET SHARE RESULTS

SUMMARY

The semiconductor industry had an exceptional year in 1984, in spite of a slackening of demand in the last quarter. DATAQUEST estimates that worldwide semiconductor sales grew approximately 45.2 percent for the year. Strongest growth was noted by companies with high concentrations in MOS, specifically memory and microprocessor devices. Several significant rank changes can be seen in the following tables of total semiconductor, IC, and digital MOS revenues for Japanese and U.S. suppliers.

Total Semiconductor Market Share

Our preliminary data indicate that the average growth rate of semiconductors among the top ten suppliers was 52.7 percent. Major U.S. companies grew by approximately 47.0 percent, while Japanese suppliers grew by 58.9 percent. NEC moved into second position for total semiconductor revenues, moving ahead of Motorola by one place. All other positions remain unchanged, as shown in Table 1.

Integrated Circuit Market Share

Average growth among the top ten integrated circuit suppliers was 59.5 percent. Ranking throughout the list changed slightly as Fujitsu moved ahead of Toshiba for the number seven slot. Detailed market share data are shown in Table 2.

Digital MOS Market Share

Among the top ten suppliers in digital MOS, average growth was 64.8 percent. As shown in Table 3, the ranking of the top three manufacturers remained unchanged, with NEC still in the number one position. Exceptional strength in MOS memories enabled Texas Instruments to displace Motorola in fourth place. Growth in excess of 100 percent moved AMD from tenth to eighth position in 1984 and Mitsubishi also joined the ranks of the top ten.

Note: The data presented are a summary of a larger study that will be published within the next month. Market share data will offer 1984 company revenues for the following categories: semiconductors, integrated circuits, digital bipolar, bipolar memory, bipolar logic, digital MOS, NMOS, PMOS, CMOS, MOS memory, MOS microprocessor devices, MOS logic, linear, discrete, and optoelectronic devices. Seven years of history will also be available with the study. The market share study will be available to Semiconductor Industry Service notebook holders.

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Jean Page
Barbara A. Van

Table 1

ESTIMATED 1984 VS. 1983 SEMICONDUCTOR REVENUES AND RANKINGS
(Millions of Dollars)

1984 Rank	1983 Rank	Company	1983 Revenues	1984 Revenues	Percent Change
1	1	Texas Instruments	$1,638	$2,408	47.0%
2	3	NEC	$1,413	$2,210	56.4%
3	2	Motorola	$1,547	$2,097	35.6%
4	4	Hitachi	$1,277	$1,977	54.8%
5	5	Toshiba	$ 983	$1,561	58.8%
6	6	National	$ 914	$1,263	38.2%
7	7	Intel	$ 775	$1,201	55.0%
8	8	Fujitsu	$ 673	$1,165	73.1%
9	9	Matsushita	$ 600	$ 944	57.3%
10	10	AMD	$ 505	$ 936	85.4%

Source: DATAQUEST

Table 2

ESTIMATED 1984 VS. 1983 INTEGRATED CIRCUIT REVENUES AND RANKINGS
(Millions of Dollars)

1984 Rank	1983 Rank	Company	1983 Revenues	1984 Revenues	Percent Change
1	1	Texas Instruments	$1,535	$2,301	49.9%
2	2	NEC	$1,093	$1,797	64.4%
3	3	Motorola	$1,060	$1,499	41.4%
4	4	Hitachi	$ 912	$1,496	64.0%
5	6	National	$ 864	$1,203	39.2%
6	5	Intel	$ 775	$1,201	55.0%
7	8	Fujitsu	$ 605	$1,072	77.2%
8	7	Toshiba	$ 613	$1,035	68.8%
9	9	AMD	$ 505	$ 936	85.4%
10	10	Signetics	$ 435	$ 765	75.9%

Table 3

ESTIMATED 1984 VS. 1983 DIGITAL MOS REVENUES AND RANKINGS
(Millions of Dollars)

1984 Rank	1983 Rank	Company	1983 Revenues	1984 Revenues	Percent Change
1	1	NEC	$786	$1,396	77.6%
2	2	Intel	$720	$1,101	53.0%
3	3	Hitachi	$638	$1,094	71.5%
4	5	Texas Instruments	$572	$ 865	51.2%
5	4	Motorola	$607	$ 803	32.3%
6	6	Toshiba	$458	$ 770	68.1%
7	7	Fujitsu	$406	$ 735	81.0%
8	10	AMD	$224	$ 480	114.3%
9	8	Mostek	$315	$ 467	48.3%
10	12	Mitsubishi	$223	$ 443	98.7%

Source: DATAQUEST

Nielsen Dataquest USER UPDATE

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NEW WORKSTATIONS FUEL GROWING PROGRAMMABLE LOGIC MARKET

Designing and using programmable logic arrays (PLAs) just became easier. We expect recently announced advanced workstations to fuel this rapidly growing market. PLAs require Boolean equations for programming, which makes them unfamiliar territory for some engineers. The fundamental issue driving this market is to train engineers in how to use PLAs--the key user-friendly CAD tools.

On the forefront of user-friendly PLA workstations are Assisted Technology Inc. of San Jose, California, and Data I/O Corporation of Redmond, Washington. This week, Assisted Technology announced its new IBM PC XT-based advanced workstation for designing PLAs without writing logic equations. Both Assisted Technology and Data I/O recently announced that their logic design languages have been adapted to run on Valid Logic Systems' workstation. These announcements are expected to accelerate the growth of the PLA market. Currently:

- DATAQUEST estimates that PLA growth will exceed 28 percent CAGR for the years 1984 to 1989, as shown in Table 1.

Table 1

ESTIMATED WORLDWIDE CONSUMPTION OF PROGRAMMABLE LOGIC
(Millions of Dollars)

	1984	1985	1986	1987	1988	1989	CAGR 1984-1989
Total PLA	$ 190	$273	$353	$421	$536	$667	28.6%
MOS	$ 0.5	$ 21	$ 42	$ 74	$134	$232	241.4%
Bipolar	$189.5	$252	$311	$347	$402	$435	18.1%

Source: DATAQUEST
January 1985

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- The CMOS segment is growing and is expected to be approximately one-half of the total PLA market by the end of the decade.

- There are 8 companies delivering parts and 25 potential players. Of the potential entrants, 80 percent have indicated that they will use the CMOS process.

PLA WORKSTATIONS

Assisted Technology's CUPL-GTS (Gate Translation System) turns an engineer's IBM PC XT into a workstation for programmable logic. The CUPL-GTS includes a high-resolution graphics board, mouse and interface, and logic compiler CUPL. Also included is CSIM, a simple stimulus/response function table simulator for PLAs.

This is a major step in the advancement of user-friendly CAD tools. CUPL-GTS allows the hardware designer to design PLAs by drawing schematics with the mouse. The self-teaching system is menu driven, with interactive prompts for the user. Placing a logic function in a PLA is as easy as choosing "translate" from the command menu. Output from the IBM PC is via an RS-232 port to drive a logic programmer unit such as those made by Stag Microsystems and Valley Data Science.

CUPL-GTS supports all manufacturers' PLAs, including the new erasable PLAs. In some cases, this gives the designer the freedom to place the same logic schematic into different PLAs or, basically, to use a second-source socket.

Both Assisted Technology with CUPL and Data I/O with ABEL (Advanced Boolean Expression Language) recently announced that their software will run on version 7.0 of Valid's Scaldsystem I, II, and IV. Both CUPL and ABEL are already compatible with the IBM PC XT and Digital's VAX running under VMS or UNIX. Each program compiles Boolean equations, truth tables, or state diagrams into fuse maps for programmable devices including PROMs, PLAs, and all integrated fuse logic (IFL).

DATAQUEST OPINION

DATAQUEST believes that the real boom in the PLA market will happen as more user-friendly workstations become available. The advantages of PLAs include: faster working parts for engineers, lower up-front costs, and unprogrammed parts, which can be held in inventory. These advantages, coupled with the growth of some of the higher gate count PLAs, are expected to have a negative impact on the low end of the gate array market.

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Stan Bruederle
Katy Guill

Nielsen Dataquest
USER UPDATE

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ASICs--POSSIBLE SOLUTIONS TO THE DESIGN CHALLENGES OF ADVANCED MILITARY SYSTEMS

SUMMARY

At the recent Government Microcircuit Application Conference (GOMAC) held in Las Vegas, Nevada, government and industry representatives discussed the accelerating demand for and insertion of Application-Specific Integrated Circuits (ASICs) in advanced military weapon systems. DATAQUEST believes that the issues discussed will have a major impact on the military semiconductor industry. The discussions focused on three key issues:

- ASICs in the military market
- Vendor selection criteria
- Military qualifications and standards for ASICs

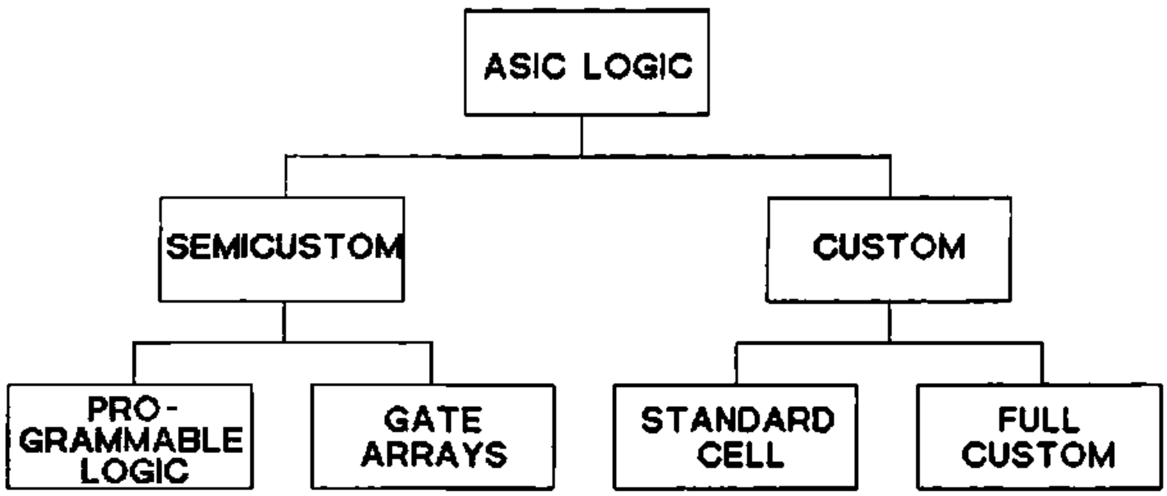
ASICs IN THE MILITARY MARKET

Figure 1 illustrates the various segments of the ASIC market. Of the four ASIC market segments--full custom, gate arrays, standard cells, and programmable logic arrays (PLAs)--this newsletter will address only the market growth and design implementation issues of gate arrays and standard cells in military systems.

Table 1 shows that the merchant ASIC market grew substantially from 1983 to 1984. The total 1984 market was nearly $2.5 billion, up from $1.7 billion in 1983, with an expected leap to $9.0 billion by 1989. This represents a 32 percent compound annual growth rate (CAGR) from 1983 through 1989.

Figure 1

ASIC FAMILY TREE



Source: DATAQUEST

Table 1

ESTIMATED WORLDWIDE CONSUMPTION OF
APPLICATION-SPECIFIC INTEGRATED CIRCUITS
(Millions of Dollars)

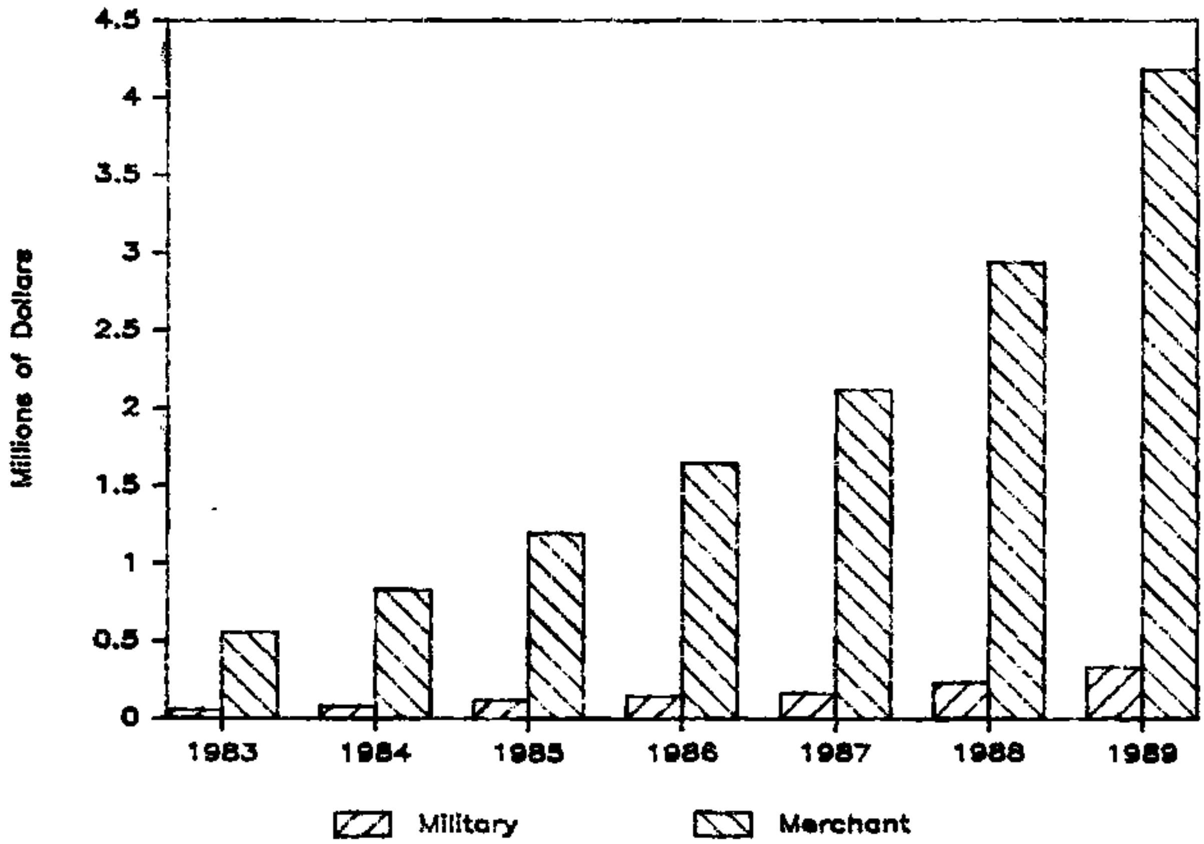
	1983	1984	1985	1986	1987	1988	1989
Merchant ASICs	$1,714.2	$2,468.0	$3,434.6	$4,333.4	$5,391.7	$6,986.8	$9,053.4
Total Semicustom	$ 622.1	$ 937.6	$1,302.4	$1,717.3	$2,092.2	$2,711.7	$3,599.7
Gate Arrays	$ 511.6	$ 737.6	$1,029.4	$1,364.3	$1,671.2	$2,175.7	$2,932.7
MOS	$ 259.9	$ 402.8	$ 584.1	$ 794.4	$ 993.0	$1,300.8	$1,769.2
Bipolar	$ 251.7	$ 334.8	$ 445.2	$ 569.9	$ 678.2	$ 874.8	$1,163.5
Programmable Logic	$ 110.5	$ 200.0	$ 273.0	$ 353.0	$ 421.0	$ 536.0	$ 667.0
MOS	$ 0.5	$ 10.5	$ 21.0	$ 42.0	$ 73.6	$ 134.0	$ 231.8
Bipolar	$ 110.0	$ 189.5	$ 252.0	$ 311.0	$ 347.4	$ 402.0	$ 435.2
Total Custom	$1,092.1	$1,530.3	$2,132.2	$2,616.1	$3,299.5	$4,275.1	$5,453.7
Standard Cell	$ 48.0	$ 93.9	$ 167.4	$ 282.7	$ 448.9	$ 759.6	$1,245.2
Full Custom	$1,044.1	$1,436.4	$1,964.9	$2,333.4	$2,850.6	$3,515.5	$4,208.5

Source: DATAQUEST
January 1985

As shown in Figure 2, military consumption of ASICs is minimal in comparison to the total merchant market. Nevertheless, Table 2 clearly substantiates the assimilation of ASICs into the military arena. We expect a 45 percent growth in military ASIC consumption from $83 million in 1984 to $120 million in 1985. We believe that demand for military ASICs will show relatively steady growth through 1986, followed by a period of resounding growth from 1987 through 1989 due to increased replacement of systems that use costly obsolete standard ICs with sophisticated custom and semicustom designs.

Figure 2

ESTIMATED U.S. MILITARY CONSUMPTION OF GATE ARRAYS AND STANDARD CELLS



Source: DATAQUEST
January 1985

Table 2

ESTIMATED U.S. MILITARY MARKET CONSUMPTION
OF APPLICATION SPECIFIC INTEGRATED CIRCUITS
(Millions of Dollars)

	1983	1984	1985	1986	1987	1988	1989
Total Semicustom and Custom	$ 56	$ 83	$120	$148	$170	$235	$334

Source: DATAQUEST
January 1985

Gate Arrays

Initially, improvements in availability, reliability, durability, and portability of gate arrays and standard cells over standard small scale integration (SSI) and medium scale integration (MSI) circuits will boost usage of ASICs in military systems. We expect gate arrays to be in the forefront of ASIC implementation in military equipment, since they offer:

- Shorter turnaround times than other ASICs
- Reduced design costs compared to full custom or standard cells
- Reduced screening costs compared to standard ICs
- Reduced printed circuit board size
- Lower power consumption than standard ICs
- Increased reliability over standard ICs due to fewer interconnections
- Pretested systems, reducing test time
- Design security advantages over standard ICs
- Improved yield over SSI and MSI components

Standard Cells

Although standard cells have lower relative design costs and shorter design times than full custom designs, their recurring design costs are higher and design times are longer than gate arrays. The advantages to implementation of standard cells over full custom designs are:

- Lower costs and shorter turnaround times
- Adaptability to logic, memory, and analog functions
- Automatic placement and routing
- Ease of design changes
- Custom cell design

VENDOR SELECTION CRITERIA

For the military end user, successful implementation of ASICs into systems commences with suitable development resources and a well-defined user/vendor working relationship. Some of the vendor selection criteria for users of custom and semicustom products are:

- Vendor's design specifications that meet user contract specifications
- Vendor's fabrication facilities that meet military test and quality inspection procedures
- Vendor-to-vendor comparison of non-recurring costs
- Vendor's lead time to production schedules
- Vendor's second source availability
- Vendor's product performance over military temperature range (-55 degrees centigrade to +125 degrees centigrade)
- Vendor's product radiation hardness characteristics
- Dedicated vendor/user interface
- User accessibility to vendor services and industry standard software
- Packaging capabilities that meet military system requirements

Table 3 lists the gate array and standard cell suppliers that can support MIL-STD-883 processing, test, and packaging requirements.

Table 3

MILITARY ASIC VENDOR SELECTION

Companies	Product Gate Arrays	Types Standard Cells	Technology CMOS	Technology Bipolar	Second Source	Location
American Microsystems, Inc.	X	X	X		X	U.S.
AMCC	X			X	X	U.S.
Array Technology	X	X	X	X	X	U.S.
Barvon Research, Inc.	X	X	X		N/A	U.S.
California Device, Inc.	X	X	X	X	X	U.S.
Circuit Technology, Inc.	X	X	X		X	U.S.
CIC-Custom Integrated Circuit	X	X		X	N/A	U.S.
Custom MOS Array	X	X	X		N/A	U.S.
Exar	X		X	X	X	U.S.
Fairchild Semiconductor	X	X	X	X	N/A	U.S.
Fujitsu	X	X	X	X	X	Japan
GE Intersil	X	X	X		X	U.S.
General Instrument Corporation	X	X	X		X	U.S.
GTE Microcircuits	X	X	X		X	U.S.
Harris	X	X	X	X	X	U.S.
Holt	X	X	X	X	N/A	U.S.
Honeywell Inc.	X			X	X	U.S.
Hughes Solid State	X	X	X		N/A	U.S.
Integrated Microcircuits (IMC)	X		X		X	U.S.
Interdesign (Ferranti)	X		X	X	X	U.S.
International Microcircuits (IMI)	X		X		X	U.S.
International Microelectronics Products (IMP)	X	X	X		X	U.S.
LSI Logic Corporation	X	X	X		X	U.S.
Master Logic Corporation	X	X	X		X	U.S.
MCE Inc.	X	X	X	X	X	U.S.
Monolithic Memories Inc.	X			X	X	U.S.
Mostek	X		X		N/A	U.S.
Motorola	X	X	X	X	X	U.S.
National Semiconductor Corporation	X	X	X	X	X	U.S.
NCM Corporation		X	X		N/A	U.S.
NEC Electronics USA	X	X	X	X	N/A	Japan
Nitron Inc.	X		X		X	U.S.
Plessey	X	X	X	X	N/A	Europe
Raytheon Company	X		X	X	X	U.S.
RCA Corporation	X	X	X	X	N/A	U.S.
Semi Processes Inc.	X		X		X	U.S.
Signetics Corporation	X	X	X	X	X	U.S.
Telmos Inc.	X		X		X	Europe
Texas Instruments	X	X	X	X	X	U.S.
Toshiba	X	X	X		X	Japan
Universal Semiconductor	X		X		X	U.S.
Zymos Corporation		X	X		X	U.S.

N/A = Not Available

Source: DATAQUEST
January 1985

MILITARY QUALIFICATIONS AND STANDARDS FOR ASICs

Limited by complex military standard microcircuit test methods and procedures, manufacturers and military end users have historically avoided implementation of ASICs into critical weapon systems. Aware of the complications that these limitations pose to military technological advancements, Rome Air Development Center has implemented the following software programs and modifications to its military standards for design rule and macrocell library qualification and fabrication line certification.

MIL-STD-976 has been revised. This specification covers Line Certification audit requirements for Very High Speed Integrated Circuit (VHSIC) and Very Large Scale Integration (VLSI) manufacturers' process and fabrication facility capabilities. Areas that are addressed include cell library and macrocell verification, device fabrication, die attach, wire bonding, and package sealing.

MIL-STD-883, Test Method 5007, a wafer qualification test, is being evaluated for use in acceptance of VHSIC/VLSI wafers.

MIL-STD-883, Test Method 5010, test procedures for VHSIC/VLSI devices, pinpoints the need for in-line testing by certifying the bonder/operator, wafer, package, and die attach to fully implement test structures for VHSIC/VLSI device acceptance. An additional feature of this new procedure is the requirement of separate package certification prior to device acceptance testing.

MIL-M-38510, Appendix X, General Requirements for VHSIC/VLSI devices, is currently under review.

Tester Independent Support Software System (TISSS) is a new, automated test specification and test generation system developed to minimize the cost of generating test specifications. The Tester Independent Data Base (TIDB) of this system will be a machine-readable device electrical test specification that will eventually replace the MIL-M-38510 hard copy. The TISSS system is expected to be operational by 1987.

Aerospace Corporation of El Segundo, California, under contract to the U.S. Air Force, has recently released Military Handbook 339, Custom Large Scale Integrated Circuit Development and Acquisition for Space Vehicles. This handbook documents design standards and manufacturing procedures for custom device applications in avionic and space systems.

RCA's Advanced Technical Technology Laboratories of Camden, New Jersey, under contract to the Army Electronics Research and Development Command (ERADCOM), has developed a Computer-Aided Design/Design-Automation System (CADDAS). The CADDAS program tools, which support a standard cell placement and routing system referenced MP2D, a logic simulator (LOGSIM), and an automatic topology and connectivity checker (TACC), are available license-free from ERADCOM.

FUTURE TRENDS

Although the military end use market for custom and semicustom devices has been slower to develop than the commercial end use market, DATAQUEST expects a 45 percent increase in military ASIC consumption from 1984 through 1985. We expect custom and semicustom devices to maintain a growing stronghold on advanced weapon system implementation, gradually displacing SSI/MSI components and offering numerous advantages to the military end user and manufacturer, including the following:

- Reduced system volume, a particularly important feature in avionic, satellite, and portable communication systems

- Sophisticated security design preventing security leaks of intelligence data and export of technology

- Lower manufacturing costs resulting in lower systems costs to the end user

- Shorter production times affording improved lead times

As manufacturers move toward two-layer metal interconnects and sub-2-micron processes, CMOS technology will represent a growing portion of the military ASIC market. We believe that this unprecedented growth in a market by military end users will be achieved through substantial progress in research and development of gallium arsenide (GaAs) ICs and gate arrays during the 1987 through 1990 time frame. DATAQUEST estimates that $100 million will be spent by the Defense Advanced Research Project Agency (DARPA) on its GaAs pilot production project.

Honeywell, Inc., of Richardson, Texas, under a DARPA contract award, is building a 3-inch GaAs pilot production line, with GaAs logic array availability expected by 1985. Harris Microwave Semiconductor, of Milpitas, California, has recently developed a GaAs Cell Array for semicustom ICs. Texas Instruments Incorporated, of Dallas, Texas, is developing a gallium arsenide and gallium aluminum arsenide (GaAs/GaAlAs) heterojunction bipolar 1K gate array. Table 4 lists the sources currently involved in GaAs gate array development.

Mary A. Olsson
Andy Prophet

Table 4

SOURCES OF MILITARY GaAs GATE ARRAYS, 1985

Bell Laboratories
Honeywell, Inc.
Lockheed Missiles & Space Company
Rockwell Microelectronics Research & Development Center
Tektronix
Texas Instruments, Inc.

Source: DATAQUEST
January 1985

Nielsen Dataquest USER UPDATE

SUIS Code: Newsletters
No. 84-27

GENERAL INDUSTRY UPDATE: ADJUSTING TO THE SLOWDOWN

SUMMARY

In view of the rapid slowdown in the U.S. economy and stronger pressure on prices than we anticipated, DATAQUEST has revised its U.S. semiconductor consumption estimates downward. We estimate a decline in dollar volume of 6.5 percent in the fourth quarter of 1984 compared with the previous quarter. Our forecast for the first quarter of 1985 is for a further decline of 2 percent compared with the first quarter of 1984. We expect consumption to grow by 6.4 percent in 1985 over 1984. Table 1 gives DATAQUEST's estimates for quarterly semiconductor consumption growth for 1983 through 1985. However, unit consumption continues to increase, and the current decline is predominantly price driven. Although the outlook for the semiconductor industry in the immediate future is more pessimistic than in our previous newsletter ("General Industry Update: a Period of Adjustment," November 9, 1984), we still expect sustained but slower growth in the nation's economy during 1985.

The book-to-bill ratio declined to 0.61 to 1 in November and is expected to remain depressed into 1985. Billings also declined in October for the first time since July.

ECONOMIC TRENDS

The U.S. Commerce Department's index of leading economic indicators fell in October to 163.8, from a revised September estimate of 165 (1967 = 100). This was the third drop in five months. Although this decline suggests that the current economic slowdown could continue into the first months of 1985, most economists expect a modest return to growth rather than the beginnings of a recession.

The sharp increase in the money supply (M1) reported for the week of November 19, together with the recent decline in interest rates, had allayed the fears of some economists that slow growth in the money supply could push the economy into a recession. However the sharp decline in the money supply in early December has caused some concern. The Federal Reserve Board is likely to move to increase the money supply, possibly by lowering the discount rate to 8 percent from the current 8.5 percent.

Unemployment declined from 7.4 percent in October to 7.0 percent in November. This decrease is a positive sign, although some of the improvement may be seasonal.

Although industrial production rose in most European countries in October, Europe never participated in the strong recovery achieved in the United States during the early part of 1984. We expect the European economies to be adversely affected by the current slowdown in the U.S. economy.

The level of consumer spending during the Christmas season could well determine whether we return to a path of economic growth or continue the current slowdown. The outlook, based on the high level of retail sales in November, is reasonably good, with consumer confidence remaining high.

TODAY'S SEMICONDUCTOR MARKET

The process of adjustment that we discussed in our previous newsletter is continuing. Although we still believe that inventory adjustment must work its way through the system before semiconductor consumption can get back on a strong growth path, we have seen a worsening of conditions over the past month--the book-to-bill ratio declining to 0.61 to 1 in November and expected to remain low into the first quarter of 1985; most semiconductor companies experiencing cancellations and stretchouts on orders; and prices for commodity products declining much more rapidly than was anticipated. Semiconductor users are still working through the inventory buildup that developed when lead times were longer. Because of concern over shortages, companies built inventories that were not only higher than usual, but also out of mix when they accepted partial shipments.

The softening of the economy led semiconductor users to reduce their own expectations of sales, and this led to further declines in orders. The personal computer market is still very slow, and major computer companies such as IBM and Digital Equipment Corporation have cancelled or reduced orders.

The other significant factor in the decrease in dollar volume is the rapid decline in the prices of commodity products. Memory devices, such as the 64K DRAM, have declined in price by as much as 40 percent. Unit shipments continue to increase as new fabrication capacity comes on stream. The increase in capacity puts additional price pressure on the commodity market.

Because the slowdown is in prices, commodity products have been hit much harder than the more specialized products that have a limited number of suppliers. Companies that have developed a base of value-added products with less price elasticity will fare better in the months ahead than companies that are heavily dependent on commodity devices for their revenues.

SEMICONDUCTOR INDUSTRY FORECAST

DATAQUEST forecasts a decline of 6.5 percent in U.S. semiconductor consumption in the fourth quarter of 1984 compared with the preceding quarter. Consumption in the first quarter of 1985 is expected to decline a further 2 percent compared with the fourth quarter of 1984, to $2,988 million. After quarter-to-quarter growth rates of 3.9 and 4.4 percent in the second and third quarters respectively, consumption is forecast to grow by 8.7 percent in the fourth quarter of 1985 compared with the third quarter. Semiconductor consumption in the United States is expected to increase by 6.4 percent in 1985 over the 1984 figure, with most of the growth taking place in the last quarter of the year. We forecast the 1985 total to be $12,857 million compared with $12,089 million in 1984. Slow growth or no growth in the first quarter of a year has a cumulative effect on the forecast for subsequent quarters.

Despite the current slowdown in the economy, unit consumption of semiconductors continues to rise. We expect the economy to improve in the coming year, but at a slower rate than was experienced in the first half of 1984. A return to economic growth will make the difficult period of adjustment reasonably short, and we expect semiconductor consumption to return to its historic growth patterns in the second half of 1985.

Jean Page
Frederick L. Zieber

Table 1

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1983				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 294	$ 342	$ 371	$ 416	$ 1,423
Integrated Circuits	1,382	1,626	1,816	2,090	6,914
Total	$1,676	$1,968	$2,187	$2,506	$ 8,337
Percent Change from Previous Quarter		17.4%	11.1%	14.6%	
Percent Change from Previous Year					

	1984				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 442	$ 491	$ 501	$ 477	$ 1,911
Integrated Circuits	2,260	2,586	2,760	2,572	10,178
Total	$2,702	$3,077	$3,261	$3,049	$12,089
Percent Change from Previous Quarter	7.8%	13.9%	6.0%	(6.5%)	
Percent Change from Previous Year	61.2%	56.4%	49.1%	21.7%	45.0%

	1985				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 466	$ 471	$ 485	$ 499	$ 1,921
Integrated Circuits	2,522	2,634	2,756	3,024	10,936
Total	$2,988	$3,105	$3,241	$3,523	$12,857
Percent Change from Previous Quarter	(2.0%)	3.9%	4.4%	8.7%	
Percent Change from Previous Year	10.6%	0.9%	(0.6%)	15.6%	6.4%

Source: DATAQUEST
December 1984

Nielsen Dataquest RESEARCH BULLETIN

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SEMI INDUSTRY FORECAST
ECONOMIC TRENDS: PERILS AND PROMISES

At the Semiconductor Equipment Manufacturers' Institute forecast meeting held in Santa Clara, California, on December 12, the two speakers from the semiconductor industry presented differing views of the outlook for 1985. Wilfred J. Corrigan, President and CEO of LSI Logic, described the situation as "moving from overheated expansion to flat growth." He expects the excess inventory problem to be solved by the end of the first quarter of 1985. Charles E. Sporck, President and CEO of National Semiconductor Corporation, painted a somewhat darker picture. Mr. Sporck believes that the inventory problem is more severe than was previously believed, and is now extending beyond the personal computer area. He suggested that 1985 would be "a lousy year."

The two speakers also addressed different aspects of the semiconductor equipment industry in their speeches. Mr. Corrigan discussed "The Changing Interface Between Semiconductor Manufacturers and the Equipment Vendor," while Mr. Sporck spoke on "Forecasting Future Semiconductor Equipment Capital Spending Patterns as Driven by the Leading Edge of Technology."

WILFRED J. CORRIGAN, LSI LOGIC

Mr. Corrigan said that the facilities additions of the past 12 to 14 months are not yet fully on stream. We are looking at a period of very high capacity. The coming months will be a time for reassessment, with semiconductor manufacturers reconsidering their plans about moves to 6-inch wafer equipment and other advanced process techniques. There will be a demand for tactical fabs--small facilities where capability is more important than capacity.

There is a need for closer relationships between vendors and users of semiconductor equipment. The high capital cost of equipment means that users need to run it 7 days a week, 24 hours a day. Such operation requires strong service and support from equipment vendors. Automation is the key to improved yields in the future, but it must be truly reliable.

If U.S. semiconductor equipment manufacturers are to be successful, they must meet the challenge of Japanese manufacturers. Manufacturers must stress quality, reliability, and above all, service.

CHARLES E. SPORCK, NATIONAL SEMICONDUCTOR CORPORATION

Mr. Sporck stated in his presentation that the high level of capital spending necessary to remain competitive in the semiconductor industry is far more difficult for U.S. companies to achieve than for companies in Japan. Using DATAQUEST capital spending estimates, Mr. Sporck showed that Japanese semiconductor companies' capital expenditures as a percentage of sales are consistently higher than those of U.S. companies. Current estimates suggest that many U.S. companies will decrease their capital spending in 1985 versus 1984, while Japanese companies expect to increase spending in 1985.

U.S. companies are at a disadvantage because of the high cost of capital in this country. A recent government report showed that the cost of capital in 1981 in the United States was 16.6 percent, compared with only 9.2 percent in Japan. One reason for the lower cost of capital in Japan is the high rate of personal savings. Over the past ten years the average Japanese worker has saved 18 percent of his income, compared with 6 percent saved by the average U.S. worker. The Japanese economic system is structured so that the money saved is available to Japanese industry.

A second difference between the United States and Japan is the high debt-to-equity ratio that is common in Japan. Loans, rather than equity, are the main source of funds for Japanese companies, and Japanese investors are looking for returns on their investments rather than equity growth. The result of this situation is that the main concern of a Japanese company is to service its debt. For this reason, a Japanese company will fight to gain market share, even at the expense of profit margins. Investors in the United States, on the other hand, are looking for equity growth and react very rapidly to changes in a company's performance. This means that U.S. companies must work hard to look good in the short term. In order to compete with Japanese semiconductor manufacturers, U.S. companies need a supply of "patient money" rather than the volatile capital of today's investors.

Although manufacturers can work to plan capital spending wisely, the basic problems must be addressed by the U.S. government. Among them:

We need a macroeconomic policy that creates a more stable economic environment. In spite of the increasing pervasiveness of semiconductors, the industry is not immune to changes in the economy.

The government must create incentives to save. Tax exemptions or lower tax rates for savings could help increase the supply of lower-cost capital.

The government must develop investment incentives for industry. The R&D tax credit should be made permanent, and investment tax credit policies should be reviewed. Realistic depreciation schedules for rapidly obsolete equipment are also essential to encourage sound investment.

Although no one of these actions can eliminate the disadvantage under which U.S. companies operate, each can contribute to alleviating it.

Jean Page
Joe Grenier
Robert McGeary

Nielsen Dataquest USER UPDATE

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No. 84-25

A NEW SOURCE OF ON-LINE COMPONENT INFORMATION--VIDEOLOG

INTRODUCTION

Staying current with new semiconductor products and their sources is becoming increasingly difficult. The average design engineer receives about 500 pounds of magazines and trade journals per year, not to mention data sheets and component lists. Just organizing that amount of material for easy access becomes a formidable task. VideoLog, launched at WESCON in November 1984, offers a solution to these problems. VideoLog is an on-line videotex service with color graphics that provides information on part types and data sheets, as well as new product information and industry news. In addition, VideoLog offers an electronic mail connection between users and suppliers, primarily semiconductor manufacturers.

USING VIDEOLOG

The VideoLog system includes the D.A.T.A. data base, which covers more than half a million integrated circuits and discrete semiconductors from most manufacturers. The data base also contains data sheet information, including graphics from 21 major semiconductor manufacturers so far. Those currently participating in the system include Advanced Micro Devices, Amperex, Dionics, Electronic Designs, Fairchild Semiconductor, Gould-AMI, Harris Semiconductor, Hitachi, Intel, Monolithic Memories, Mostek, Motorola, Plessey, RCA Solid State, Signetics, Siliconix, Solid State Scientific, Synertek, Texas Instruments, Xicor, and Zilog. The service is rounded out with an on-line version of the Harris Electronic Industry Telephone Directory, an alternate-source directory of 7,000 suppliers.

The VideoLog data base, which is menu-driven, can be accessed via a modem and a personal computer or dumb terminal. Users can choose to access component data by part number, generic type, manufacturer, or keyword, giving the design engineer considerable flexibility. Parametric searching, where specification ranges are set, enables the user to focus in on the part most suited to the design in question. The user can then view the manufacturer's data sheets, if the manufacturer is a participant in the service, and can send an electronic mail message for more information. Such requests may include pricing and availability information, data sheets, technical questions, and requests for sales calls.

Although the screens are designed in color, they can be viewed on a monochrome display. Screens can also be downloaded for later use or printing.

The cost to the subscriber is $15 per hour for simple lookups and $39 per hour for parametric searches and other, more complex searches. Subscribers are billed only for the actual time used each month. The starter kit, which costs $150, includes videotex graphics decoding and terminal emulation software, a user manual, and an ID number and one free hour of use. It runs on IBM-compatible PCs. An Apple version is under development. Both DEC and IBM also sell similar software to connect to videotex services like VideoLog.

A NOTE ON VIDEOTEX

Videotex is an interactive medium for transmitting text and graphic information via telephone lines. An early version, called Viewdata, was used by the British post office to launch its Prestel Service in 1979. Other countries, including Canada, France, Germany, and Japan, have also developed videotex systems. Efforts to develop one international standard for videotex have been unsuccessful.

In 1981, the North American Presentation Level Protocol Syntax (NAPLPS), sponsored by AT&T, was launched. In 1983, the American National Standards Institute (ANSI) adopted NAPLPS as an official graphics/communications standard. This system, which permits the transmission of high-quality graphics, is the one used for VideoLog.

FURTHER INFORMATION

Further information on VideoLog may be obtained from:

VideoLog Communications
50 Washington Street
Norwalk, CT 06854
(203) 838-5100
1-800-VIDEOLOG

Jean Page

SUIS Code: Newsletters
No. 84-24

COMPANIES NEWSLETTER
SEPTEMBER-OCTOBER 1984

INTRODUCTION

This monthly newsletter is intended to provide brief information on semiconductor companies to enable you to stay current on recent events. The company discussions appear alphabetically by company and cover the following areas:

- Facilities
- Finance
- Organization
- Prices
- Products

Topics that involve more than one company, such as second-source agreements, will appear under each company involved. This is the first issue of this newsletter; we welcome your ideas and suggestions for future issues.

COMPANIES

Advanced Micro Devices Inc.

Products

Advanced Micro Devices (AMD) is now sampling the Am9968 and Am99L68 4Kx4 static RAMs that it announced in May of this year. The 45ns parts are the first CMOS devices to be offered by AMD. The devices are available in 20-pin plastic or ceramic DIPs and in military-grade versions. The price for 100-piece orders is $20.90 each for plastic and $25.00 each for ceramic.

Advanced Micro Devices is now offering a 64K EEPROM that is available from distribution. The Am9864 EEPROM is pin-compatible with AMD's 64K EPROM.

Applied Micro Circuits Corporation

Products

Honeywell has become a second source for Applied Micro Circuits Corporation's (AMCC) Q700 series of bipolar logic arrays. The arrays range in complexity from 200 to 1,000 gates and are TTL or ECL compatible. AMCC also introduced the Q3500 3,500-gate TTL/ECL-compatible array. The Q3500 has 0.5-nanosecond typical propagation delays.

Fairchild Camera and Instrument

Organization

Fairchild has formed an Analog Business Unit from its linear, discrete, hybrid, telecommunications, and computer products groups. Thomas Palamenghi is vice president and general manager of the unit.

Products

Fairchild will open seven gate array design centers during the next 18 months. The centers will support bipolar and CMOS gate arrays. The Fairtech centers will also provide applications support for all Fairchild products. The first four centers will be opened in January 1985 in Waltham, Massachusetts; Bloomington, Minnesota; Costa Mesa, California; and Richardson, Texas.

Fujitsu Microelectronics Inc.

Facilities

Fujitsu will build its first U.S. wafer fabrication facility for manufacturing 256K DRAMs and other memory products. The plant will be located near Portland, Oregon. The company could invest as much as $150 million in the facility, which will initially employ approximately 500 people.

Products

Fujitsu introduced a 256K CMOS EPROM in September. The device is organized as 32Kx8, with 250ns and 300ns parts available now, and 200ns parts promised shortly. The 100-piece price is $115 for the 300ns part and $130 for the 250ns part.

General Instrument

Finance

General Instrument expects to achieve semiconductor sales of $300 million in 1984, an increase of 29 percent over the 1983 total of $233 million. Eighty percent of the company's production is in 2-micron and 5-micron NMOS and CMOS technology. Morris Chang, president and CEO, made these statements at a New York Society of Security Analysts meeting in September. Mr. Chang stated that company growth was limited by operational problems associated with ramping up production of its state-of-the-art 2-micron process technology. He said that this capability gave the company a base for further growth.

Prices

General Instrument dropped its 256K ROM prices about 40 percent, from $10.33 to $6.25 in 10,000-piece quantities for the 250ns product. Lead times were reduced to 5-8 weeks from 8-10 weeks. Prices for 300ns 128K and 64K ROMs were reduced from $4.03 to $2.90 and from $2.63 to $2.25, respectively.

Products

General Instrument has announced plans to enter the one-time programmable (OTP) EPROM market in 1984. The devices will be manufactured at the company's facility in Chandler, Arizona.

GTE Microcircuits

Products

GTE Microcircuits and Plessey Semiconductor have agreed to the joint process development and exchange of CMOS gate arrays with from 640 to 10,044 gates.

Hitachi

Facilities

Hitachi is adding a gate array metallization processing capability to its assembly facility in Irving, Texas. This will enable the company to provide short turnaround times by inventorying partially processed wafers in the United States and applying the customer-defined interconnect in the local market.

Products

Hitachi announced two new 256K DRAMs in early October. Both devices are organized as 64Kx4. The HM50465P uses nibble mode; the HM50464 uses page mode. The devices are priced at $75 for sample quantities. Volume production will begin in the first quarter of 1985.

Hyundai Electronics, America

Facilities

Hyundai Electronics, America, has begun production of 16K SRAMs and 128K ROMs at its new $40-million facility in Santa Clara, California. The 100,000-square-foot facility includes 11,000 square feet of class 100 wafer manufacturing area capable of producing 4,000 5-inch wafers per month. The first devices are being produced using a 2.0- to 2.5-micron NMOS process. Future products will be CMOS.

Industrial Electronic Engineers, Inc.

Products

Industrial Electronic Engineers, Inc., has introduced a low-cost, 68-lead pin grid array that was designed to be used with the Motorola 68000 microprocessor. The package is made with a thermoplastic, polyester fiber body that is less expensive than the fiberglass epoxy materials that have been used for other low-cost packages.

Inmos

Finance

Thorn-EMI, which recently purchased the British government's share of Inmos, has announced plans to offer shares of Inmos stock on the U.S. and U.K. over-the-counter markets.

Products

Inmos introduced two new 64K DRAMs: a MIL-STD device and an 80ns high-performance product. The MIL-STD device is processed to MIL-STD-883C, screened to method 5001, and qualified to method 5005. It is specified to operate from -55 degrees C to +110 degrees C. The INS2600M is offered in a 120ns version for $25.00 and a 150ns version for $20.00 in a side-brazed ceramic package. Delivery is six weeks. The high-performance INS2600P-80 is priced at $12.45 in 1,000-piece quantities.

Integrated Device Technology Inc

Finance

Integrated Device Technology announced earnings of $1.4 million on revenues of $7.5 million for its fiscal first quarter, ending July 1, 1984. The majority of the company's revenues came from the sale of 16K SRAMs.

Intel

Products

Corona Data has introduced its Mega PC multiuser system, which uses the 8088-2, 8MHz, 8/16-bit MPU and the 8088.

International Microelectronic Products

Products

International Microelectronic Products (IMP) has developed a software program called the Universal Netlist Translator (UNT). This program will convert the netlist of any gate array or standard cell design so that it can be entered into IMP's netlist format and implemented as an IMP semicustom integrated circuit. This device enables IMP's customers to develop alternate-source capability for their semicustom designs.

International Rectifier

Facilities

International Rectifier will invest $90 million in a 250,000-square-foot processing and assembly plant in Rancho, California. This plant will be the second plant the company has built to manufacture HEXFET power MOSFET devices. The plant will begin production in 1987 and will employ 700 people when it is in full production.

Lattice Semiconductor Corporation

Products

Lattice plans to start sampling its 64K static RAM in the fourth quarter of 1984.

VLSI Technology (VTI) and Lattice have signed a cross-licensing agreement under which VTI will manufacture Lattice's high-performance EEPROMs, SRAMs, and programmable logic devices. In exchange, VTI will provide wafer fabrication, test, and assembly capacity to Lattice.

Matra Harris Semiconducteurs

Facilities

Matra Harris Semiconducteurs (MHS) is doubling production capacity and starting a 1.6-micron CMOS process. The company's sales in fiscal 1984 were $36.2 million. The company plans to grow 47 percent per year to $168 million by 1988. By that time, almost 50 percent of its business will be microprocessor-based. A significant part of MHS's future business will be in CMOS and HMOS 8086-based microprocessors sold to IBM.

Micron Technology

Prices

Micron Technology reduced its price for 64K DRAMs to less than $2.00 at the end of September. Prices for 150ns parts were reduced to $1.95 and prices for 200ns parts were set at $1.85. This move places prices quoted in the United States (at least by Micron Technology) at or below prices for the same products in Japan. In a third quarter survey, DATAQUEST found prices in Japan to be 510 to 560 yen, or $2.08 to $2.30, for 150ns products. Other manufacturers have not followed Micron Technology's lead yet, but DATAQUEST expects 64K DRAM prices to move toward the $2.00 level during 1985.

Motorola

Products

Motorola extended its 68000 second-source agreement with Thomson-CSF for five more years. The agreement includes the 32-bit 68020 if Thomson-CSF meets specified technology exchange commitments. Motorola chose Thomson-CSF as its initial second source for the 32-bit device because Thomson-CSF had developed the largest number of 68000-based microprocessors and related products.

NEC

Facilities

NEC will build a 6-inch wafer fabrication facility in Livingston New Town, Scotland. The $95 million facility will become operational in the first half of 1986. This plant and the existing assembly facility will increase employment from the present 200 people to 650 when it is fully operational. The plant will produce 6 million devices per month when it reaches full capacity in 1987. The facility will be used for the manufacture of 256K DRAMs, 64K SRAMs, and 1-Mbit memory products, as well as microprocessors.

Performance Semiconductor

Finance

Start-up Performance Semiconductor completed an $11.3-million round of financing from institutional and private investors and a $6-million lease line guaranteed by Westinghouse Electric Corporation. The company, founded by Thomas A. Longo, a former executive of Fairchild Semiconductor, will manufacture CMOS logic, memory, and microcomputer products.

N.V. Philips

See Signetics Corporation.

Plessey Company plc

Facilities

Plessey has ended negotiation to acquire Storage Technology Corporation's (STC) microtechnology division because of STC's present financial problems. Plessey is still looking for a U.S. manufacturing facility to help increase its penetration of the U.S. market.

Products

GTE Microcircuits and Plessey Semiconductor have agreed to the joint development and exchange of CMOS gate arrays with from 640 to 10,044 gates.

RCA

Products

RCA has upgraded its 8-bit CMOS MPU, the 6805, from 8 Kbytes of addressable system memory to 64 Kbytes of external memory.

SGS Semiconductor Corporation

SGS Semiconductor has developed a 2-chip subscriber line interface circuit (SLIC). The device is housed on SGS's proprietary multiwatt package to allow heat dissipation of up to 7 watts during ringing without the need for internal heat sinks.

Signetics Corporation

Facilities

Signetics has opened a 128,000-square-foot research and development center in Sunnyvale, California. The facility, which includes a 19,000-square-foot wafer fabrication area is dedicated to VLSI research.

Products

Texas Instruments announced an agreement with N.V. Philips and its U.S. subsidiary Signetics Corporation covering the companies' standard cell products. Under the agreement, the companies will merge their CMOS standard cell libraries and cooperate in the design and development of new cells.

Signetics stopped shipment of source control drawing (SCD) products on October 8. An internal outlet indicated that documented test procedures were not consistent with actual test methods. Twenty-five of 280 customers could be involved. The deviations that were made were to allow Signetics MIL-STD-883 product in place of product tested to the customer's SCD drawing.

Products

Signetics has introduced two low-power, high-performance linear ICs for cellular radio applications. The SA 602 is a 500MHz, double-balanced, mixed oscillator and the SA 607 is a low-power FM IF device.

Siliconix

Finance

Siliconix reported third quarter income of $2.5 million on sales of $23.7 million. Sales for the first three quarters of 1984 totaled $65 million, an increase of 43 percent over the same period last year. The record performance was attributed partly to the strength of demand for the company's products and partly to recent investments in factory automation and productivity improvement programs.

Synertek

Organization

Dick Abraham, president of Synertek, resigned to become executive vice president of Gould's Electronic Components business sector. He will replace Glenn Penisten, who resigned a year ago. Mr. Abraham will have overall responsibility for the company's semiconductor, materials, and components operations, and will report to Gould's president and COO.

Telmos

Organization

Jean Hoerni, chairman of the board of Telmos, assumed the position of president of the company after Luc O. Bauer resigned as president. William Johnson, vice president of engineering, and Murray Siegel, director of worldwide marketing and sales, resigned and left the company at the same time. These changes come at a time when the company has decided to focus on CMOS products, high-voltage components, and analog/digital gate arrays. A company profile of Telmos is included in Volume II of the SUIS binders.

Texas Instruments

Products

In early September, Texas Instruments gave out information on a new 1-micron CMOS technology the company plans to introduce into manufacturing in 1985. It is expected that the company's 1-Mbit DRAM will be developed using this technology.

Texas Instruments announced an agreement with N.V. Philips and its U.S. subsidiary Signetics Corporation covering the companies' standard cell products. Under the agreement, the companies will merge their CMOS standard cell libraries and cooperate in the design and development of new cells.

A Defense Department quality assurance team made a two-week audit of Texas Instruments' Midland, Texas, facility. The audit was to determine if the improper testing reported recently also occurred on JAN products and to assess what corrective actions TI has taken. No device quality problems were found.

Thomson-CSF

Products

Motorola extended its 68000 second-source agreement with Thomson-CSF for five more years. The agreement includes the 32-bit 68020 if Thomson-CSF meets specified technology exchange commitments. Motorola chose Thomson-CSF as its initial second source for the 32-bit device because Thomson-CSF had developed the largest number of 68000-based microprocessors and related products. Thomson-CSF expects to sell more than $50 million worth of semiconductors in the United States in 1984.

Toshiba

Products

Toshiba has begun production of a CMOS version of the Zilog Z80 microprocessor at its Sunnyvale facility. The company is also producing an NMOS version of the Intel 8085. Both products are being manufactured under second-source agreements. Toshiba is also manufacturing the products in its new facility in Iwate, Japan.

Products

Toshiba has overtaken Hewlett-Packard as the largest producer of LEDs. Toshiba currently produces 180 million LED chips per month.

VLSI Technology, Inc.

Products

VLSI Technology, Inc. (VTI) and Lattice Semiconductor Corporation have signed a cross-licensing agreement under which VTI will manufacture Lattice's high-performance EEPROMs, SRAMs, and programmable logic devices. In exchange, VTI will provide wafer fabrication, test, and assembly capacity to Lattice.

Western Digital

Products

Western Digital has established a European Technical Center in Paris to provide application support in southern Europe for the company's VLSI semiconductors and board-level products.

Xicor

Finance

Xicor reported record earnings and sales for the third quarter of 1984. Net income was $1.5 million on sales of $9.8 million. Sales for the first three quarters of 1984 increased 176 percent to $25.6 million, with earnings of $3.4 million.

Zilog

Organization

Zilog and Xilinx have settled their lawsuit in which Zilog accused Xilinx of hiring Zilog engineers and using Zilog trade secrets.

Zymos

Finance

Zymos reported an operating loss of $8.5 million for the first three quarters of fiscal 1984, ending July 31, 1984. The company lost $2.97 million in the third quarter, in contrast with $1.49 million in the same period in 1983. Sales for the nine-month period were $14.7, more than twice the $6.4 million level of the same period in 1983.

Jean Page

Nielsen Dataquest

USER UPDATE

SUIS Code: Newsletters
No. 84-23

USER WORKSHOP AT DATAQUEST'S SEMICONDUCTOR INDUSTRY CONFERENCE

INTRODUCTION

At DATAQUEST's Semiconductor Industry Conference held in Coronado, California, in October, the Semiconductor User Information Service (SUIS) held a workshop to enable users attending the conference to meet and discuss topics of mutual interest. The workshop covered the following subjects:

- Semiconductor Procurement in Japan
- Surface-Mount Packaging
- Just-in-Time Purchasing

This newsletter gives a brief overview of the session and reports participants' views on the topics discussed.

SEMICONDUCTOR PROCUREMENT IN JAPAN

Stan Bruederle, Director of SUIS, presented the results of recent research showing that prices of commodity semiconductors has been consistently lower in both Europe and Japan than in the United States. In recent months, this situation has encouraged large purchasers of semiconductors to consider purchasing directly in Japan.

Japanese domestic prices have been consistently lower than U.S. prices, even during times of relative shortage. Participants suggested a number of reasons for this. Prices in Japan do not fluctuate with the business cycle to the extent that they do in the United States. Their stability is partly due to the fact that Japanese companies are more strongly committed to negotiated prices than their U.S. counterparts, and they seldom renegotiate prices once they are agreed.

Japanese manufacturers selling into the United States tend to follow the U.S. suppliers' price trends because the Japanese are concerned about possible accusations of dumping. Pursuit of these two widely varying policies has resulted in the differences in prices between Japan and the United States.

Workshop participants described a number of problems encountered in their attempts to buy directly in Japan. One problem is that Japanese manufacturers frequently will not deal directly with a buyer from a U.S. company in Japan; U.S. buyers in Japan often have to deal with a trading company or a distributor. However, most participants said that they had good delivery from these distributors. Other participants described problems they have encountered when purchasing through a third party. They mentioned specific instances when the devices they received were fallout products with serious reliability problems.

Japanese subsidiaries of U.S. companies find it easier to purchase products in Japan than their parent companies. However, buyers at the session described major bureaucratic problems encountered if they tried to ship the devices back to the United States. On the other hand, they experienced no problems if they wanted to ship the devices to assembly plants in the Asia Rim countries.

The general consensus was that a Japanese subsidiary purchasing for an offshore assembly plant could indeed produce substantial savings in semiconductor procurement costs.

SURFACE-MOUNT TECHNOLOGY

The issue of how and when to consider a move to the use of surface-mount packages was high on everyone's mind. Estimates of the percentage of semiconductors shipped in surface-mount packages by 1990 varied from 20 to 50 percent.

Most of the participants were aware of the potential for cost savings represented, but there was some skepticism about how easy it would be for a company to invest in surface-mount assembly.

The most widely expressed concern was over the lack of standardization of the packages available. Participants expressed their beliefs that both manufacturers and users were waiting for someone else to take the lead. Automation will be the driving force behind the adoption of surface-mount technology. At present, automatic testing and handling equipment for surface-mount products is not readily available. The availability of adequate, reliable equipment will determine the rate at which surface-mount technology is adopted.

There were two main concerns over the packages themselves: reliability and price. Participants were not confident that surface-mount packages could offer the same level of reliability as conventional packages. Since the most widely accepted surface-mount packages are plastic, military users were very concerned about hermeticity problems. Buyers were looking for information about when surface-mount packages would reach price parity with DIPs. Some manufacturers are forecasting parity by mid-1985 for some products, but much depends on the sales volumes achieved.

Participants agreed that while surface-mount technology will ultimately offer many advantages, especially to large manufacturers, there are still many issues to be resolved before the technology is widely accepted.

JUST-IN-TIME PURCHASING

Just-in-time delivery programs recently have received a lot of attention from the technical press. The basic concept is to have a materials and resources program that minimizes inventory to reduce manufacturing cost. The advantages of the system include:

- Reduced inventory costs
- Better use of factory space
- Tighter budget control
- More efficient use of labor
- Lower overall manufacturing costs

Participants in the workshop recognized the value of implementing a just-in-time (JIT) program, but expressed a number of concerns about achieving this goal. One important factor in the use of a JIT system is accurate manufacturing forecasting. The success of a JIT program depends on producing products at exactly the forecast rate; there is no room for large swings in production volume.

The success of JIT also relies heavily on the quality of incoming parts. The system does not allow leeway for the return and replacement of defective devices. The value of having suppliers located close to the manufacturing site was also cited as an important factor in the implementation of a JIT program. More than any other factor mentioned, the participants stressed that the need for complete trust and cooperation between supplier and user is essential to the success of such a program.

CONCLUSION

Participants in this workshop valued the opportunity to share their opinions and experiences. We plan to offer a number of similar interactive workshop sessions at the forthcoming Semiconductor Procurement Conference to be held in Tucson, Arizona, in February 1985.

Jean Page

Nielsen Dataquest
USER UPDATE

SUIS Code: Newsletters
No. 84-22

THE AUTOMOTIVE SEMICONDUCTOR MARKET: THE RACE CONTINUES

INTRODUCTION

The requirements are tough and the demands are high, but today's auto industry continues its push for sophisticated electronics in state-of-the-art vehicles. Once dependent on sleek styling and faster speeds to sell their cars, auto manufacturers have now turned to the semiconductor industry for technology that will enhance their products and positions in a highly competitive marketplace.

This push by the auto industry represents a significant market for semiconductor manufacturers. In the past, despite slumping auto sales, the auto semiconductor market grew significantly because content per vehicle was on the rise. Today, however, due both to the increased use of semiconductors in automobiles and to an outlook for continued growth in U.S. auto sales, DATAQUEST believes that U.S automotive and light-truck semiconductor consumption will be $671 million in 1984, expanding to $1,156 million in 1989.

THE FIRST WAVE OF AUTO ELECTRONICS

As shown in Table 1, DATAQUEST estimates that the average semiconductor content in U.S. cars made a significant jump from $9.70 in 1978 to $40.60 in 1982. This dramatic growth in content drove the upswing in the overall auto semiconductor market despite the simultaneous decline in U.S. auto factory sales (see Table 2).

Foreign competition and federal agencies exerted severe pressure on U.S. manufacturers, forcing advances in fuel efficiency, exhaust emission control, safety, and vehicle downsizing. Since meeting emission standards while increasing fuel economy were goals that were largely at odds with each other, manufacturers turned to innovative design and engineering techniques using ICs to meet their goals. Similarly, advances were made in digital entertainment technology. Table 3 illustrates these increases as percentages of automobile unit shipments. Success in these areas opened the door for solid-state electronics in today's automobiles.

Table 1

SEMICONDUCTOR VALUE--AVERAGE U.S. VEHICLE

	1978	1982	1983	1984	1989
Auto	$9.70	$40.60	$51.60	$65.50	$105.00
Truck	$6.20	$26.00	$36.12	$49.13	$ 85.00

Source: DATAQUEST
September 1984

Table 2

U.S. FACTORY SALES
(Millions of Units)

	1978	1982	1983	1984	1989
Auto	9.5	5.8	6.8	8.0	8.5
Truck	3.7	2.2	2.7	3.0	3.1

Table 3

U.S. AUTOMOBILE FACTORY-INSTALLED ELECTRONIC EQUIPMENT
(Percent of Auto Unit Shipments)

	1980	1983
Entertainment		
Electronically Tuned Radio	5.4%	29.4%
Engine Electronics		
Fuel Injection	0.7%	25.6%
Feedback Carburetor	9.4%	55.4%
Antiknock	0.9%	5.0%
Idle Control	5.4%	39.3%
Spark Timing	5.4%	78.4%

Source: Ward's Automotive
DATAQUEST
September 1984

THE SECOND GENERATION OF AUTO SEMICONDUCTOR CONSUMPTION

The Auto Market: The Forces at Work

At present, 1984 is a good year for the auto industry. Table 2 reflects the recovery of U.S. factory sales since the lean years of the recession. An upswing began in 1983 that by all indications will move through 1984 and 1985. At the same time, U.S. market share is recovering from the intense competition of the early 1980s, when foreign auto manufacturers captured 27 percent of the U.S. market.

Overall, as a mature industry, the market will experience modest growth throughout the last half of the 1980s. The forecast of 1989 unit auto sales considers the following:

- There is great potential for catch-up buying. In the few years preceding 1983, auto industry analysts estimated that sales of motor vehicles were 14 million units below an average trend line. In 1983, the average age of cars on the road exceeded a 1982 peak of 7.2 years. That number is still rising.

- Demographic trends indicate a long-term aging of the U.S. population. A mature population increases the number of potential drivers and car owners and may also positively affect disposable income and consumer spending.

- As overall fuel efficiency and prices improve, consumers are purchasing larger cars with more options. These options play a considerable part in determining sales prices. The overall price of new cars in the United States is increasing due to both the rising number of options and to inflation.

  In the long run, this trend toward higher prices positively affects new auto sales. Higher prices tend to drive up the market value of used cars, which, in turn, increases trade-ins for new autos. In addition, higher valuations on used cars can also be realized on the open market, thus acting as a catalyst for consumers to sell and then purchase new autos directly.

- Auto manufacturers are taking great strides in automated design and manufacturing. By 1989, auto factory capacity will well exceed 8 million autos per year--a feat that is difficult to achieve in today's factories.

New Growth in Electronic Applications

The increase in average semiconductor content from $51.60 in 1983 to an estimated $105.00 in 1989 reflects the growing use of semiconductors in existing automotive technology and the use of ICs in new areas. These new functional areas are detailed, along with engine and entertainment electronics, in Figure 1, which graphically depicts the automobile of today and tomorrow. Table 4 breaks down these areas into the percentages of total semiconductor value per vehicle. DATAQUEST believes that growth in automotive semiconductor use has, to date, been fueled by entertainment and engine electronics. While new applications may be realized in these areas, we believe that future growth in the auto semiconductor market will largely be due to advances in body electronics and driver information features.

Body electronics experienced its first surge of growth between 1982 and 1984. We believe that as a percentage of the total, continued growth in this area can be expected due to innovations like voice-controlled trunks, automatic headlight adjustment, and antiskid braking.

Previously, cost, demand, and technology limitations inhibited the overall expected growth in driver information features (although one area, digital clocks, grew significantly). Now that setbacks have been overcome, DATAQUEST believes that driver information will be the fastest-growing segment between 1984 and 1989 with a compound annual growth rate of 30.5 percent in dollars per vehicle. Key applications include trip and navigation computers, all types of digital gauges, and voice warning systems.

Table 4

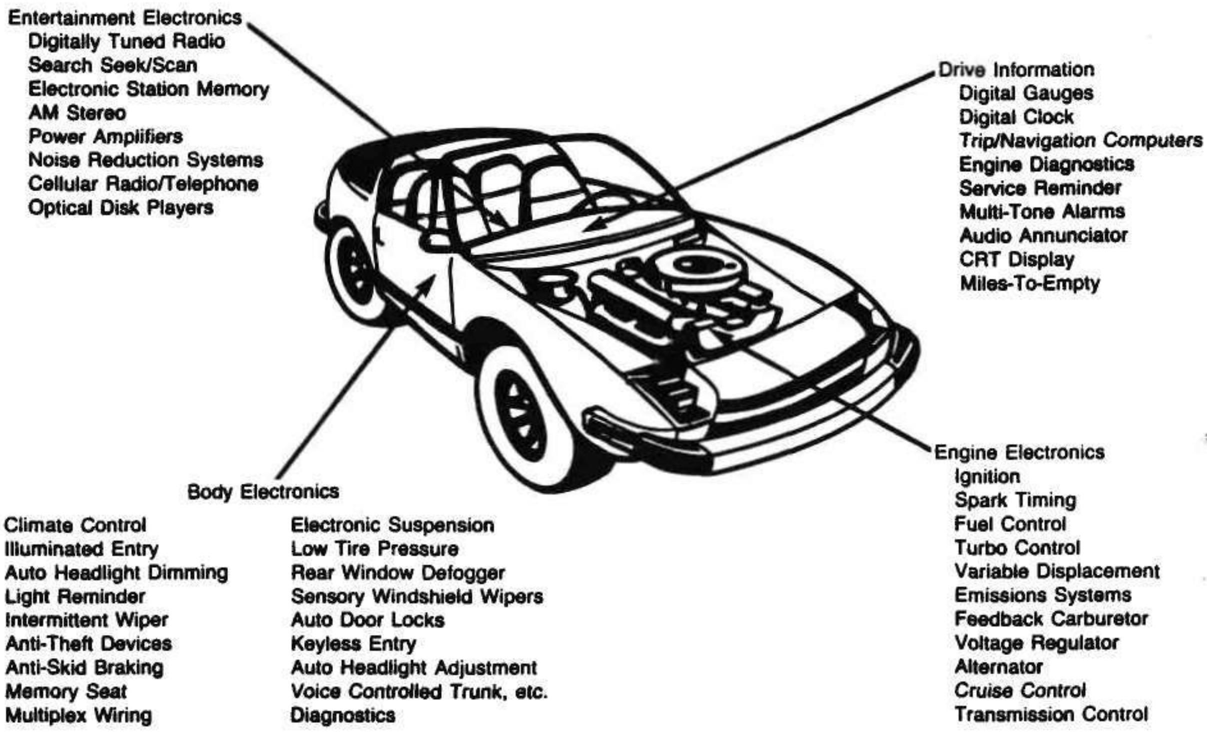
AUTOMOTIVE SEMICONDUCTOR CONTENT BY FUNCTIONAL CATEGORY
(Percent of Total Semiconductor Value)

	1978	1982	1983	1984	1989
Entertainment Electronics	26.8%	13.1%	14.1%	15.3%	13.9%
Body Electronics	13.4%	9.1%	9.8%	10.5%	11.0%
Driver Information	0.0%	7.1%	6.6%	6.4%	15.0%
Engine Electronics	59.8%	70.7%	69.6%	67.8%	60.1%
	100.0%	100.0%	100.0%	100.0%	100.0%

Source: DATAQUEST
September 1984

Figure 1

ELECTRONICS IN PRESENT AND FUTURE AUTOMOBILES



Source: DATAQUEST

CONCLUSIONS

Overall, our 1989 automotive semiconductor consumption forecast is driven by ambitious opportunity in all areas, including:

- Continued growth in U.S. new vehicle factory sales

- Increased factory installation of already existing systems and applications

- Development of electronic automotive technology in all functional areas and accompanying increases in their factory installations

- Increased demand for semiconductor-intensive options, which is a function of the trend toward larger cars in the U.S. auto sales mix

As a mature industry, U.S. auto manufacturers have been rather atypical semiconductor end users. Most end users exist in a marketplace where intense competition has always been based on advantages in leading-edge electronics. For the auto industry, this kind of competition is relatively new, but the commitment to electronics and to working with the semiconductor industry has been established. We believe that such an effort can only bring successful innovation and prosperity to both players.

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Jean Page
Anthea C. Stratigos

Nielsen Dataquest
RESEARCH BULLETIN

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No. 84-21

THE 1984 GOMAC: "SYSTEMS AND TECHNOLOGY IN TRANSITION"

INTRODUCTION

The 1984 Government Microcircuit Application Conference (GOMAC) was held in Las Vegas, Nevada, November 6-8. The series of technical sessions and company-sponsored exhibits offered an informative exchange of ideas from government and industry spokespersons on the use of microcircuits in high-performance systems applications.

The 1984 conference marks the return of GOMAC as an annual conference, a move well received by the attendees, as the conference is expected to keep both government and industry abreast of microcircuit advancements and developments. The GOMAC proved to be well attended and a highly informative exchange of technical issues and developments from leading device and systems designers from government, industry, and the academic community.

Highlights of the 1984 program were the keynote speakers: the Honorable Ed Zschau (R-California), chairman of the High Technology Task Force and a member of the House Committee on Foreign Affairs; and Admiral B. R. Inman (USN-Retired), current president and chief executive officer of Microelectronics and Computer Technology Corporation (MCC).

More than 120 papers were delivered during the 18 technical sessions. In addition to the technical sessions, the 21 companies listed in Table 1 participated in the exhibit booths, introducing their new products and advanced systems concepts.

Technical Sessions

Table 2 lists the conference topics covered during the technical sessions and published in the 1984 GOMAC Digest of Papers. The papers will not be discussed in detail in this publication because they are subject to export control under the International Traffic in Arms Regulations (ITARS) 22 U.S.C. 7778. DATAQUEST will incorporate the information from these papers into a series of newsletters for future publication.

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GOMAC 1985

The 1985 GOMAC will be held at the National Bureau of Standards in Gaithersburg, Maryland, November 12-14. The theme for the 1985 conference will be "Microelectronics--Key to Affordable Systems in the '90s."

Mary A. Olsson

Table 1

GOMAC COMPANY EXHIBITS

ARACOR
AT&T Technologies (Federal Systems)
Barnes Engineering
Florod, Inc.
Gigabit Logic
Harris Semiconductor
Hazeltine Corporation
Honeywell
Hughes Aircraft Company
IBM Federal Systems Division
INMOS
Intel Corporation
Isotronics
Perkin-Elmer Corporation (Physical Electronics Division & Semiconductor Equipment Group)
RCA Government Systems Division (Advanced Technology Labs)
Scanning Electron Analysis Labs
Texas Instruments
TRW Electronics and Defense
TRW LSI Products Division
United Technologies Microelectronics Center
UTI Instruments
Westinghouse (Defense and Electronics Center)

Table 2

GOMAC TECHNICAL PROGRAM TOPICS

Gallium Arsenide Digital High-Speed Devices
Fault Tolerance
Computer-Aided Design and Engineering
VHSIC Technology Insertion
Quality and Reliability, Assurance Techniques for VLSICs
A/D and D/A Converters
Gallium Arsenide Analog MMICs and Microwave Systems
Advanced Systems Concepts
Memory Technology
Signal Processing
System Reliability and Maintainability
Packaging Techniques
Radiation Hardness
Advanced Semiconductor Processes and Concepts

Source: GOMAC
DATAQUEST

Nielsen Dataquest USER UPDATE

SUIS Code: Newsletters
No. 84-20

GENERAL INDUSTRY UPDATE: A PROCESS OF ADJUSTMENT

SUMMARY

The semiconductor industry is facing two difficult quarters of inventory adjustment by end users. The weakened demand will shorten lead times and is already causing price pressure in commodity products. DATAQUEST forecasts that in the fourth quarter of 1984, U.S. semiconductor consumption will grow only 5 percent over the preceding quarter. Quarter-to-quarter growth in the first quarter of 1985 is expected to be 3.8 percent. Table 1 shows our estimates of quarterly growth for 1983 through 1985.

The book-to-bill ratio has declined steadily throughout 1984, reaching 0.84 to 1 in September. (See Figure 1.) Such a decline has previously been the forerunner of an industry recession that has been associated with an economic recession. However, although the economy is slowing, we do not believe that it is entering a recession. The situation suggests a process of adjustment rather than a downturn.

ECONOMIC TRENDS

Economic indicators suggest that, although the economy is slowing, it will continue to be healthy throughout 1985. The relatively low inflation rate suggests that the economy is not overheating, and that expansion will continue. The index of leading indicators rose 0.5 percent in August after two months of decline. September figures showed personal income rising by 0.9 percent and consumer spending rising by 1.4 percent over the previous month, suggesting continued consumer confidence in the economy. People are reacting to the realization that inflation has remained low, long-term interest rates are falling, and the money supply has remained in reasonable check.

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Economic growth in other major countries has not reflected that of the United States. Europe's recovery remains slow, although at 1.3 to 1, the European semiconductor book-to-bill ratio is higher than that of the United States. This positive ratio is partly due to the fact that European semiconductor consumption patterns tend to lag those of the United States by three to six months.

The Japanese economy did not achieve the rapid growth experienced by the U.S. economy in the early part of 1984, and a slowdown is forecast for 1985. We believe that the slowdown in the United States could begin to affect Japanese exports before the end of 1984.

THE PROCESS OF ADJUSTMENT

In the past two or three months, semiconductor users' inventories have built up very rapidly, especially at companies involved in the office automation and personal computer markets. The euphoric expectations of earlier in the year have come face-to-face with a less buoyant economy and reality. As semiconductor users have seen demand for their own products increase more slowly than they had anticipated, they have lowered their expectations, and decreased or stretched out their semiconductor orders accordingly. In markets such as that for personal computers, where companies' anticipated market share added up to significantly more than 100 percent of the total available market, there have inevitably been disappointments and some disasters.

As demand has declined, products have become more available, prices have softened, and lead times have shortened. This situation has caused purchasers to cut back on purchases and in some cases to cancel and renegotiate orders to obtain lower prices. The problem feeds on itself, because as prices decline and lead times become shorter, purchasers decide that they no longer need to maintain the high inventory levels of the past months--causing a further decline in demand.

Semiconductor manufacturing capacity has expanded tremendously during the last few quarters. After their experience of emerging from the previous two recessions, semiconductor manufacturers were more ready to meet the upturn in demand when it occurred. U.S. merchant capital expenditures declined only 10.4 percent during the last recession in 1982, compared to a 53.2 percent decline in the recession of 1975, indicating a substantial increase in new fabrication capacity. Companies also increased their capacity by increasing the number of shifts operating at existing facilities.

This combination of high capacity and declining demand is usually the forerunner of a downturn in the semiconductor industry. However, such a downturn has always been associated with a decline in the nation's economy. For this reason, DATAQUEST views the current situation as a relatively short period of inventory adjustment. This view is supported by major semiconductor manufacturers who have seen demand declining only in the office automation market and not in the military, automotive, or telecommunications markets. Price pressure is occurring predominantly in the commodity devices area, and many high value-added devices, such as the newer microprocessor families, are still holding their prices. The turbulence caused by the period of adjustment will be a painful one for semiconductor manufacturers, but once excess inventory has been used up, buyers will return to buying patterns more closely related to the demand for their own products.

SEMICONDUCTOR INDUSTRY OUTLOOK

Although U.S. semiconductor consumption in 1985 is not expected to grow at the astounding 49.5 percent year-to-year rate forecast for 1984, DATAQUEST expects growth of 23.8 percent to a total of $15,432 million. Table 2 shows our estimates of U.S. semiconductor consumption for 1983 through 1985.

As shown in Table 1, the first quarter of 1985 is expected to grow by only 3.8 percent over the last quarter of 1984, as the period of inventory adjustment continues. The rate of growth in the second quarter of 1985 should increase to 5.3 percent over the first quarter with consumption estimated at $3,744 million. Historically, the third quarter of a year usually shows a slower growth rate than the second--we are estimating growth of 4.2 percent over the second quarter. In the last quarter of 1985, we expect a healthy 8.5 percent growth over the third quarter with consumption totaling $4,232 million.

The decline in consumption growth rates can most clearly be seen by comparing each quarter with the same quarter of the preceding year. This same-quarter growth rate peaked in the first quarter of 1984 when U.S. semiconductor consumption was 61.2 percent higher than the first quarter of 1983. Same-quarter growth rates in 1985 are decidedly less robust--the first quarter of 1985 is expected to be 31.6 percent higher than the first quarter of 1984, and the third quarter of 1985 is forecast to be only 19.6 percent higher than the same quarter of 1984. Such growth rates are, of course, only modest by semiconductor industry standards.

Semiconductor manufacturers are facing a difficult few months. We expect to see companies moving to stretch out their capital expenditure plans and rewrite budgets for next year. Many companies have already cut their hiring plans even if they have not imposed an outright hiring freeze. The book-to-bill ratio will probably not reach unity until early 1985. Since the ratio is a three-month rolling average, the very low bookings in September will affect October and November, and softening prices for new orders will also affect the next few months.

We expect price pressure and declining demand to fall unevenly on the various products. Companies with a high ratio of proprietary products to commodity products will fare better than those that are more focused on commodity products. Companies that achieved market share as overflow suppliers during times of shortage will now have to work very hard to retain user loyalty. In a market where purchasers are working to cut their supplier bases, it is even more important to retain status as a preferred vendor. Companies with single product lines are facing an especially difficult challenge.

Jean Page
Frederick L. Zieber

Table 1

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1983				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 294	$ 342	$ 371	$ 416	$ 1,423
Integrated Circuits	1,382	1,626	1,816	2,090	6,914
Total	$1,676	$1,968	$2,187	$2,506	$ 8,337
Percent Change from Previous Quarter	1.4%	17.4%	11.1%	14.6%	
Percent Change from Previous Year	7.1%	14.9%	30.1%	51.6%	26.1%

	1984				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 442	$ 491	$ 501	$ 520	$ 1,954
Integrated Circuits	2,260	2,586	2,760	2,905	10,511
Total	$2,702	$3,077	$3,261	$3,425	$12,465
Percent Change from Previous Quarter	7.8%	13.9%	6.0%	5.0%	
Percent Change from Previous Year	61.2%	56.4%	49.1%	36.7%	49.5%

	1985				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 529	$ 549	$ 558	$ 582	$ 2,218
Integrated Circuits	3,026	3,195	3,343	3,650	13,214
Total	$3,555	$3,744	$3,901	$4,232	$15,432
Percent Change from Previous Quarter	3.8%	5.3%	4.2%	8.5%	
Percent Change from Previous Year	31.6%	21.7%	19.6%	23.6%	23.8%

Source: DATAQUEST

Figure 1

BOOK-TO-BILL RATIO--1984

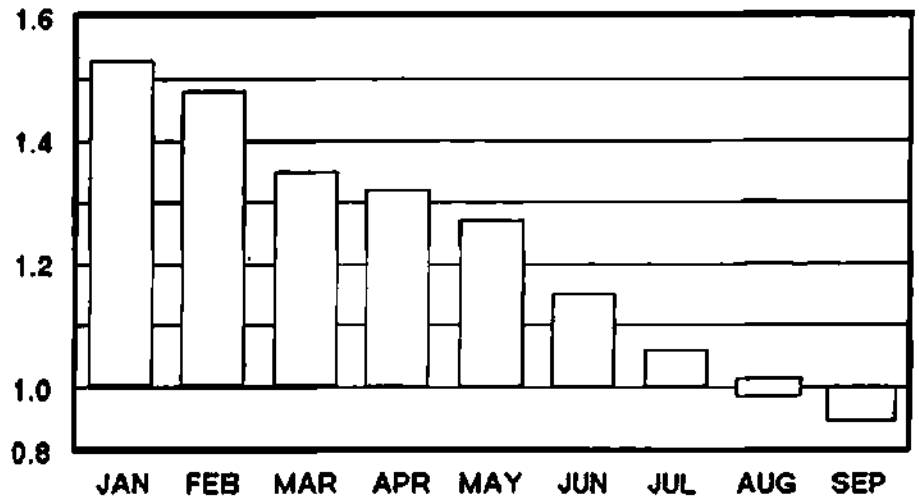

Table 2

ESTIMATED U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1983	1984	1985
Discrete Devices	$1,423	$ 1,954	$ 2,218
Integrated Circuits	6,914	10,511	13,214
Total	$8,337	$12,465	$15,432

Source: DATAQUEST

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NATIONAL SEMICONDUCTOR CORPORATION-- 1984 ANNUAL STOCKHOLDERS' MEETING

OVERVIEW

National Semiconductor Corporation held its annual stockholders' meeting on October 26, 1984, at the Hyatt Hotel in Palo Alto. The formal presentations were devoted to the company's semiconductor product lines, a definite departure from previous annual meeting formats.

Although references to a softening in demand for all components segments in the first quarter of fiscal 1985 permeated the meeting, the company was jubilant about its excellent sales record for fiscal 1984. The components segments represented 60 percent of National's fiscal 1984 dollar sales, and 80 percent of its fiscal 1984 development dollars.

Group representatives discussed the following National Semiconductor product lines:

- Logic
- Linear
- MOS microprocessor
- MOS memory
- Bipolar/LSI
- Customer-specific

The most notable growth in National's product groups occurred in MOS microprocessors and bipolar/LSI. Customer-specific products constituted the only unprofitable line for National; its unprofitability was due to the current investment of development dollars. The customer-specific line is expected to move up in product ranking because of estimated market growth in application-specific integrated circuits.

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SALES

National's net sales for fiscal 1984 were $1,655.1 million, representing a 37 percent increase in sales over the $1,210.5 million in fiscal 1983. National's fiscal 1984 Research and Development expenditures totaled $158.5 million, a 38 percent increase over fiscal 1983's $114.7 million. The semiconductor components area of National spent approximately $131.3 million on research and development in fiscal 1984. Capital expenditures exceeded $278 million in fiscal 1984, a 112 percent increase over fiscal 1983 expenditures of $131 million. Capital expenditures were directed toward the component area with construction of the MOS III 2-micron facility in West Jordan, Utah. Sampling of 64K CMOS SRAMs and 256K DRAMs is expected in the first quarter of 1985.

Capital expenditures are expected to increase significantly in 1985 as National focuses on the development of new wafer fabrication facilities. A 6-inch CMOS fab facility is presently under construction in Arlington, Texas. Completion is expected in the first quarter of 1985, with product sampling of gate array, microprocessor, and logic products during the second and third quarters of 1985. A 5-inch wafer fab facility is located in Greenock, Scotland, for production of analog and digital bipolar products. A $75 million R&D center, with 5-inch wafer fab capability for development of linear, bipolar, and customer-specific products will be located in Santa Clara, California. A 1.5-micron CMOS facility is under construction in Migdal Haemek, Israel, with completion expected in the fourth quarter of 1985.

MAJOR PRODUCT GROUPS

The logic product group is National's largest product area, with digital bipolar and CMOS logic products representing more than $100 million each in annual sales. R&D spending for logic increased 64 percent in 1984. The major emphasis is on introducing approximately 110 high- speed CMOS products during 1984.

The linear product group is the second largest revenue-producing unit for the company. National estimates that 80 percent of the products in the linear market will be introduced by National in 1984. The linear group expects to reach 1.5-micron geometries in CMOS linear products in 1985. Emphasis is on surface-mount packaging technology with 20-lead packages handling high-power, 50-watt devices.

Microprocessor group revenue grew by a factor of three during 1984. As a percent of sales, the microprocessor group profits exceeded corporate profits during the last three quarters of fiscal 1984. Research and development expenditures represented 20 percent of sales. National expects to sample its Series 32000 32-bit CMOS microprocessor family during the fourth quarter of 1984. High-end volume shipments of the single-chip 32-bit CPU, the NS32032, is expected in the first quarter of 1985.

The 64K DRAM and the 16K SRAM are the most successful MOS memory products for National. Research and development spending increased 40 percent in 1984 for the MOS memory product group. National began sampling 2-micron DRAM and SRAM products during the second quarter of 1984. All next-generation CMOS DRAM, SRAM, and EPROM products will be in 1.25-micron geometries, with CMOS EEPROM products at 2.0-micron geometry. National will be sampling its 64K DRAM products in surface-mount packaging technology in 1985, and will offer the 256K DRAM in 18-pin plastic leadless chip carrier packages.

The bipolar/LSI product group experienced an 85 percent growth in sales in fiscal 1984, expanding its product base by introducing the 1K and 4K ECL RAMs, Registered PROMs, and series 20A programmable logic families.

The customer-specific product group introduced in 1983 is expected to be the fastest growing product group for National over the next few years. National regards the customer-specific product group as the new frontier for National Semiconductor and although presently nonprofitable, it is expected to be a sharp investment in the future.

COMPANY OUTLOOK

National is experiencing a softening demand for component products. Bookings dropped substantially across various product markets during July and August 1984 due to user inventory corrections after a previous six-month double-ordering spree. These user overcommitments and cancellations are now impacting supplier lead times and backlogs. National has an estimated six-month backlog of approximately $600 million.

The high cancellation rates of July and August 1984 are leveling off; October bookings have improved over September bookings; and overall, National's business outlook for fiscal 1985 is positive. Therefore, National expects a return to its traditional 10 to 12 percent increase in business during fiscal 1985.

Mary Olsson

Nielsen Dataquest RESEARCH BULLETIN

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No. 84-18

AMD ANALYSTS' MEETING--
STAYING TOUGH

INTRODUCTION

Describing the semiconductor market as enjoying a respite from the boom of past months, Jerry Sanders, President of AMD, forecast two flat quarters. He attributed the softening in demand to inventory correction and the shakeout in the PC market. Speaking at the company's Analysts' Meeting in Palo Alto, California, on October 25, 1984, Mr. Sanders said that he expected many semiconductor purchasers to cancel backlogs and renegotiate contracts with their vendors.

CMOS PRODUCTS

Jim Downey, Senior Vice President, Operations, reiterated AMD's commitment to CMOS products. He explained that when device geometries reach the sub-2-micron level, CMOS becomes virtually essential. AMD currently has 29 CMOS devices in the development or early production stages.

CMOS Memories

Mr. Downey forecast that more than 50 percent of AMD's memory products would be CMOS by 1987. The company is currently prototyping a CMOS 256K DRAM and expects to introduce a 1-Mbit EPROM and a 256K ROM for production in fiscal 1986 (AMD's fiscal year begins in April).

AMD is currently in limited production with a 4Kx4 CMOS SRAM and expects to introduce an 8Kx8 device in the first quarter of 1985. Introduction of 16Kx4 and 64Kx1 CMOS SRAMs is expected in fiscal 1986.

CMOS Logic

AMD plans to introduce a number of CMOS telecommunication and data communication devices, as well as a CMOS version of the popular 8051 microcontroller. The company also announced its LL7000 CMOS gate array family.

BIPOLAR PRODUCTS

Despite the advances in CMOS capability, there are still some areas where bipolar technology is essential. The speed of bipolar ECL makes it the technology of choice for devices used in graphics and high-speed computation. AMD will introduce a 32-bit floating-point processor and a 16Kx8 bipolar PROM in the first quarter of 1985. The company is also introducing a family of ECL gate arrays. A bipolar microprocessor, the 29325, will be introduced before the end of the next fiscal year.

MICROPROCESSORS

AMD has seen a considerable decline in demand for the 8086/8088 microprocessors. The company is already sampling the 80186 and expects to be in production by the end of this year. AMD also expects to have limited production of the 80286 by the end of this year. Mr. Sanders expects 80286 demand to be even higher than the current optimistic forecasts.

CONCLUSIONS

As are most semiconductor companies, AMD is seeing a softening of prices for commodity products. However, prices for proprietary products still remain firm.

Steve Zelencik, Senior Vice President, Sales and Marketing, announced at the meeting that starting January 1, AMD will guarantee a 500-parts-per-million quality level for all its products for AC and DC electrical test over all temperature ranges. With its commitment to quality and an aggressive program of new product introductions, AMD seems well positioned to meet the current market situation.

Jean Page

Nielsen Dataquest RESEARCH BULLETIN

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INTEL ANALYSTS' MEETING

INTRODUCTION

The mood at the Intel Analysts' Meeting held in Palo Alto on October 24, 1984, reflected the softening in demand in the semiconductor marketplace. Describing current business conditions as "turbulent," Andrew S. Grove, President and COO, said that the business picture was, on balance, weaker than it had been three months ago. Intel expects the rate of revenue growth to decline over the next two quarters, although Mr. Grove specifically rejected the possibility of a decline in revenues.

PRICES

Commodity product prices have softened and are expected to continue to decline for the next two quarters. Prices for Intel's 8086 and 8088 microprocessor families and the 8051 microcontroller are expected to weaken as demand slows. The PC market shakeout has caused the slower growth rates for these products. Prices for the 80186 and the 80286 are expected to remain firm in the face of rapidly growing demand for these devices. Intel's CMOS DRAM products are commanding prices approximately twice those of NMOS DRAMs.

MEMORIES

Intel has no intention of being a commodity memory supplier. The company's strategy is to compete in high-margin niches of the memory market. Intel's shipments of EPROMs are currently capacity limited and are expected to remain so for the next two quarters.

Intel is seeing stronger orders for its CHMOS DRAM products. Prices are twice those of NMOS devices and the CHMOS products are expected to continue to command a premium. Although Intel has no competition in this area, CHMOS DRAMs represent only a small part of the company's total revenues.

MICROPROCESSORS

Demand for the 8086/8088 and 8051 families has declined significantly due to the turbulence of the PC market. These devices are expected to be readily available and prices are expected to weaken in the first half of 1985. Orders for the 80286 are extremely strong. Although shipments have increased rapidly throughout 1984, they will have to ramp up even more steeply in 1985 to satisfy orders. Intel expects substantial demand for this microprocessor because of its use in the recently announced IBM PC AT. Although orders for the 80186 are still growing rapidly, demand for this device is not as strong as that for the 80286.

DATA COMMUNICATIONS

A major portion of the meeting was devoted to a presentation on data communications networks, with emphasis on Intel's 82586 LAN coprocessor. Intel estimates that by 1988, 80 percent of PCs shipped will have on-board networking capability. David L. House, Vice President and General Manager, Microcomputer Group, described this as a new era of productivity. The PC revolution greatly enhanced personal productivity, and networking capability will offer similar improvements in organizational productivity.

CONCLUSIONS

Intel expects two flat quarters in the semiconductor industry as office automation and PC manufacturers work to adjust their inventories. The company sees no such order softening in other areas. Industrial, automotive, military, and telecommunications markets all show continued strength.

Start-up problems at Intel's Plant 7 in Albuquerque, New Mexico, are expected to continue to be a financial drain on the company until the second quarter of 1985. However, Intel expects to continue rapid expansion of its wafer fabrication capability. Capital expenditures for 1984 were $400 million and are expected to be about the same in 1985.

After weathering two quarters of inventory adjustment, and the associated softening of commodity prices, Intel expects the semiconductor industry to regain its momentum. Intel's book-to-bill ratio has been consistently higher than the industry average, and the increasing emphasis on value-added devices in Intel's product mix will help the company weather the next few months.

Jean Page

Nielsen Dataquest

RESEARCH BULLETIN

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NTT ANNOUNCES 16K GALLIUM ARSENIDE MEMORY DEVICE

On September 25, Nippon Telegraph and Telephone's (NTT) Atsugi Laboratory announced that it has successfully developed a 16K gallium arsenide memory device with 100,000 field-effect transistors (FETs) using its self-aligned implantation for n positive/negative layer technology (SAINT). The chip measures 7.2 mm by 6.2 mm and has an access time of 4.1 nanoseconds and a power consumption of 1.5 watts. According to NTT, the FET was developed using high uniformity, no-defect GaAs crystals and reduction projection lithography. These breakthroughs have been achieved since NTT's announcement of a 2.8-ns GaAs 4K SRAM with 26,600 FETs at the ISSCC Conference in San Francisco earlier this year.

As shown in Figure 1, NTT has beaten DATAQUEST's forecast of its GaAs announcement by three months. We anticipated that NTT would announce a 16K SRAM at the ISSCC Conference next year and a 64K SRAM in either 1986 or 1987. Based on the current announcement, we believe that it is possible that NTT could introduce a 64K SRAM as early as 1986.

DATAQUEST believes that these devices will be used in supercomputers and superminicomputers within two or three years, since Japanese semiconductor makers have made significant progress in the GaAs crystal growth research necessary for producing digital ICs. The following major announcements made within the last year and a half are indicators of this progress:

- In August 1984, MITI's Perfect Crystal Project Team announced a new crystal growth method that theoretically makes possible GaAs devices with speeds of 1 picosecond.

- In July 1984, NTT announced a defect-free 5-centimeter (1.95-inch) GaAs crystal that will allow more than 100,000 transistors on a 5-mm-square chip.

- In April 1984, Sumitomo Electric developed 2.5-inch GaAs wafers with less than 200 defects per square centimeter for computer chips, and 5-inch GaAs wafers for microwave devices.

- In March 1984, Oki Electric announced mass production technology for GaAs ICs using heat-resistant tungsten aluminum alloys.

- In March 1983, MITI's Optoelectronics Project announced a magnetic field Czochralski method for producing uniform GaAs crystals.

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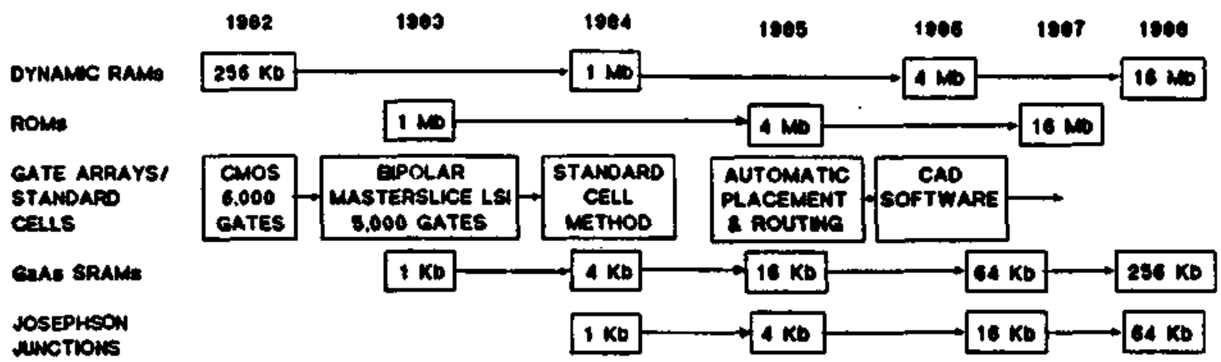
Jean Page
Sheridan Tatsuno

Figure 1

FORECAST OF NTT RESEARCH PAPERS
(Papers Presented at ISSCC)



Source: DATAQUEST
August 1984

Nielsen Dataquest USER UPDATE

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HIGH-PERFORMANCE SILICON: THE NEXT GENERATION EMERGES

SUMMARY

The semiconductor industry can develop high-performance VLSI circuits faster than equipment manufacturers can use them effectively. Until IBM announced the PC/AT (for Advanced Technology), the Intel 80286 16-bit microprocessor was one of these circuits. IBM's announcement, however, heralds the beginning of a new generation of microprocessor-based systems. Memory management in microprocessor systems is an idea whose time has come. MPUs with memory management capability have been available since 1980 but have largely been ignored. DATAQUEST believes that products with memory management capability from all manufacturers will receive more attention. We believe that the concept will gain popularity because there will be a rush of IBM competitors designing equipment with similar or better features in an attempt to defend their meager market shares against IBM's new offering.

AVAILABILITY--THE CRITICAL ISSUE

DATAQUEST does not expect availability of the 80286 to be a problem in the industry. Volume shipments of the 80286, as shown in Table 1, began in the second quarter of 1983 and have grown rapidly. Intel is presently the only supplier, but AMD and Siemens both have a second-source license to manufacture and market the part. AMD expects to have the new chip in volume production by the second quarter of 1985. In addition, IBM has a license to manufacture the 80286 for its own consumption. Intel is also negotiating with a major Japanese supplier.

According to a company spokesman, Intel will ship "multiple millions" of the 80286 next year. In 1984, industry production of the 80286 will be 20 times greater than in 1983. Next year, the industry production is expected to increase tenfold.

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Table 1

ESTIMATED INDUSTRY SHIPMENTS OF 80286 AND ALL 16-BIT MPUs
(Thousands of Units)

Shipments	1983	1984	1985
80286	13	300	3,000
All 16-Bit MPUs	7,138	14,230	27,030

Source: DATAQUEST
September 1984

There are still painful memories of the parts shortage problems brought on by the recovery, especially the severe shortage of Intel's 80186 during 1983. Speculation was rampant then that the shortage was caused by IBM's making large purchases of the 80186 for a future product. Not true. In fact, IBM appears to have leapfrogged the 80186. However, we believe that this will not affect availability of the 80186. Many personal computer makers were attempting to outdo IBM in the technology race by using the 80186. Even though they will now scramble to retrofit their designs with the 80286, they represent a small percentage of 80186 applications. Most of the other 80186 design commitments are in products that are not affected by IBM's recent move.

Even though we do not anticipate an availability problem, we do encourage close user-vendor relationships. Consequently, we recommend that companies contemplating use of the 80286 notify their selected vendors six to twelve months prior to ordering.

THE 80286--THE HEART OF THE PC/AT

The 80286 is a member of Intel's high-performance microprocessor family, which includes the 8088, the 8086, the 432, and the future 80386. Although the part is available in 6-, 8,- and 10-MHz clock speeds, IBM has chosen the 6-MHz version for its new computer. IBM claims that the PC/AT operates two to three times faster than the PC/XT. DATAQUEST's analysis, presented in Table 2, shows that the 80286 at 6 MHz is capable of operating six times faster than the 8088 operating at 4.77 MHz in the present PC/XT.

Table 2

EXECUTION TIME OF VARIOUS 8086 COMPATIBLE MPUs
(Time in Milliseconds)

	8088 4.77 MHz (msec)	8088 5 MHz (msec)	8088 8 MHz (msec)	8086 5 MHz (msec)	8086 8 MHz (msec)	8086 10 MHz (msec)	80286 6 MHz (msec)	80286 8 MHz (msec)	80286 10 MHz (msec)
Bubble Sort	3.824	3.648	2.280	1.824	1.140	0.912	0.620	0.465	0.372
Block Translation	3.119	2.976	1.860	1.488	0.930	0.744	0.552	0.414	0.331
XY Transformation	4,699.4	4,484.0	2,802.0	2,242.0	1,401.0	1,121.0	380.0	285.0	228.0
Parts Inspection	2,797.5	2,668.0	1,668.0	1,334.0	834.0	667.0	291.7	219.7	175.0
Relative Performance	1.00	1.05	1.68	2.10	3.35	4.19	6.17	8.22	10.28

Source: Intel Corporation
DATAQUEST
September 1984

In addition to the CPU functions, the 80286 contains four levels of protection, virtual memory capability, and memory management. The chip can directly address 16 Mbytes, and each task can have up to 1 billion bytes of address space because of the virtual address translation.

All product family members share a common architecture as well as compatible instructions and data types. Therefore, all application software written for the 8088 and 8086 will run on the 80286.

The 80286 has 130,000 active devices compared to approximately 29,000 devices for the 8086. The die was more than 108,000 square mils when it was introduced in 1982, but it was designed to be shrunk to 73,000 square mils.

LIMITS OF COMPATIBILITY

Higher performance is often achieved at the expense of compatibility with the past. Although software written for the earlier 8088 and 8086 is generally upward compatible with the 80286, some changes are needed to realize the full power of the new device. Application programs operating at the lowest privilege level are the easiest to convert and may not require any changes. Most of the required software changes are in the operating system. The changes are due to the added memory protection features and to the enhancements in the addressing structure to support virtual memory. The number of changes depends on the type of operating system, its internal structure, and the functions it performs. If the operating system must isolate tasks from each other and protect itself from less trusted tasks, then more source code changes are required.

Software changes are obviously needed to take advantage of the multitasking and multiuser features of the 80286. Most of the changes to the operating system relate to initialization and the interrupt table.

There are also some new instructions available to programmers. The 80186 had new instructions for fast index calculation, subroutine linkage, I/O data transfers, and program error detection. The 80286 includes those instructions and adds others for controlling its protection hardware.

The 80286 has two operating modes. One is called the real address mode and the other is called the protected virtual address mode, (usually referred to as the protected mode). In the real address mode, the 80286 "looks" just like the 8086 in terms of both address structure software development. In this mode, it is completely binary compatible with the 8086, but some software may require modification because of the transition from an 8-bit to a 16-bit data transfer.

ANALYSIS

DATAQUEST believes that a time lag of 3 to 5 years occurs between the introduction of a VLSI component and high-volume usage of the device. This is true for 16-bit microprocessors, which were introduced approximately 5 years ago and are now becoming a significant part of the total microprocessor market. The introduction of the PC/AT makes IBM the latest in a small group of personal computer manufacturers to use full 16-bit microprocessors. In spite of recent publicity about new 32-bit microprocessors, we believe that 16-bit microprocessors are about to enter the rapid growth phase of their product life cycle.

The advanced features available with the current generation of microprocessors will now receive more attention from potential designers. Products with features such as memory management, virtual memory, and instruction pipelining will become more widely used in many applications. In addition to Intel, other manufacturers of such products will benefit from this increased awareness. This greater interest will be caused by anticipation of declining prices due to higher production volumes, by more third-party software, and by increased user experience with advanced minicomputer-like concepts. Much to the delight of manufacturers of high-performance 16-bit microprocessors, the volume market has finally arrived.

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Jean Page
Mel Thomsen

Nielsen Dataquest USER UPDATE

SUIS Code: Vol. II, Thomson Semiconducteurs

THOMSON SEMICONDUCTEURS--A NEW SEMICONDUCTOR START-UP

INTRODUCTION

In 1983, Thomson Semiconducteurs was reborn. The company initially comprised the 1982 merger of the semiconductor activities of Thomson-CSF and Thomson-EFCIS; Eurotechnique and the semiconductor activities of CIT-Alcatel were added to the group during 1983. DATAQUEST believes that a new dynamic company has emerged, headed by Jacques Noels (ex-Texas Instruments) and aided by his commercial director, Carlo Zanni (also ex-Texas Instruments).

Combining a complete restructuring of the operations and staff functions with an aggressive sales plan, Noels aims to take Thomson back into the top 10 worldwide merchant manufacturers by 1990.

A graduate of the prestigious Ecole Nationale Supérieure des Arts et Métiers, Paris, Noels joined Thomson in 1982. He immediately began making sweeping changes in his management team--his goal was to reorientate the division, which has always enjoyed a good reputation for its design qualities, into a serious production house.

As an example, the company has greatly streamlined its wafer fabrication processes at the Grenoble (MOS) and nearby St. Egreve (bipolar) facilities. As a result, with no increase in staffing levels, production output in 1983 rose fivefold and threefold, respectively.

BACKGROUND

The changes in Thomson Semiconducteurs are to some extent directly linked with the changes currently under way in the parent company, the Thomson Group. Shortly after Alain Gomez became chairman of the Thomson Group in February 1982, a series of radical changes began to take place. Besides slashing the headquarters staff from 900 to 300 and enforcing rigorous financial controls, the Harvard Business School graduate disposed of several peripheral activities to concentrate on four major electronics areas: consumer, military, medical, and components.

Gone are the light bulb and minicomputer operations, the consumer credit and leasing operations, and--biggest of all--Thomson's unprofitable US$1.3 billion telecommunications group. Gomez, once known as a left-wing socialist, is now proud to be called an industrialist. No stranger to a challenge, Gomez had previously earned a reputation for toughness by turning the red-ink-stained packaging branch of Compagnie de St. Gobain into that company's most profitable unit.

In 1982, Thomson Semiconducteurs' worldwide semiconductor revenues were US$148 million, down 18 percent from $180 million in 1981. At the same time, the world semiconductor consumption grew approximately 4 percent, from $14,327 to $14,871. Thomson's worldwide semiconductor ranking fell from 15th position in 1976 to 25th place in 1982. Fortunately, Thomson Semiconducteurs did not suffer from a lack of investment, either in R&D or capital, and did have a good technology base already installed. What was lacking was a strategic plan.

Given this dilemma, Gomez started virtually afresh. He persuaded Texas Instruments veteran Jacques Noels to leave his post as president of Texas Instruments, France, to run Thomson Semiconducteurs. Noels brought in experienced top executives from Texas Instruments, Motorola, and other semiconductor manufacturers. By mid-1983, the time was ripe for Thomson to move. The world semiconductor markets were emerging from the longest semiconductor down period in their history, and a revitalized, aggressive Thomson began to emerge from the foray.

By the end of 1983, the company had already achieved a substantial turnaround. Thomson's worldwide semiconductor revenues had increased to $195 million, up 32 percent from 1982, against a market growth of 26 percent. Only one other European-owned semiconductor company, SGS-Ates, under the equally dynamic leadership of Pasquale Pistorio, achieved a comparable performance. Tables 1 and 2 give DATAQUEST's estimates of Thomson's worldwide and European semiconductor revenues for 1978 through 1983.

PRODUCTS AND MARKETS

Thomson is a broad range semiconductor manufacturer covering all the major IC and discrete product categories except optoelectronic devices. These are manufactured within the Thomson group, but by a separate division not currently integrated into Thomson Semiconducteurs. The single, most important item missing from the product line is the MOS dynamic RAM. DATAQUEST expects Thomson to make a substantial commitment to this market segment before the end of 1984, since we believe that it will not be possible for Thomson to be among the top 10 world semiconductor suppliers without a significant DRAM presence.

The MOS division, headed by Marc Lassus (ex-Motorola/Matra-Harris), is already active in the other MOS memory areas--for example, static RAMs and EPROMs, both in NMOS and CMOS technology. We expect EEPROM devices to be announced shortly.

On the microprocessor side, Thomson has backed the Motorola 6800/68000 8-bit and 16-bit families (MOS), and the AMD 2900/9400 4-bit families (bipolar). The 5-year-old technology and product exchange agreement signed with Motorola in 1978 is about to be renewed, and we believe that it will be extended to cover the 68020 32-bit microprocessor family. DATAQUEST believes that such an agreement would be-of immense benefit to both parties and is a natural extension of the existing agreement.

In the newer IC growth area of Application Specific ICs (ASICs), Thomson aims to be a major contender, both in full custom and gate arrays. For example, a Thomson custom IC is currently used in a smart card application, and a gate array IC in the Thomson-Brandt personal computer.

The company continues to strongly support discrete devices, especially in the areas of power devices, RF transistors, and zener diodes (where Thomson is the number two supplier worldwide after Motorola). We believe that Thomson plans to enter the smart power device area during the next 12 to 18 months. Furthermore, given its strong government and military participation, DATAQUEST expects Thomson to be a major contender in the GaAs product areas.

The European sales and marketing organization has recently been reorganized as part of Thomson's program to expand its non-French European revenues. In 1983, DATAQUEST estimates that France accounted for around 46 percent of Thomson's worldwide semiconductor revenues, or $92 million. We expect this to decrease to 20 to 25 percent by 1990. This reduction does not reflect a decreasing importance of the local market, but rather a decision, for the first time, to seriously address the world semiconductor markets.

Because of the broad nature of the French market, and its importance both in European and worldwide terms, DATAQUEST believes that Thomson has a natural role to play here. This is especially important in the French military equipment industry, where Branche Equipment et Systémes (BES), Thomson-CSF's military division, with 1983 revenues of $2.6 billion, is currently the second largest worldwide manufacturer behind Hughes and ahead of Raytheon. Also of strategic importance are the automotive (Renix) and consumer (Thomson-Brandt) end-user segments.

Thomson currently supports all the major end-use market areas, though it is placing particular emphasis on the automotive, government and military, and telecommunications market areas.

CURRENT YEAR HIGHLIGHTS

DATAQUEST believes that Thomson's worldwide semiconductor revenues are likely to grow by approximately 65 percent in 1984, reaching approximately $320 million. This is almost twice the rate of the worldwide market, which is forecast to grow by only approximately 38 percent in the same time frame. Mr. Noels' plan calls for a further 50 percent growth in 1985, climbing to more than $0.5 billion dollars.

In addition, while 1983's IC revenues accounted for approximately 50 percent of the total semiconductor revenues, we expect them to increase to around 56 percent in 1984, and to more than 75 percent by 1990. Thomson is achieving this by placing a strong emphasis on the high-growth IC product and market areas.

Preliminary first half-year results, both in bookings and billings, show Thomson ahead of plan. Exports in 1984 are estimated to account for 65 percent of the total worldwide revenues--one year ahead of Noels' original goal. In Europe, Thomson's market share has increased from 4.7 percent in 1983 to around 5.2 percent.

U.S. MARKET KEY TO FUTURE SUCCESS

For Thomson to be in the top 10 worldwide semiconductor manufacturers, DATAQUEST believes that it must succeed in the world's biggest market--the United States. Presently, Thomson's U.S. manufacturing capability is restricted to the RF discrete facility in Montgomeryville, PA (near Philadelphia), originally purchased from Solid State Scientific Inc. in 1979. DATAQUEST believes that this facility will need to be supported by a network of design centers, and eventually, a full IC manufacturing capability.

In addition, a complete sales organization has been set up in Canoga Park, near Los Angeles. Both this facility and the Montgomeryville operation report into a consolidated U.S. operation headed by Jacques Fauque, Vice President of Thomson Components U.S., and General Manager of the Semiconductor headquarters in Rutherford, NJ. The U.S. sales plan calls for a near doubling of sales in 1984 over 1983, and reaching around $350 by 1988.

DATAQUEST ANALYSIS

DATAQUEST believes that there has been a significant change in mood among some of the European electronics companies. Some European success stories have already emerged; Ericsson, Ferranti, Nixdorf, Olivetti, SGS-Ates, and Sinclair, for example. We believe that others, including Inmos, Thomson, and Siemens, are also enroute to success. We further expect these ranks to increase over the next few years.

The one ingredient that is common to all these companies is a changed management philosophy. The new management teams are determined to competitively develop and produce new products for world markets in a free market environment. Protectionism and tariff barriers are becoming less vital ingredients for these companies. Rather, they have become more willing to break the barriers of industrial tradition and restrictive and inflexible working practices.

Thomson Semiconducteurs currently shows all the signs of following these trends. With the current growth in the worldwide and European electronics industries, and the company's adequate access to high technology, DATAQUEST believes that Thomson Semiconducteurs is well on its way to rejoining the top ten world semiconductor companies.

(This newsletter was first published by DATAQUEST's European Industry Service and is reprinted with its permission.)

Jean Page
Malcolm G. Penn

Table 1

ESTIMATED WORLDWIDE SEMICONDUCTOR REVENUES
(Millions of Dollars)

	1978	1979	1980	1981	1982	1983
Total Semiconductors	140	171	221	180	148	195
Integrated Circuits	40	51	81	59	60	99
Discrete	100	120	140	121	88	96
Optoelectronics	0	0	0	0	0	0
Exchange Rate: FFr/US$	4.51	4.25	4.23	5.43	6.57	7.62

Table 2

ESTIMATED EUROPEAN SEMICONDUCTOR REVENUES
(Millions of Dollars)

	1978	1979	1980	1981	1982	1983
Total Semiconductors	130	159	186	144	133	157
Integrated Circuits	40	51	81	59	58	79
Discrete	90	108	105	85	75	78
Optoelectronics	0	0	0	0	0	0
Exchange Rate: FFr/US$	4.51	4.25	4.23	5.43	6.57	7.62

Source: DATAQUEST
August 1984

Nielsen Dataquest

RESEARCH BULLETIN

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CHMOS--TECHNOLOGY TARGETING
INTEL ANALYST MEETING

At an analyst meeting held on July 26, 1984, in Palo Alto, California, Intel reaffirmed its image as a technology leader among semiconductor manufacturers. Andy Grove, President and COO of Intel, described the company's strategy as "wrapping engineering around wafers."

Announcing that the company plans to quit the bipolar market by the end of 1985 and cease production of NMOS DRAMs by mid-1985, Jack Carsten, Senior Vice President and General Manager Components Group stated Intel's commitment to CHMOS technology. Mr. Carsten cited DATAQUEST estimates that show the CHMOS market in 1989 as larger than the total IC market today, and said that Intel plans to increase its CMOS output from 12 percent of total production in 1984 to 50 percent by 1986.

CHMOS is really an umbrella name for a range of advanced CMOS processes. Building on the basic HMOS technology are N-well and P-well alternatives. Both the N-well and P-well alternatives have double-poly versions, with N-well offering advanced thin dielectrics and P-well offering a double-metal alternative. The advantages of using this building block approach to CHMOS are the cost and time reductions in process development. The variety of processes enables processes to be optimized for different applications.

Virtually all new designs at Intel will use CHMOS; Intel plans to introduce more than 20 new CHMOS products by the end of 1984. The flagship of Intel's CHMOS product line will be the 256K DRAM recently announced. Intel does not expect to see a comparable product on the market for at least 18 months.

Intel has taken a number of steps to achieve the capacity required both for this push into CHMOS and to support demand for its microprocessor families. The company has adopted a program of die contracting to support demand for its older products. In die contracting, other manufacturers are qualified by Intel to run Intel processes and produce wafers. Intel undertakes test and assembly and supports the devices after sale. Three manufacturers are now fully qualified by Intel and the company expects 5 percent of its production to be from die contracting by the end of 1984. The majority of the die contracted parts are bipolar and older HMOS devices.

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Die shrinks are another method of increasing capacity. Between 1981 and 1984, Intel shrank its 8051 microcontroller to 50 percent of its original size.

Intel also has an aggressive program for building capacity. The company's new facility in Albuquerque, New Mexico, began production in April of this year and is beginning to ramp up to full capacity. The facility recently went to 7-day, 168-hour operation. Albuquerque is the first 150-mm (6-inch) facility to be built and Intel has had to cope with the problems of debugging totally new equipment. However, the company plans to convert all its capacity to 150-mm beginning this year. A new wafer fabrication facility in Jerusalem, Israel, is scheduled to begin production in mid-1985. Intel plans capital expenditures of $350 million in 1984, and Gordon Moore, Chairman and CEO, has said that he expects 1985 capital expenditures to be at least as high as in 1984.

DATAQUEST ANALYSIS

Intel has long maintained an image as a leading-edge technology manufacturer, and the company's commitment to CHMOS is consistent with that image. Viewing the product line as split between commodity products (such as standard memory) and value-added products (such as microprocessors and peripherals), Mr. Moore commented that commodity products represented the lowest percentage of total products in Intel's history this year. As CMOS becomes the major technology of the 1980s, Intel will need to succeed in the implementation of its CHMOS program to retain its leadership position.

Jean Page

Nielsen Dataquest USER UPDATE

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WORLDWIDE INTEGRATED CIRCUIT PRICING: USER COST SAVINGS OPPORTUNITIES

Semiconductor users that can buy their parts in the world markets can considerably reduce their purchasing costs. Table 1 shows pricing of logic and memory ICs in the United States, Japan, and Europe. Prices and trends differ in each of these major semiconductor markets. Japanese prices are by far the lowest, U.S. prices are the highest, and European prices are in the middle.

Both contract and spot market prices are quoted in the table. Contract prices are for quantities of 500,000 units or greater for logic, and for quantities of 100,000 units or greater for memory. Spot prices are based on any quantity.

PRICE TRENDS: LOGIC INCREASING, MEMORY DECREASING

Logic prices in all markets have been increasing and are expected to continue to increase throughout 1984. U.S. prices have been increasing since mid-1983, while European and Japanese increases started in early 1984. Japanese prices have increased 10 to 15 percent, while U.S. and European prices have gone up more dramatically. DATAQUEST expects average logic selling prices in Europe and the United States to be equal by third quarter 1984. Average selling prices in Japan are expected to remain lower than U.S. prices for the foreseeable future.

Memory prices have been decreasing on all markets and are expected to continue to decrease. Prices in Japan are by far the lowest. DATAQUEST believes that memory prices worldwide will move toward the Japanese price levels as availability improves during 1985.

U.S. companies with worldwide purchasing capability have been able to take advantage of lower memory and logic prices outside the United States.

PRICE SUMMARY BY REGION

United States

Prices have remained high in the United States relative to Europe and Japan because of the very strong U.S. semiconductor recovery. Because the recovery started earlier and has grown rapidly, U.S. logic prices have increased more than in the other regions and memory prices have decreased less. DATAQUEST believes that logic prices will not grow as rapidly in the United States in 1985 and that memory prices will decrease faster than in Europe and Japan.

Japan

Logic prices in Japan have remained low in spite of severe product shortages similar to those experienced in the rest of the world. DATAQUEST believes that a two-level pricing structure exists in this market. Products are being manufactured and sold in Japan at the contract prices shown in the table, while products being imported into Japan by U.S. manufacturers appear to be selling for prices near U.S. price levels. DATAQUEST expects the prices for Japanese manufactured goods sold in Japan to increase 15 to 20 percent in constant currency terms during 1984.

Memory prices in Japan are expected to decrease more slowly than in other regions in 1985 because of the already lower levels.

Europe

European prices are lower than U.S. prices in spite of the 17 percent duty that must be paid for imported products. DATAQUEST believes that this price gap between the United States and Europe will narrow during 1985, but that memory prices will remain lower in Europe.

EFFECT OF EXCHANGE RATES

The increasing strength of the U.S. dollar against foreign currencies has caused prices in Europe and Japan to increase more slowly or decrease faster than prices expressed in the local currency. This has had the effect of making prices in Europe and Japan more attractive to U.S.-based companies than they might otherwise have been. DATAQUEST believes that the current exchange rates, coupled with more conservative attitudes toward increasing prices in Japan, have caused the significant disparity between U.S. and Japanese prices.

Stan Bruederle

Table 1

WORLDWIDE PRICING--SECOND QUARTER 1984
(Prices in U.S. Dollars)

Product	United States		Japan		Europe	
	Contract	Spot	Contract	Spot	Contract*	Spot
LOGIC						
74LS00	$0.21	$0.25-$1.00	$0.12	$0.16-$3.00	$0.19	$0.25-$1.00
74LS74	$0.25	$0.35-$1.00	$0.17	$0.22-$2.00	$0.23	$0.35-$1.00
74LS160	$0.37	$0.48-$1.30	$0.32	$0.36-$1.00	$0.40	$0.55-$1.30
74LS244	$0.63	$0.75-$1.60	$0.60	$0.75-$2.25	$0.65	$1.00-$1.70
74LS373	$0.63	$0.75-$1.90	$0.50	$0.65-$1.75	$0.60	$0.80-$2.00
MEMORY						
64K DRAM (150 ns)	$3.80	$4.50-$7.50	$2.50	$3.00-$3.75	$3.35	$4.00-$7.00
16K SRAM (6116-3)	$3.50	$4.75-$5.50	$2.50	$2.90-$3.10	$2.85	$3.00-$5.00
64K EPROM (2764-3)	$6.00	$7.50-$8.50	$3.65	$4.20-$4.90	$4.25	$3.50-$6.50

*Notes:

Logic contract quantity: 500,000 units; memory contract quantity: 100,000 units

Contract prices are quoted for new contracts starting in the second quarter of 1984.

Spot prices are the range of prices quoted for one-time purchases of product directly from the manufacturer, through distributors, or from brokers.

Exchange rate: $1.00 = ¥235, DM 2.75, £1.39, FFr8.4

Source: DATAQUEST

SUIS Code: Newsletters
No. 84-12

DEFENSE ELECTRONICS INDUSTRY UPDATE: GLOBAL GROWTH

SUMMARY

DATAQUEST estimates a 15.8 percent growth in U.S. military semiconductor consumption from $1.159 billion in 1984 to $1.342 billion in 1985. We expect 1984 consumption to surpass that of 1983 by 15.9 percent, as shown in Table 1. Integrated circuits are projected to increase to $1.097 billion in 1985, up from an estimated $0.941 billion in 1984; discrete devices will increase to $0.245 billion in 1985, up from an estimated $0.218 billion in 1984, as shown in Figure 1.

We expect a 15 percent compound annual growth rate (CAGR) in military semiconductor consumption from 1985 through 1987. We then expect a decline in the CAGR to 13 percent from 1987 to 1988; a significant drop to 10.6 percent from 1988 to 1989; continuing down to 9.5 percent by 1990, due to administrative changes and defense budget cuts. Table 2 shows the estimated U.S. military semiconductor consumption from 1983 through 1990.

DATAQUEST estimates that U.S. user demand for military semiconductor devices increased to 50 percent during the first and second quarters of 1984. This unprecedented demand pushed the fourth quarter 1983 883- and 38510-qualified device lead times of 18 to 26 weeks out to 18 to 40 weeks during this time. The supply/demand problems plaguing both manufacturers and users of military semiconductors during the first and second quarters of 1984 are expected to continue through the rest of 1984, resulting in the following DATAQUEST predictions:

- Third and fourth quarter 1984 prices are expected to increase 5 percent over second quarter prices.
- Military semiconductor manufacturers will maintain allocation programs through the fourth quarter of 1984.
- Second quarter 1984 lead times of 18 to 40 weeks will be extended through fourth quarter 1984.

MILITARY SEMICONDUCTOR FORECAST

Production increases of military-standard devices are not expected until the third quarter of 1984. We expect continued capacity problems to cause shortages in 38510-qualified devices, with product availability late in the fourth quarter of 1984 and in the first quarter of 1985. Overall prices are not expected to increase in 1985 over fourth quarter 1984 prices. Allocation programs for various military-standard devices will continue through the first and second quarters of 1985. We believe that fourth quarter lead time estimates of 18 to 40 weeks will be extended through the second quarter of 1985.

We expect military-standard product acquisition in the first half of 1985 to be further complicated by three major factors:

- Implementation of revised military specifications
- Voluntary and/or involuntary removal of products and manufacturers from the Department of Defense (DoD) qualified parts list (QPL)
- Enactment of the Defense Appropriations Act, Section 794, of March 1984, and the Small Business Administration Act H.R. 2133, of May 1984

These issues are discussed further in SUIS Volume I, Section 4, Prices and Lead Times.

FUTURE TRENDS

DATAQUEST projects a 19 percent increase in DoD electronics procurement from 1984 to 1985. The DoD budget emphasis on research and development, and procurement for the MX missile, B-1 bomber, Trident II, Stealth, VHSIC, M1-tank, and Command, Control, and Communications of Intelligence (C^3I) programs indicate an increased demand for improved electronic technologies. The DoD's C^3I 1983 program budget of $14.5 billion, grew to $16.0 billion in 1984, with an expected increase to $18.0 billion for fiscal year 1985. The C^3I budget is expected to command 6.9 percent, ($25 billion) of the DoD budget by 1988. Funding for the B-1 and Stealth bombers is expected to account for $500 million of the DoD budget through 1988. The M-1 tank program budget is expected to be $720 million for the next four years. The DoD's VHSIC budget estimates grew to $120.1 million in 1984, up from an estimated $66.0 million in 1983. The VHSIC program is expected to reach $120.3 million by 1985.

Key electronic product/technology areas that will be affected by this DoD program growth are:

- Memories
- Bipolar and MOS logic

- Microprocessors and related circuits
- Semicustom and custom
- Radiation-hardened devices
- CMOS
- Gallium arsenide (GaAs)

MOS memory consumption is expected to grow from 6.0 to 6.5 percent through 1989, with heavy emphasis on CMOS static RAMs, EPROMs, and EEPROMs. MOS memories, MOS logic, and MOS microprocessor consumption is expected to increase 15 percent through 1986.

Military custom and semicustom IC use is expected to increase to $120 million in 1985, up from an estimated $83 million in 1984, for application in smart bombs and battlefield systems.

Radiation-hardened devices will represent 11 percent of the $1.159 billion U.S. military semiconductor market in 1984, increasing to 12 percent of the 1985 market, and up to 13 percent in 1986, as demand increases for electronic insertion to military space systems.

As manufacturers move toward submicron processes, CMOS technology, and GaAs ICs, we expect that GaAs semiconductors will represent a growing portion of the 1986 military electronic market. DATAQUEST estimates that $100 million will be spent by the Defense Advanced Research Project Agency (DARPA) to develop very high-speed, moderate- to low-power dissipation rad-hard GaAs that can survive nuclear blasts. We expect GaAs ICs to represent $600 million in military consumption by 1987. Honeywell, of Richardson, Texas, under a DARPA contract award, is building a 3-inch GaAs pilot production line, with GaAs logic array availability expected by 1985. Estimated costs of 3-inch wafer GaAs facilities range from $20 million to $40 million per line. Table 3 lists the sources currently involved in GaAs research and development for the military.

MILITARY MARKET

DATAQUEST projects U.S. and European military semiconductor consumption to grow at a CAGR of 17 percent during the next four years. Table 4 shows the estimated military semiconductor consumption of the United States and Europe from 1983 through 1988. The Japanese military investment/spending is limited to 1 percent of the Japanese gross national product (GNP). However, it should be noted that Japan has seen an 8.6 percent increase in military investment to 0.9 percent of the Japanese GNP, up from an estimated 0.8 percent of the 1983 GNP.

CONCLUSION

DATAQUEST believes that the growing demand from the military community for electronic equipment and semiconductors will exceed the source of supply available from manufacturers of these military-grade devices. Although major U.S. semiconductor manufacturers are producing more ICs and discrete devices screened to military specifications for military consumption, the sources of supply are few. We expect that the military standard semiconductor user community will continue to experience long lead times into the first two quarters of 1985. Niche market contractors and subcontractors are expected to benefit from this situation through DoD program extensions. As user/supplier delivery dates lengthen, the DoD will accommodate both users and suppliers of military semiconductors by stretching program budgets.

Mary A. Olsson

Table 1

ESTIMATED U.S. MILITARY SEMICONDUCTOR CONSUMPTION
1983-1984
(Millions of Dollars)

	1983	Percent Change 1983-1984	1984	Percent Change 1984-1985	1985
Discrete Devices	$ 190.0	14.7%	$ 218	12.4%	$ 245
Integrated Circuits	810.0	16.1%	941	16.6%	1,097
Total	$1,000.0	15.9%	$1,159	15.8%	$1,342

Source: DATAQUEST
July 1984

Figure 1

ESTIMATED INCREASE IN MILITARY SEMICONDUCTOR CONSUMPTION
1984-1985
(Millions of Dollars)

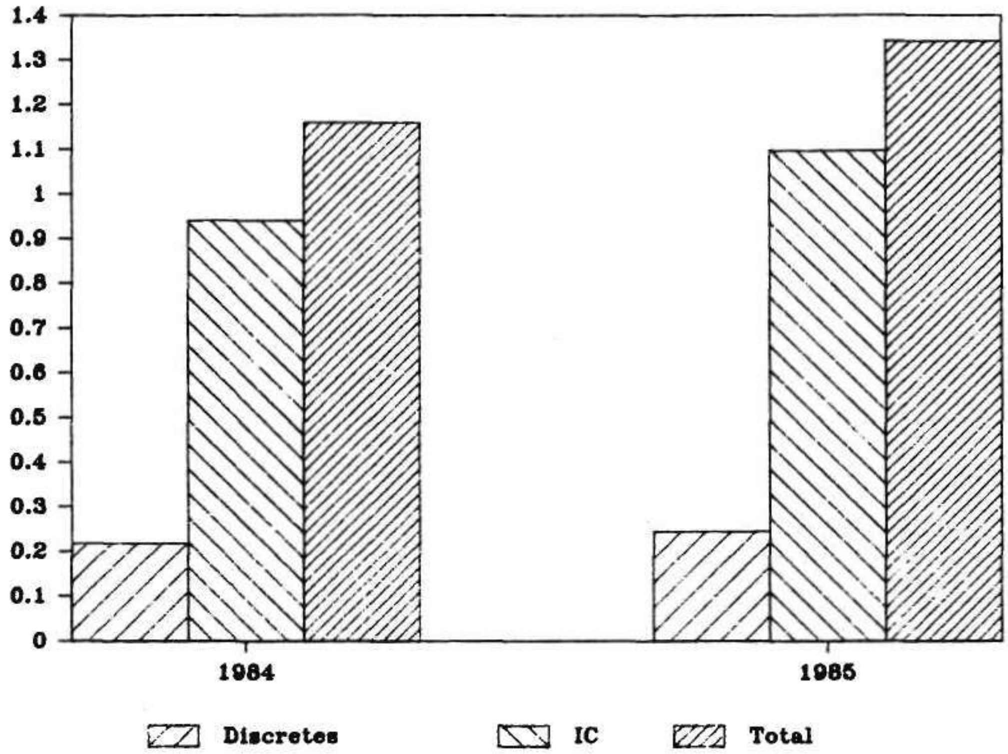


Table 2

ESTIMATED U.S. SHIPMENTS OF SEMICONDUCTORS
TO THE MILITARY MARKET
1983-1990
(Millions of Dollars)

	1983	1984	1985	1986	1987	1988	1989	1990
Discretes	$ 190	$ 218	$ 245	$ 269	$ 296	$ 316	$ 331	$ 347
ICs	810	941	1,097	1,271	1,479	1,681	1,878	2,072
Total	$1,000	$1,159	$1,342	$1,540	$1,775	$1,997	$2,209	$2,419

Source: DATAQUEST
July 1984

Table 3

SOURCES OF MILITARY GaAs RESEARCH & DEVELOPMENT
1984

Cornell University
Gigabit Logic
Harris Corporation
Honeywell, Inc.
Hughes Aircraft Company
Mayo Foundation
McDonnell Douglas Corporation
Microwave Semiconductor Corporation
MIT
Ortel Corporation
Raytheon Company
Rockwell International Corporation
Texas Instruments, Inc.
TRW, Inc.
United Technologies Corporation

Table 4

ESTIMATED MILITARY SEMICONDUCTOR CONSUMPTION
1983-1988
(Millions of Dollars)

	1983		1984		1985		1986		1987		1988	
	IC	Discrete	IC	Discrete	IC	Discrete	IC	Discrete	IC	Discrete	IC	Discrete
United States	$810	$190	$941	$218	$1,097	$245	$1,271	$269	$1,479	$296	$1,681	$316
Europe	$124	$182	$156	$211	$ 201	$249	$ 262	$292	$ 340	$354	$ 441	$431
Japan	N/A		N/A		N/A		N/A		N/A		N/A	

N/A = Not available

Source: DATAQUEST
July 1984

Nielsen Dataquest

USER UPDATE

SUIS Code: Newsletters
No. 84-11

DYNAMIC GROWTH--AN UPDATE ON THE 256K DYNAMIC RAM

INTRODUCTION

Shipments of 256K DRAMs are expected to increase from 1.7 million in 1983 to 700 million in 1986. Such a dramatic rise in forecast consumption demands the potential user's attention. This newsletter gives an update on the status of the 256K DRAM market in light of the introduction of the first commercial CMOS version of the device.

THE MARKET

Current DATAQUEST estimates suggest that the 256K DRAM market will grow faster than we estimated in our earlier newsletter on this subject ("The 256K DRAM Market Gains Momentum," October 24, 1983). Table 1, which gives our estimates of unit shipments for 1983 through 1986, shows a dramatic increase in shipments from 1.7 million units in 1983 to 700 million units in 1986.

Table 1

ESTIMATED 256K DRAM SHIPMENTS
(Millions of Units)

1983	1984	1985	1986
1.7	40	200	700

Source: DATAQUEST
June 1984

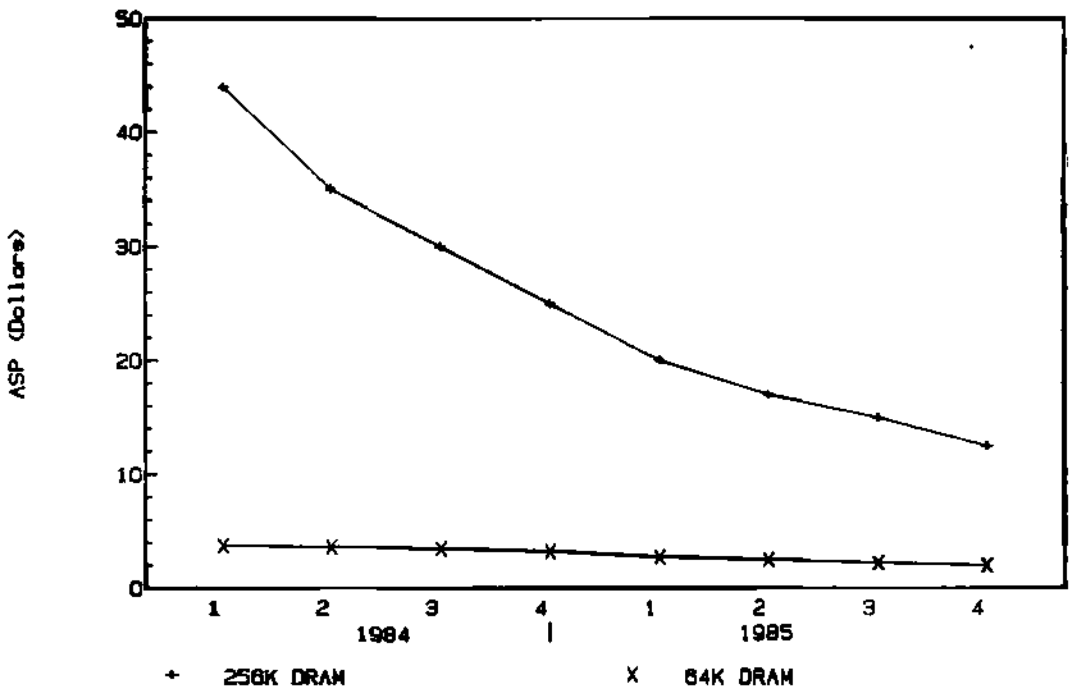
In 1983, Japanese suppliers dominated the market with well over 90 percent of all shipments. Our estimates for the first half of 1984 suggest that the Japanese market share is still in excess of 90 percent, and much of the U.S. share is produced by AT&T Technologies, Inc. (formerly Western Electric), which is a predominantly captive supplier.

PRICES

Average selling prices (ASPs) for 256K DRAMs are showing the rapid decline that is typical of a product in its introductory phase. Figure 1 shows DATAQUEST estimates of the quarterly ASPs for 1984 and 1985 for both 64K and 256K DRAMs.

Figure 1

AVERAGE QUARTERLY U.S. SELLING PRICES FOR 256K DRAMS



Source: DATAQUEST
June 1984

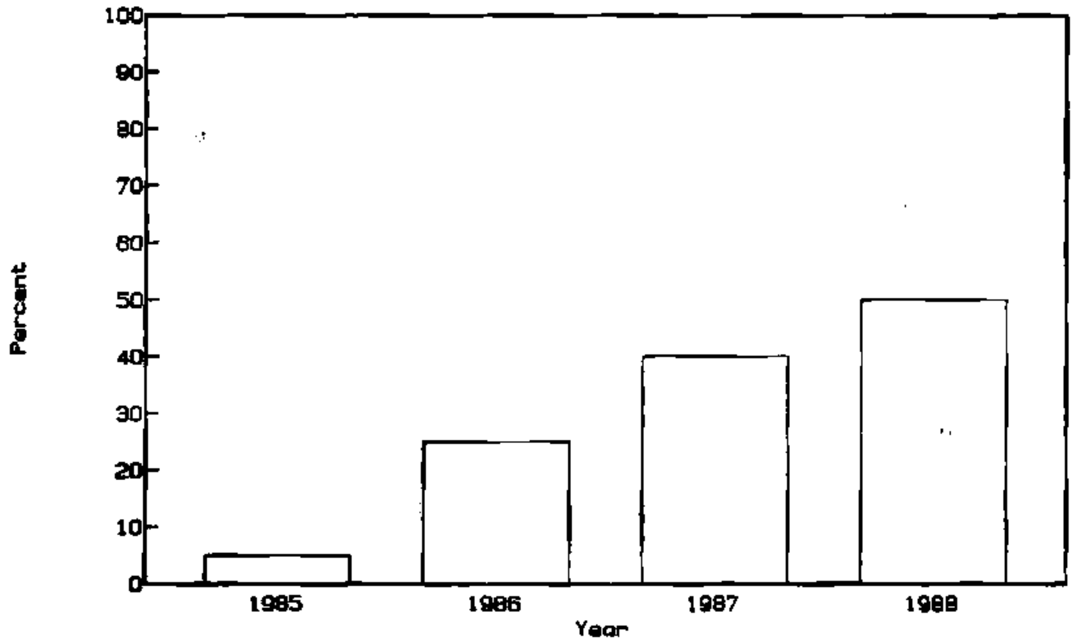
The other significant price trend that has become apparent is the difference between prices in Japan and in the United States. Current Japanese prices are as much as 25 to 30 percent lower than those in the United States. DATAQUEST expects this price differential to continue for at least two years.

THE TECHNOLOGY

Until now, the predominant technology for 256K DRAMs has been NMOS. However, with Intel's introduction of a CMOS part on June 18, 1984, the picture is beginning to change. Figure 2 shows DATAQUEST estimates of the percentage of CMOS 256K DRAMs for 1985 through 1988.

Figure 2

CMOS SHARE OF 256K DRAM UNIT SHIPMENTS



Source: DATAQUEST
June 1984

By the end of 1985, we expect 5 percent of 256K DRAM shipments to be CMOS, and this percentage is expected to ramp up steadily to 50 percent by 1988. The advantages of CMOS are low power consumption--making it appropriate for portable systems such as lap-top computers--and low heat dissipation, which makes it possible to design denser electronic circuits without the problems of overheating.

In addition to Intel, Advanced Micro Devices, Inmos, and Motorola have all announced their intentions of entering the CMOS 256K DRAM market. DATAQUEST expects a number of Japanese companies to offer devices by early 1985. NEC Electronics already has a CMOS 64K DRAM available and is likely to be an early contender in the marketplace. We also expect Japanese companies such as Toshiba and Fujitsu, which have strong CMOS capabilities, to offer CMOS 256K DRAMs.

Portable personal computers can benefit from the advent of high-density CMOS DRAMs because these devices will enable computer manufacturers to offer larger amounts of memory in the basic configuration of their machines. This in turn will enable software designers to offer the user-friendly software demanded by today's computer user.

THE DEVICES

Early analysis of the 256K DRAM market suggested that it would be substantially more fragmented than earlier DRAM markets. Organizations using the x4 or x8 configuration were anticipated. So far, we have not seen these niche markets developing as quickly as we had expected. In 1984, we expect 95 percent of 256K DRAMs to be 256Kx1 in organization. We do, however, anticipate the growth of the other areas in the future. By 1988, DATAQUEST predicts that architectures other than 256Kx1 could account for as much as 35 percent of the market.

CAPACITY

DATAQUEST expects capacity for 64K DRAMs to increase substantially during the next few months. As Figure 3 shows, we expect a changeover from excess demand to excess capacity to occur by the beginning of 1985. This new capacity will be capable of being used for either 64K or 256K devices, and we expect many manufacturers to increase their production of 256K devices as price pressure on the 64K DRAM increases during 1985. Companies that have announced plans for 64K/256K facilities additions are listed in Table 2.

Table 2

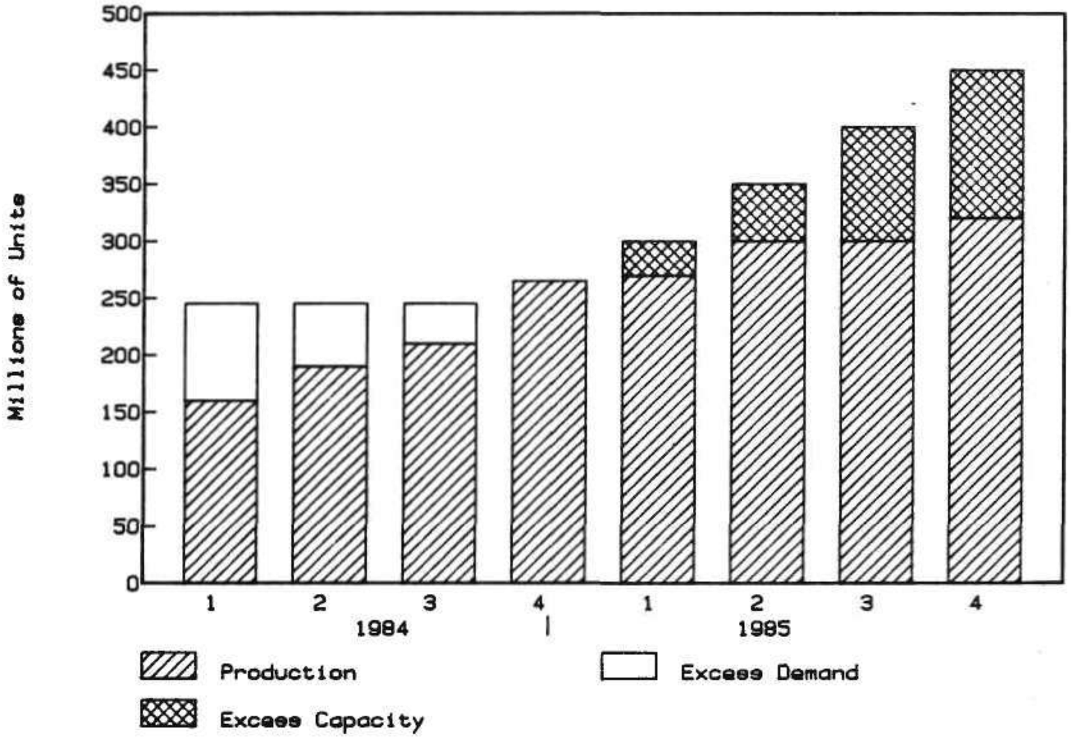
COMPANIES ADDING FABRICATION CAPACITY FOR DYNAMIC RAMS

Company	Comments
Fujitsu	Fujitsu has announced planned expenditure of $444 million for new facilities in fiscal 1984. Part of this investment will be for the construction of a development center and production facility for LSI products, including 256K DRAMs, in Kuwana, Japan. The company is also planning to assemble 256K DRAMs at its San Diego, California, facility.
Hitachi	Hitachi has announced plans for two new MOS wafer fabrication facilities in Japan. The two facilities will cost a total of $170 million and are expected to be operational in the second half of 1985. In April 1984, Hitachi announced plans to expand its Irving, Texas, assembly facility. The facility, which handles 64K and 256K DRAMs, will have a capacity of 1.2 million units per month--an increase of 20 percent over its present capacity.
Mitsubishi	Mitsubishi announced in May 1984 that it would begin work on a second factory building at its Aijo plant in Japan. We believe that this building is intended for the production of 256K DRAMs. After completion of the second building in summer 1985, the total capacity of the plant will be 10 million units per month.
NEC Corporation	NEC announced plans to spend ¥110 billion on semiconductor plants and equipment in 1984. Most of the expansion will be for 64K and 256K DRAM production.
Toshiba	In May 1984, Toshiba announced that it had completed the first phase of construction on a VLSI facility in Oita, Japan. The plant is intended for the production of 64K and 256K DRAMs and other VLSI devices. The facility will have a capacity of 4 million units per month when it is operational.

Source: DATAQUEST
June 1984

Figure 3

WORLDWIDE 64K DRAM SHIPMENTS



Source: DATAQUEST
June 1984

DATAQUEST ANALYSIS

In our earlier newsletter, we suggested that the price per bit crossover for 64K and 256K DRAMs is expected in the second half of 1985. We now expect this crossover to stretch out to the second quarter of 1986, due to the price pressure on 64K devices caused by increases in capacity. A number of companies are planning to offer plastic-packaged devices by the end of 1984, which should also affect the average selling prices of the 256K DRAM. Prices for CMOS devices are more than double those of NMOS products, but are expected to move rapidly down the learning curve.

Jean Page
Lane Mason

Nielsen Dataquest RESEARCH BULLETIN

SUIS Code: Newsletters
No. 84-9

EDIF--SEARCHING FOR A STANDARD INTERFACE FORMAT

OVERVIEW

With more than 105 semiconductor companies, 10 CAD/CAM companies, and a host of OEM companies all participating in the application-specific integrated circuit (ASIC) marketplace, it almost goes without saying that some form of standard design interface is needed. Most of the equipment currently used to design custom and semicustom integrated circuits is based on incompatible formats. As a result, a designer who wishes to use a combination of CAD tools from different vendors must first convert various software formats before completing the design.

A standard interface format would make ASICs more accessible to the user. Since the new standard would provide an interface between various types of hardware and software, the potential for second-sourcing would be greater. The user's selection of design tools would not be a limiting factor in the selection of a supplier.

ENTER EDIF--ELECTRONIC DESIGN INTERCHANGE FORMAT

Bound together by this common problem, seven organizations have formed a committee to seek out a standard interface. The members of this committee are Daisy Systems, Mentor Graphics, Motorola, National Semiconductor, Tektronix, Texas Instruments, and the University of California at Berkeley. Each of the participants has committed to adopt the EDIF once it has been defined. The new standard is intended to provide an interface between the many types of hardware and software used to design, test, and manufacture such ASICs as gate arrays, standard-cell ICs, and custom chips.

The committee wishes to solicit extensive industry comment prior to release of the first EDIF version. Copies of Version 0.8, which is currently being circulated, are available by calling Gwen Larsen at (408) 721-4856. Comments should be submitted by June 15. The next general meeting will be held on July 16. Publication of documentation is targeted for the third quarter 1984 and will reside in the public domain.

DATAQUEST believes several existing languages are being proposed as the starting point for the new standard, including the following:

- TIDAL (Design-Automation Language) from Texas Instruments
- TDF (Technology Definition File) from Motorola and Mentor Graphics
- GAIL (Gate Array Interface Language) from Daisy Systems
- CIDF (Common Interchange Data Format) from National, Tektronix, and UC Berkeley

It should also be noted that once a format has been defined and implemented, the EDIF committee hopes to transfer responsibility for further enhancement and general administration to a recognized standards organization.

DATAQUEST believes that the proposed EDIF standard warrants careful review--particularly since the members of the committee represent an influential group that could establish important standards.

Jean Page
Andrew Prophet

SUIS Code: Newsletters
No. 84-8

TRADITION BREAK FOR TEXAS INSTRUMENTS

INTRODUCTION

In a sharp break with the past, Texas Instruments announced that it will join the World Trade Statistics Program, originally sponsored by the Semiconductor Industry Association. TI has also decided to participate in the Semiconductor Research Cooperative, which was founded to conduct basic research through a pooling of resources.

DATAQUEST believes that TI's willingness to provide confidential sales figures to Price Waterhouse for incorporation with statistics of other U.S, European, and, recently, Japanese manufacturers is part of a strategy to move aggressively in this currently supply-limited market. We see the Dallas-based manufacturer aggressively expanding its gate array, standard cell, and CMOS business in order to keep pace with both the Japanese and with the current U.S. market leaders, Motorola and National. It is our opinion that the CMOS semiconductor market has the highest growth potential of the industry's emerging new product opportunities.

AN AGGRESSIVE NEW STRATEGY

As shown in Table 1, TI is pursuing an aggressive strategy to capture share of the microcontroller and rapidly growing application-specific IC (ASIC) markets. In 1983, TI signed second-sourcing agreements with Seeq and General Instrument for its successful TMS7000 8-bit MCU. In the gate array field, TI has joined with Fujitsu, Japan's strongest semicustom maker, to second-source Fujitsu's bipolar and CMOS arrays. Harris will second-source TI's CMOS gate arrays, which are being designed according to military specifications under the VHSIC program.

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Although TI's sales of CMOS devices have grown at a compound annual growth rate (CAGR) of 35.7 percent since 1980, TI has lost revenues to companies offering CMOS gate arrays, such as LSI Logic. To strengthen its position in the semicustom market, TI has moved aggressively in several directions:

- Developing a 2.0-2.5 um CMOS process in Houston
- Merging its gate array product center and design automation into the Custom Components Division in Dallas and introducing a line of CMOS standard cell logic for integrating 54/74 logic functions
- Adapting its in-house Transportable Integrated Design Automation Language (TIDAL) to run on Apollo 32-bit type workstations
- Licensing its CAD system in exchange for second-sourcing Fujitsu's bipolar and CMOS gate arrays
- Adding 4 design centers in Europe (Bedford, England; Paris, France; Frankfurt, Germany; and Milan, Italy) to its 12 centers in the United States
- Offering two levels of design for its standard cell customers

CONCLUSION

We believe that TI's move to join the World Trade Statistics Program and form partnerships in new technologies to fill voids in its product line will prove helpful in TI's quest to regain its leadership position.

Jean Page
Sheridan Tatsuno

Table 1

TI'S RECENT LICENSING AGREEMENTS AND JOINT VENTURES

Date	Partner	Agreement
Feb. 83	Seeq	Application of Seeq's EEPROM technology to TI's TMS7000 8-bit MCU
Feb. 83	Harris	Harris to second-source TI's 1000- and 2000-gate mil-spec CMOS gate arrays (VHSIC program)
March 83	General Instrument	GI to second-source TI's 8-bit TMS7000 MCU
July 83	VLSI Technology, Inc. (VTI)	VTI to second-source TI's TMS4500A 64K DRAM controller and develop new CMOS circuit for TI's 256K DRAM
July 83	Western Digital	Mutual second-sourcing of Western Digital's communications controllers and TI's universal uP peripherals
Nov. 83	General Instrument	GI to second-source TI's TMS320, an NMOS digital signal processor, and develop a CMOS version
Jan. 84	Fujitsu	TI to provide its CAD design for Fujitsu's bipolar and CMOS gate arrays
May 84	National	Second-source 32-bit MPU

Source: DATAQUEST

SUIS Code: Newsletters
No. 84-7

GENERAL INDUSTRY UPDATE

SUMMARY

Semiconductor consumption continues to increase, although the rapid growth of the last three quarters of 1983 is beginning to moderate. The industry book-to-bill ratio has declined from an all-time high of 1.66 in December 1983 to 1.41 in March 1984. U.S. semiconductor consumption reached an estimated $2,702 million in the first quarter of 1984, an increase of 6.6 percent over the fourth quarter of 1983. This represents a staggering 59.9 percent increase over the first quarter of 1983.

Since demand has increased by almost 60 percent in the course of a year, we expect capacity to be strained. The easy increases in capacity have all been used, and we anticipate slower quarter-to-quarter growth in 1984 than we saw in 1983. Consumption in 1984 is expected to grow by 39.5 percent over 1983 (as shown in Figure 1), and to continue strong growth into 1985. Semiconductor consumption in the United States is expected to reach almost $12 billion in 1984.

RECENT ECONOMIC TRENDS

The U.S. economy appears to be well positioned to continue expanding throughout 1984. The GNP increased at an annualized rate of 8.3 percent in the first quarter of 1984 over the fourth quarter of 1983, the fourth consecutive quarter of strong growth. Other indicators of a strong economy include the continued rise in the industrial production index to 160.7 in March, a moderate 4.1 percent inflation rate, and declining unemployment--the figure for both February and March was 7.8 percent. Some of the moderation in inflation can be attributed to the modest recovery in the rest of the world. Japanese industrial production grew more slowly than that of the United States in 1983, and the European countries have shown only limited growth. The strong dollar has helped bring prices of imports down in the United States.

Developments over the past few weeks suggest that the rapid pace of economic growth is beginning to slow. Such a situation is viewed in a positive light by many economists, since there was some concern that the economy would overheat and cause rapid inflation. Retail sales in March were 2.2 percent lower than in February (seasonally adjusted). Housing starts fell abruptly, and the Index of Leading Economic Indicators declined. Poor weather was only partly a factor. The rate of increase in the industrial production index was slower than it has been for several months.

THE ECONOMIC FUTURE

All the major indicators point to continued expansion of the economy. The current economic situation will be buoyed by the fact that 1984 is an election year and by the financial impact of the Olympic Games in Los Angeles. Every postwar downturn experienced by the U.S. economy has been preceded about 9 to 12 months earlier by a sharp rise in interest rates and a decline in the money supply. Over the past few months, the money supply has grown and interest rates have remained reasonably stable. Considering the strength of the economy in the last year, the modest increase in interest rates has been very encouraging.

DATAQUEST anticipates slower growth for the next two quarters, with the increase in the GNP moderating to an annualized rate of 2 to 3 percent, compared with 8.3 percent in the first quarter. This change is a very positive long-term factor. The more modest growth rate anticipated for the rest of 1984 will increase the duration of the economic cycle.

The major concerns about the U.S. economy center around the federal budget deficit and the trade deficit. The magnitude and intractability of these deficits suggest that the United States may pay for today's economic strength at a later date. It is critical that these problems be moderated.

SEMICONDUCTOR INDUSTRY OUTLOOK

The strong growth in semiconductor consumption is a function of the underlying strength of the economy. Economic growth in recent years has been heavily skewed toward the electronics and high-technology segments, while the more traditional smokestack industries have not fared so well. In the five years from the first quarter of 1979 to the first quarter of 1984, U.S. industrial production grew 4 percent, while U.S. semiconductor consumption grew 149 percent. The pervasiveness of semiconductor devices, which we have frequently noted, has assumed a new aspect. Increasingly complex devices are being used in even the simplest products. Many microwave ovens, for example, are now controlled by 8-bit microcontrollers rather than 4-bit devices.

Table 1 shows our estimates of U.S. semiconductor consumption for the years 1982 through 1984. Consumption is expected to grow 39.5 percent in 1984 over 1983. Growth of integrated circuit consumption will continue to exceed that of discrete devices, with IC consumption growing at 42.2 percent and discrete consumption growing at 25.6 percent.

Table 2 shows our estimates of U.S. semiconductor consumption for 1983 through the first quarter of 1985. In 1984, we expect to see a return to the typical pattern of consumption growth in which the second and fourth quarters show stronger growth than the first and third quarters. This pattern is clearly shown in Figure 2.

The true magnitude of the upturn in semiconductor consumption is shown most clearly by comparing each quarter with the same period a year earlier (see Figure 3). Consumption in the first quarter of 1984 is estimated to be 59.9 percent higher than in the same quarter of 1983. The increase in demand for semiconductors has resulted in a higher book-to-bill ratio, increased backlogs, spot shortages of some products, and improved profits for semiconductor manufacturers.

Such phenomenal growth has obvious implications for the coming months. All the easy semiconductor capacity has been used up. Future growth must come from new facilities, creating stress on the infrastructure of the industry. Semiconductor consumption will be supply limited throughout 1984. Prices are expected to remain relatively firm, although we do expect to see some softening of DRAM prices as new capacity comes on-stream at the end of the year.

The cost of building a wafer fabrication facility increased by a factor of 8 in the last 10 years, a problem compounded by the need to move to the next generation of devices with geometries of less than 2 microns. DATAQUEST anticipates a 62 percent increase in capital spending by U.S. semiconductor manufacturers in 1984 over 1983.

The industry has shown a distinct secular change in its rate of growth. Before 1978, industry growth averaged 13 to 15 percent; but since 1978, growth has averaged more than 20 percent. Even in a slow-growing economy, we believe that the semiconductor industry can continue relatively strong growth. The positive aspects of such a substantial rise in semiconductor consumption are the opportunities for economies of scale and the increased possibilities of niche markets. DATAQUEST expects to see strong growth in many of the new semiconductor companies.

However, in spite of the increase in the growth rate, the semiconductor industry is still a cyclical industry. Shortly after the beginning of the next economic downturn, we expect to see a halt to semiconductor industry growth, caused mainly by price pressure. The last semiconductor industry slowdown was essentially a price recession while unit volume continued to grow. This could be the predominant pattern of future semiconductor industry slowdowns.

Jean Page
Frederick L. Zieber

Figure 1

ESTIMATED INCREASES IN U.S. SEMICONDUCTOR CONSUMPTION
(Percent)

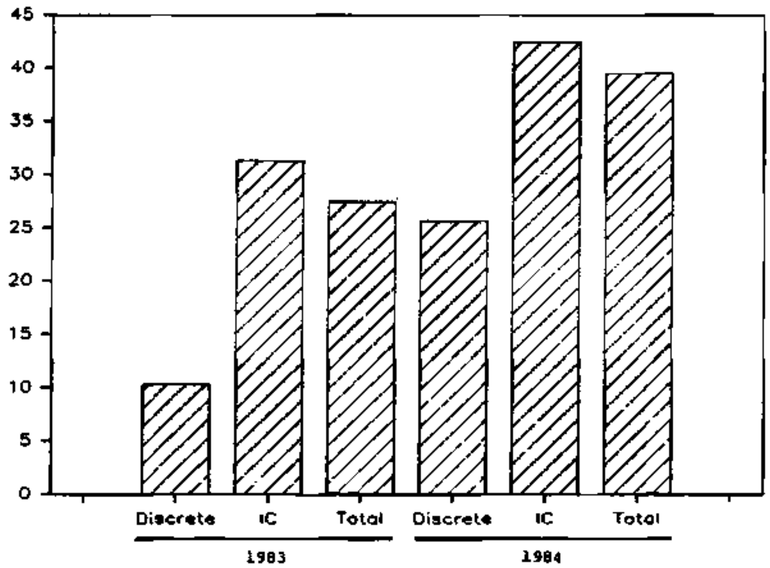


Table 1

ESTIMATED U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1982	Percent Change 1982-83	1983	Percent Change 1983-84	1984
Discrete Devices	$1,248	10.3%	$1,377	25.6%	$ 1,730
Integrated Circuits	5,364	31.3%	7,044	42.2%	10,017
Total	$6,612	27.4%	$8,421	39.5%	$11,747

Source: DATAQUEST
May 1984

Table 2

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1983				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 290	$ 331	$ 354	$ 402	$1,377
Integrated Circuits	1,400	1,652	1,858	2,134	7,044
Total	$1,690	$1,983	$2,212	$2,536	$8,421
Percent Change from Previous Quarter	2.2%	17.3%	11.6%	14.7%	
Percent Change from Previous Year	8.0%	15.7%	31.6%	53.0%	27.4%

	1984				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 404	$ 425	$ 439	$ 462	$ 1,730
Integrated Circuits	2,298	2,480	2,526	2,713	10,017
Total	$2,702	$2,905	$2,965	$3,175	$11,747
Percent Change from Previous Quarter	6.6%	7.5%	2.1%	7.1%	
Percent Change from Previous Year	59.9%	46.9%	34.0%	25.2%	39.5%

	1985				
	Q1	Q2	Q3	Q4	Total Year
Discrete Devices	$ 468				
Integrated Circuits	2,802				
Total	$3,270				
Percent Change from Previous Quarter	3.0%				
Percent Change from Previous Year	21.0%				

Source: DATAQUEST
May 1984

Figure 2

ESTIMATED QUARTERLY INCREASES IN U.S. SEMICONDUCTOR CONSUMPTION (Percent)

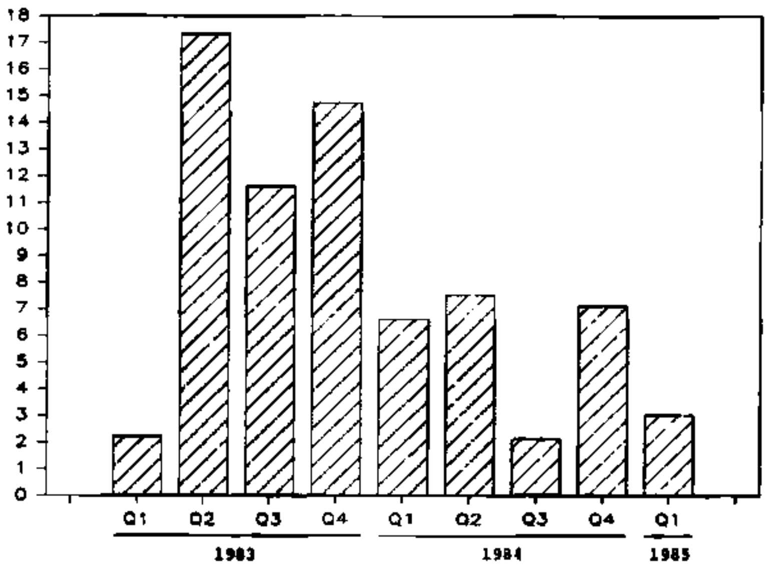
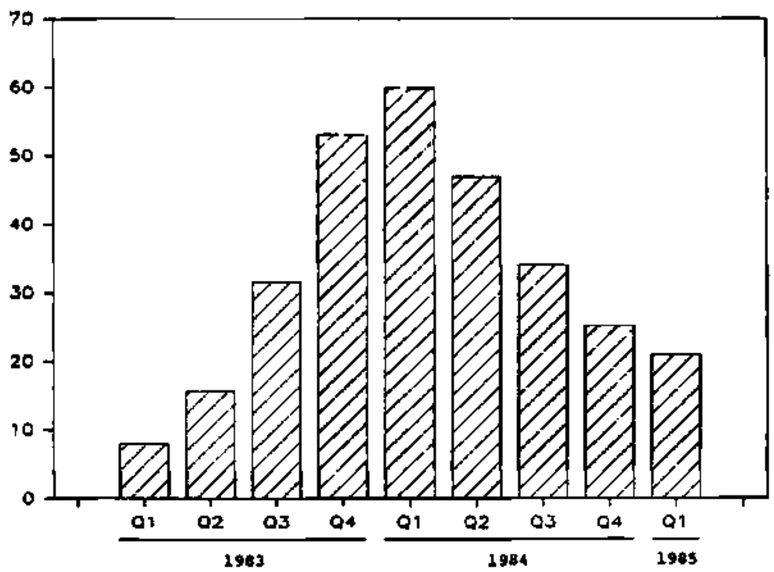


Figure 3

ESTIMATED INCREASE IN U.S. SEMICONDUCTOR CONSUMPTION OVER THE SAME QUARTER OF THE PRECEDING YEAR (Percent)



Source: DATAQUEST
May 1984

Nielsen Dataquest USER UPDATE

SUIS Code: Newsletters
No. 84-6

MILITARY STANDARDIZATION IN THE SEMICONDUCTOR INDUSTRY: MIL-M-38510 AND MIL-STD-883

The Department of Defense (DoD) is continuing to stress, develop, and process electronic device standards and specifications for military semiconductor manufacturers, in an effort to reduce life cycle costs and improve product quality.

This newsletter presents an overview of military standards MIL-M-38510 and MIL-STD-883. We will examine the impact of these standards on the semiconductor industry, and assess the impact of standardization on manufacturers and users of microcircuits for military and aerospace electronic systems.

SUMMARY

We estimate that MIL-M-38510 Joint Army-Navy (JAN) ICs will represent 25 percent of the $1.1 billion U.S. military semiconductor market in 1984. MIL-STD-883 Class B products will represent 70 percent of the 1984 market. Class C and other standard hi-rel ICs used in commercial and hi-rel applications will represent the remaining 5 percent of this market.

We estimate that military semiconductor suppliers will not be able to support the increasing demands for JAN-type ICs. As a result, we expect major shortages of JAN-type ICs throughout 1984, as discussed in the following subsections.

Limited-Capacity Production

At present, semiconductor suppliers of 38510 and 883-type devices are capacity-limited. Historically, military semiconductor consumption growth averages 11 percent per year. However, DATAQUEST estimates a 14.4 percent growth in military semiconductor consumption, from $1 billion in 1983 to $1.144 billion in 1984. This growth is expected to reach 15.8 percent in 1985 as military semiconductor consumption reaches $1.325 billion.

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Demand

In 1981 and 1982, the growth rate and demand for military standard semiconductor products was slow. Approximately 40 percent of Department of Defense funding went to research, development, test, and engineering (RDT&E) in 1982. Military usage of improved electronic technologies surged in 1983, as DoD budget emphasis shifted from RDT&E to on-line production of programs such as the B-1B, AMRAAM, and the Cruise missile. Continued release of these program funds in early 1984, coupled with increased demand for military semiconductor devices, has resulted in military-standard product lead times extending from 24 to 50 weeks.

Cost-Effective Manufacturing

Manufacturers are producing more cost-effective 883B-processed ICs. An estimated 40 percent of the 883B devices are assembled offshore and average 1.4 times the cost of equivalent commercial devices. JAN-38510 devices, which must be manufactured, assembled, and tested in the United States, average 30 to 60 percent more than offshore 883B-processed devices. MIL-STD-883B devices can be used in hi-rel and aerospace applications to replace unavailable 38510 devices. Lead times for 883B products average 20 to 28 weeks, while 38510 lead times average 30 to 52 weeks.

Documentation and Certification Requirements

Extensive documentation is involved in qualifying manufacturing facilities and devices to meet 38510 specifications. Furthermore, the processing steps and line certification approval cycle are lengthy. We estimate that throughput time, i.e., the time required to get a device qualified as JAN is from 6 months to 30 months.

OVERVIEW

Military Standard 883 and MIL-M-38510

Military documents 883 and 38510 were established by the DoD's Solid State Application Board of Rome Air Development Center (RADC). MIL-STD-883 was first published in 1968 and MIL-M-38510 in 1969. RADC introduced MIL-STD-883 as a control and constraint document, with test procedures that would provide good quality semiconductor products. It was intitially written as a standard qualifying test for the first ICs, which were very simple in architecture compared to today's complex MOS ICs.

As new technologies were introduced, MIL-STD-883 was revised and MIL-M-38510 was introduced. MIL-M-38510, the most stringent military specification, provides the agenda for standardization in manufacturing, testing, and qualifying military ICs, while 883 is a compendium of test procedures. Military semiconductor suppliers must adhere to the requirements of MIL-M-38510 to qualify devices for the Defense Electronics Supply Center's (DESC) qualified parts list (QPL). DESC, located in Dayton, Ohio, implements the military standards; supervises certifications of a supplier's fabrication, assembly, and test facility; and determines device qualification. A list of 38510 specifications and standards that must be met for DESC QPL device qualification is as follows:

Specifications:

Military

MIL-M-55565	-	Packaging of Microcircuits

Standards:

Federal

FED-STD-209	-	Clean Room and Work Station Requirement Controlled Environments

Military

MIL-STD-120	-	Marking for Shipment and Storage
MIL-STD-280	-	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms
MIL-STD-883	-	Test Methods and Procedures for Microelectronics
MIL-STD-976	-	Certification Requirements for Microcircuits
MIL-STD-1331	-	Parameters to be Controlled for the Specification of Microcircuits
MIL-STD-45662	-	Calibration System Requirements

<u>38510 Device Certification</u>

Products listed on the QPL-38510 list are certified JAN. "JAN" is a U.S. Government trademark for products that have met all 38510 specification requirements and 883 tests and procedures. JAN devices are eligible for use in Federal Government contracts or orders for products covered by this specification. JAN devices can be manufactured in the same facility used for production of non-JAN devices, with the following exceptions:

- Manufacture, assembly, and test facilities must be located in the United States and its territories.
- The facility must be DESC-certified.
- Only JAN-processed devices are to be marked "JAN" or JM38510.

<u>38510 and 883 Device Classifications</u>

Devices tested and inspected according to 883 test and screening methods are placed into three separate product assurance levels according to end use.

Class S is the highest product assurance level for microcircuit devices. Class S devices meet the reliability and lifetime standards for manned space and satellite programs. Class S devices are subjected to a battery of stress and noise tests, with burn-in times of 240 hours at 125°C, or accelerated burn-in for 72 hours at 150°C.

Class B parts are used in manned or unmanned flight and shipboard or high-reliability ground support systems. Class B parts undergo burn-in times of 160 hours at 125°C.

Class C, the least stringent reliability test class, certifies a device for ground equipment and/or high-reliability commercial use. Class C devices undergo 100 percent inspection and environmental tests, but no burn-in testing.

Device Qualification and Quality Conformance

Device and/or lot quality conformance is determined by MIL-STD-883 group tests.

Group A inspection consists of electrical parameter tests.

Group B inspection provides mechanical and environmental tests to assure design, construction, and package reliability.

Group C inspection is a die-related test performed every three months on randomly selected qualified device lots.

Group D tests are package-related. They are performed every six months and cover all the parts in a package regardless of technology group.

Group E tests determine radiation hardness levels. Sealed semiconductor devices are tested for total dose effects by ionizing radiation from either a Cobalt-60 (60°C) gamma ray source or from an electron accelerator.

Impact of the Military Specification Program: Supplier and User

Military specifications 38510 and 883 were initially developed to facilitate delivery and assure supply of 883B and JAN ICs to the users, and to improve the standardization, reliability and quality of microcircuits for military aerospace electronic systems. Major users surveyed view 883 and 38510 documentation of military devices as a guarantee that these devices will meet more stringent performance requirements over wider temperature ranges in destructive environments, and meet higher reliability levels under these conditions than the equivalent commercial parts.

Military IC semiconductor manufacturers surveyed by DATAQUEST view MIL-STD-883 as a good working document for testing both commercial and hi-rel ICs, with test steps that have improved the quality and yield of device types. Many semiconductor manufacturers have adopted the process control steps and concepts of 38510 in a desire to improve the standards, reliability, and quality of their products.

ANALYSIS

Although military IC suppliers view production of JAN and hi-rel ICs as a long-term market opportunity, and military contracts as financially lucrative, many semiconductor manufacturers have avoided establishing and maintaining JAN-certified lines for the following reasons:

- Maintenance of a separate JAN line is expensive. Capital investment in test equipment alone can exceed $250,000 per tester.

- JAN products are more expensive than 883B and commercial devices due to on-shore assembly costs, lengthy device testing and qualification time, and low-volume production runs.

- The year-to-year growth rate for military semiconductor products is shrinking in comparison to the total U.S. semiconductor growth rate. DATAQUEST's Research Newsletter "Defense Electronics Market Update: Market Growth," dated January 23, 1984, contains further discussion of this growth rate.

RADC is currently working in conjunction with semiconductor industry representatives on revisions of MIL-M-38510 and MIL-STD-883. These revisions are expected to improve quality conformance and test procedures, and define specifications for new leading-edge technologies. RADC expects to issue Appendix F to MIL-M-38510 in June 1984. Implementation of Revision C to MIL-STD-883 is expected in December 1984.

Mary A. Olsson

Nielsen Dataquest

RESEARCH BULLETIN

SUIS Code: Newsletters
No. 84-4

TEXAS INSTRUMENTS' MILITARY SEMICONDUCTOR SEMINAR: "STARS OF THE FUTURE"

Texas Instruments introduced its new family of military semiconductor products on April 10, 1984. Texas Instruments' "Stars of the Future" Lucas-like presentation was delivered from Midland, Texas, via WESTAR satellite, to major cities in the United States. Company spokespersons discussed the following product areas:

- Logic
- Linear
- Memory/microprocessor
- Chip carrier packaging
- Board material
- Connectors
- JAN 38510 and 883B product lines

The introduction of each product segment was followed by a question and answer period, giving the viewing audience the opportunity to question TI product managers and engineers on subjects ranging from pricing, product availability, and packaging to company plans for radiation hardening of memory and microprocessor products.

The seminar was well attended by representatives from government agencies, distributors, and the semiconductor and aerospace industries. The following subjects were of major interest to the viewing audience:

- What is Texas Instruments' position on the Rome Air Defense Center's (RADC) Appendix F to MIL-M-38510 and Revision C to MIL-STD-883?
- What JAN products will be available for 1984 and 1985?
- What is the status of leadless ceramic chip carriers (LCCC)?

Texas Instruments' military division expects to meet the revisions of MIL-M-38510 Appendix F and MIL-STD-883 Revision C by June 1984, with certification from the Defense Electronics Supply Center (DESC) expected by December 1984.

Twenty-seven products have been added to this JAN-38510-qualified program. JAN-38510 qualification is planned in dual in-line and ceramic chip carrier packaging for these products.

Texas Instruments is singing the praises of surface mount assemblies utilizing leadless ceramic chip carriers (LCCCs) for use in military avionics, missiles, ships, and space systems. Company spokespersons reiterated that RADC is presently utilizing LCCC in many 883B-screened products, with plans for use of LCCC JAN-level products in the future. The company expects to have JAN-qualified LCCC products available in the first quarter of 1985. Availability is contingent on installation and DESC certification of automated assembly equipment. The new three-layer LCCC package with 50-mil contact spacings conforms to JEDEC package dimension and pinout standards. TI's Attelboro, Massachusetts, facility has developed a multilayer epoxy-glass board with copper-clad invar power and ground planes to hold the solder-mounted chip carriers. Commitment to the LCCC packaging program is based on supplier test results and data on the reliability of epoxy and polyimide printed circuit boards.

Company packaging managers estimate that new developments in military systems using LCCCs and the recent demand for LCCCs over traditional DIPs and FLATPACKs will drive LCCC costs down. Price parity between FLATPACKs and LCCCs in bipolar logic products is expected by the end of 1984, with parity between DIPs and LCCCs expected by the end of the decade. The popularity of memory and microprocessor products is driving LCCC technology. Microprocessor and memory products in LCCC are reaching price parity with side-brazed packages, with an estimated 20 percent maximum price premium for LCCC over side-brazed expected by the end of 1984.

Texas Instruments has consistently maintained the largest share of the U.S. military semiconductor market. DATAQUEST estimates that TI was the leading military semiconductor manufacturer in 1982 with total military semiconductor shipments of $132 million. We estimate TI's 1983 shipments at $200 million. Forty-six percent of that market share is in bipolar logic, with strong competition coming from Motorola, National Semiconductor, Fairchild, and Signetics.

Recent Defense Department budget plans show an increase in R&D spending from $25 billion in fiscal 1985 to $35 billion by 1989. Defense Department and industry officials are forecasting that a major portion of this R&D money will go to the electronics industry. In terms of long-range planning, Texas Instruments' "Stars of the Future" military semiconductor program is headed in the right direction.

Mary A. Olsson

Nielsen Dataquest USER UPDATE

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No. 84-3

COMBO CHIPS IN THE CODEC/FILTER MARKET

INTRODUCTION

The single-chip codec/filter (combo chip) has been manufactured for captive use by Northern Telecom since 1979, but the merchant market for these chips has only emerged since 1982. DATAQUEST expects combo chips to account for an increasingly large proportion of the codec/filter market in the future. This newsletter estimates market size and average selling prices, lists the participants in the combo chip market, and considers the future trends in the market.

THE MARKET

Significant quantities of combo chips were first shipped in 1982. The worldwide total merchant market for that year was estimated at $2 million. As shown in Figure 1, DATAQUEST estimates 1983 shipments at $10 million and expects total merchant market shipments to reach $60 million by 1985.

The estimated average selling price (ASP) of a combo chip in 1983 was $10, and DATAQUEST expects the ASP of combo chips to decline by 15 percent per year between 1983 and 1990. By 1990 we expect the ASP for a combo chip to be $3.00. Table 1 shows our estimates of ASPs.

THE PARTICIPANTS

Table 2 lists those companies that have announced combo chips, together with second-source information where available.

In 1983, Motorola and Hitachi were the major shippers of combo chips with National Semiconductor in third place. Intel is currently the major merchant supplier of codec and filter devices.

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FUTURE TRENDS

The market for combo chips is expected to grow by 15 percent per year between 1983 and 1990. Currently, there is no price advantage to using a combo chip, but by the end of 1984 the combo chip will be less expensive than the two-chip solution. DATAQUEST expects users to adopt the combo chip for new products rather than redesign existing products, so we do not expect the use of combo chips to exceed that of two-chip products until at least 1986. Two-chip solutions will always command a portion of the market because they offer more flexibility than combo chips.

Combo chips are now being used in some automatic answering devices. Such uses will remain a relatively small part of the total combo chip market--probably less than 10 percent.

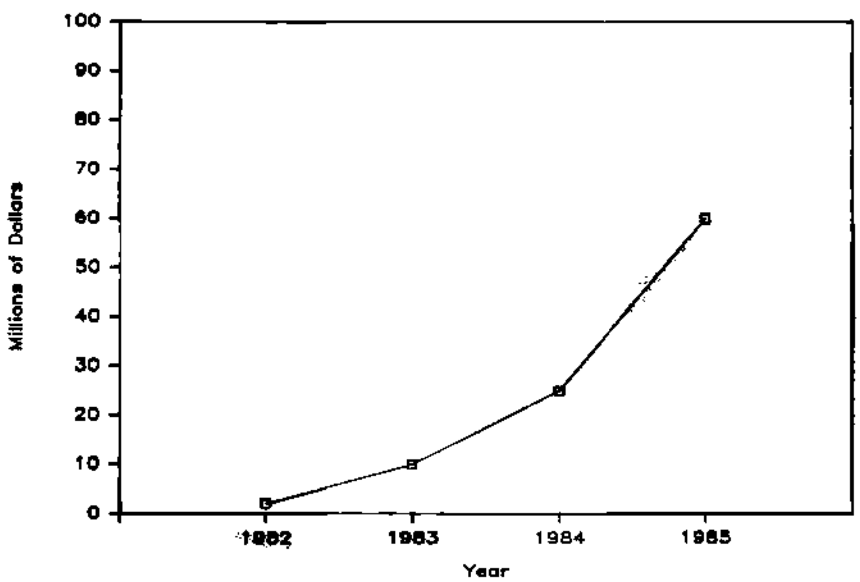
A secondary trend in the codec/filter market that is expected to occur over the next few years is the development of more complex chips that include other functions besides codec/filter functions. One example is Advanced Micro Devices' 7901 subscriber line audio-processing circuit (SLAC). The SLAC includes programmable filters and other circuitry as well as codec/filter functions.

A majority of the combo chips now available are CMOS and, since CMOS offers substantial power-use advantages over NMOS, we expect CMOS to become the dominant technology in the future.

Jean Page

Figure 1

ESTIMATED MARKET FOR COMBO CHIPS



Source: DATAQUEST
February 1984

Table 1

ESTIMATED ASPS FOR COMBO CHIPS
(Dollars)

1983	1984	1985	1986	1990
$10.00	$7.00	$5.00	$4.60	$3.00

Table 2

COMPANIES OFFERING CODEC/FILTER COMBO CHIPS

Company	Second Source	Technology
AMI	-	CMOS
Hitachi	AMI	CMOS
Intel	TI, NEC	NMOS
Mitel	-	CMOS
Mostek	Motorola	CMOS
National Semiconductor	RCA	CMOS
Texas Instruments	-	NMOS and CMOS

Source: DATAQUEST
February 1984

SUIS Code: Newsletters Volume
No. 84-2

REVISION C TO MILITARY STANDARD 883: MILITARY SPECIFICATIONS IN THE SEMICONDUCTOR INDUSTRY

OVERVIEW

Revision C to Military Standard 883 is expected to have a significant impact on prices and availability of military integrated circuits in 1984.

The Microelectronics Division of the Defense Electronics Supply Center's (DESC) Defense Logistics Agency (DLA) has introduced Revision C as a clarification to Military Standard 883 test and reliability standards for integrated circuits used in military applications.

Revision C, written by Rome Air Defense Center (RADC), will be implemented by the DLA to improve military IC suppliers' compliance with the requirements of MIL-STD-883 tests on integrated circuits. Revision C became effective 25 August 1983 and will affect all microcircuits intended for use, reference, or sale as MIL-STD-883 devices for military systems applications. The most controversial requirement in Revision C is provision 1.2, which pertains to a manufacturer's eligibility as a supplier of MIL-STD-883 devices. Section 1.2.1.1 of this provision states:

"Manufacturers of MIL-STD-883 parts must be certified to MIL-M-38510 and have at least one JAN device listed on QPL-38510 by 1 July 1984 to satisfy the requirements of 1.2."

A JAN device is one that has been certified to MIL-M-38510 and has been manufactured in the United States. As of December 1983, implementation of provision 1.2 of Revision C has been temporarily delayed by RADC until further clarification of this provision can be established. Electronic industry representatives are expected to meet with RADC representatives during the next few months to negotiate a compromise on provision 1.2.

History of Military Standards

Military standards 38510 and 883 were created by RADC, U.S. Air Force, in 1968 to establish electronic device standards and specifications for manufacturers of military ICs. Because of the lengthy and costly process steps and the extensive documentation involved in meeting 38510 requirements for JAN certification, semiconductor manufacturers have found it more cost effective to offer devices screened to MIL-STD-883.

Although a large number of JAN-type devices are listed on DESC's qualified parts lists (QPLs) and are available from major semiconductor manufacturers, the limited number of suppliers of these devices have not been able to meet the growing demand of the military community for complex JAN-type ICs.

Table 1 is a list compiled by DATAQUEST of semiconductor manufacturers on DESC's qualified parts lists I and II. Devices that are listed on Part I are products that have met the requirements of MIL-M-38510 and have been certified by DESC as JAN-type devices. Part II is referred to as the interim or temporary QPL that is granted to manufacturers that have performed sufficient tests on their devices to indicate that the products have the potential to meet Part I MIL-M-38510 requirements.

Table 1

1983 QPL-38510 MANUFACTURERS

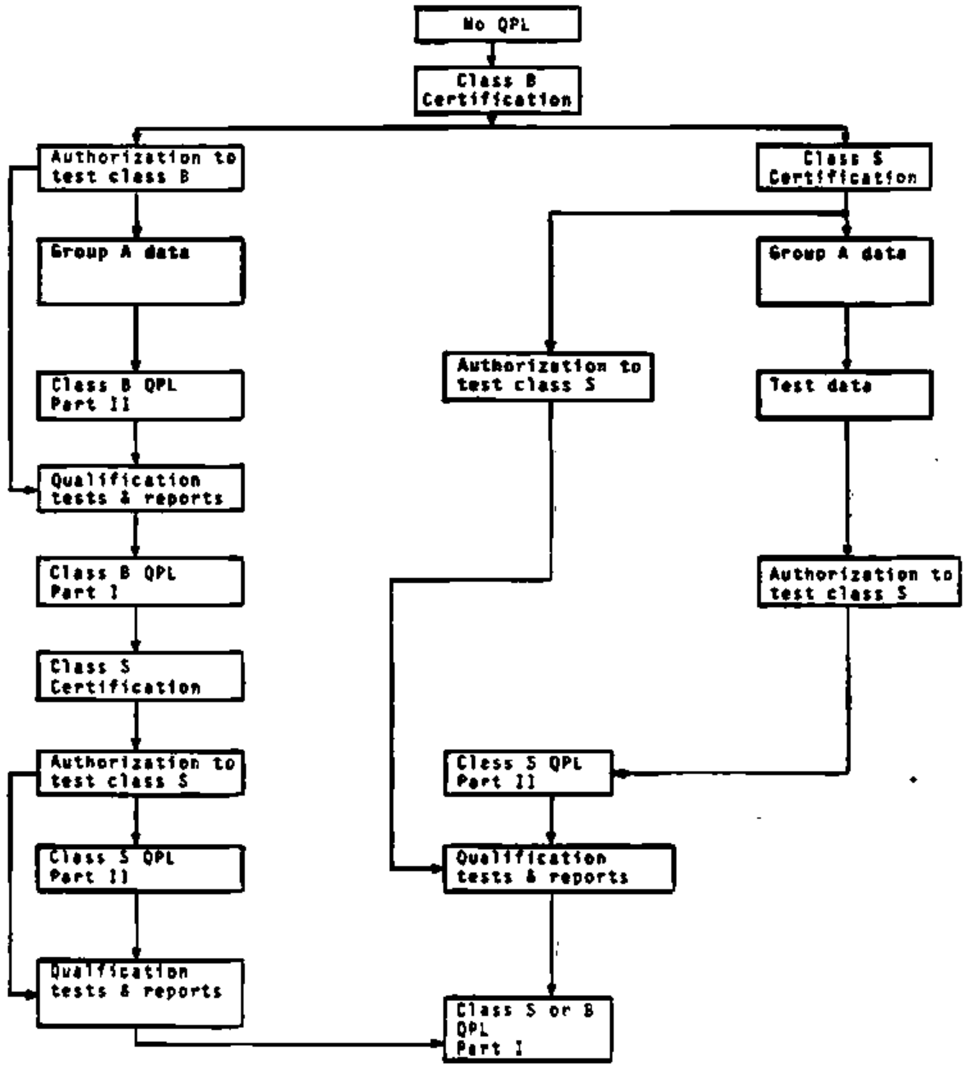
Advanced Micro Devices, Inc.	National Semiconductor Corporation
Analog Devices, Inc.	Precision Monolithic, Inc.
Fairchild Semiconductor	Raytheon Company
Harris Corporation	RCA Corporation
Intel Corporation	Signetics Corporation
Intersil, Inc.	Siliconix, Inc.
Mikros Systems	Solid State Scientific, Inc.
Monolithic Memories, Inc.	Texas Instruments, Inc.
Mostek Corporation	Zilog, Inc.
Motorola, Inc.	

Source: DATAQUEST
January 1984

Figure 1 shows the procedures of device qualification that a microcircuit manufacturer must follow to receive QPL-38510 listing.

Figure 1

MIL-M-38510 QPL PROCEDURES



Source: RADC MIL-M-38510
DATAQUEST
January 1984

DATAQUEST has made the following estimates on the QPL throughput time (QPLTT), which is the average time allotted to get a device qualified by DESC:

24-30 months maximum:	if government line certification does not exist, and if a JAN-slash sheet, indicating a device is fully compliant with MIL-M-38510, does not exist.
12-18 months maximum:	if line certification does not exist, but an alternate-source JAN-slash sheet for a device does exist.
6 months minimum:	if both line certification and JAN-slash sheet exist.

EFFECTS OF REVISION C

Vendor Decisions

Based on DATAQUEST's market research and recent surveys of major manufacturers and small speciality suppliers of military ICs, we believe that manufacturers of military ICs will pursue the following market strategies in 1984:

- Noncertified manufacturers that previously supplied MIL-STD-883 type devices will temporarily refrain from military IC production until further clarification of Revision C.

- Noncertified manufacturers that choose to comply with Revision C amendments will pass the costs of initial investments required for test and qualification procedures to their military customers.

- A few of the DESC-certified manufacturers have decided not to comply with Revision C but to continue to provide JAN-type, JAN-equivalent, and 883-type devices until an alternative to and/or a modification of provision 1.2 has been attained.

- The majority of DESC-certified semiconductor manufacturers have decided to comply with Revision C and will continue to provide JAN-type devices and 883-type devices that meet Revision C requirements while waiting for RADC's final decision on provision 1.2.

Military Products: Supply and Demand

Based on our analysis of the DESC QPL and input from suppliers of military ICs, standard bipolar logic, bipolar memory, linear, and discrete families represent the bulk of devices on the JAN QPL. Only a small percentage of the more complex LSI/VLSI and custom/semicustom devices are on DESC's QPL or are in the process of being qualified to MIL-M-38510.

According to DATAQUEST estimates, a 30 to 50 percent increase in demand for military-standard semiconductor devices is expected in 1984. We anticipate that the bulk of this demand will be for LSI/VLSI devices such as microprocessors, peripheral support chips, and MOS logic and memory devices for applications in the Supercomputer and Electronic Warfare (EW) programs.

DATAQUEST CONCLUSIONS

In general, we expect that Revision C will ultimately cause a myriad of problems for the military IC user in 1984. Acquisition of military ICs will be difficult. As Revision C is implemented, we expect that there will be moderate price increases in products manufactured in facilities that must meet Revision C requirements. Long lead times averaging 30 to 52 weeks in complex LSI and VLSI devices are expected through 1984, with the bulk of 38510 and 883 Revision C device orders not delivered until the third and fourth quarters of 1984.

Prices of EEPROM product families, 16- and 32-bit microprocessor families, and peripheral support devices are expected to increase significantly throughout 1984. This increase is expected to be temporary as manufacturers pass Revision C documentation and certification costs on to their military customers.

Mary Olsson

SUIS Code: Newsletters Volume
No. 84-1

DEFENSE ELECTRONICS MARKET UPDATE: MARKET GROWTH

DATAQUEST's Semiconductor User Information Service recently published data on the 1984 military electronics market. These data can be found in SUIS Volume I, Section(s) 3. End-Use Analysis, 4. Prices and Lead Times, and 9. Packaging Analysis. We will incorporate these data into a series of newsletters to cover the following major issues that will affect the military semiconductor market during 1984:

- Military semiconductor market growth
- Standardization in the military semiconductor industry
- Revision C to Military Standard 883
- Military semiconductor packaging trends
- Military semiconductor product and technology trends
- Military semiconductor price and lead times trends

SUMMARY

The military semiconductor market is expected to be strong for the next two years (1984-1985). DATAQUEST expects a 5 percent real growth in defense appropriations for fiscal 1984. As shown in Table 1, we estimate a 10 percent growth in military semiconductor consumption, from $908 million in 1982 to $1.0 billion in 1983. We believe that demand for military semiconductor products will continue to show a steady 11 percent average annual growth rate through 1985, with military semiconductor consumption reaching $1.3 billion by 1985.

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MILITARY SEMICONDUCTOR CONSUMPTION

Although military demand for semiconductor products increased during 1983 and demand is expected to surge during 1984, its year-to-year growth rate will continue to shrink in comparison to the total U.S. semiconductor growth rate. (See Figure 1.)

MILITARY SEMICONDUCTOR FORECAST

In 1981 and 1982, the growth rate and demand for military semiconductor products was slow, because 40 percent of the estimated Department of Defense (DoD) funding was marked for research, development and test (RD&T), and procurement. DoD budget emphasis was on such programs as the B1B, AMRAAM, and Cruise missile. As these programs move into production, and as military funding becomes available in 1984, the military electronics market in 1984 is expected to accelerate.

DATAQUEST estimates a 30 to 50 percent increase in demand for military semiconductor devices in 1984 for two reasons: the fourth quarter 1983 book-to-bill ratio averaged 1.4, and military usage of improved electronic technologies is increasing rapidly. However, acquisition of military grade devices will be difficult, for the following reasons:

- Semiconductor companies supplying military grade 38510 and 883-type devices are capacity limited.
- The number of manufacturers supplying complex MIL-M-38510 type devices is limited.
- The recent addition of Revision C to the MIL-STD-883 test methods and procedures manual for microelectronics, is expected to limit the sources of military ICs in 1984 until the non-qualified manufacturers can meet the provisions of Revision C.

DATAQUEST expects these factors to increase prices and limit the availability of military ICs throughout 1984. However, this situation may improve if present limitations are altered by faster than expected increases in production capacity. We will follow these developments during the year and update our forecasts as necessary.

Mary Olsson

Table 1

ESTIMATED U.S. MILITARY SEMICONDUCTOR
CONSUMPTION BY TECHNOLOGY
(Millions of Dollars)

Technology	1980	1981	1982	1983	1984	1985
Discretes	$150	$160	$179	$ 190	$ 218	$ 245
ICs	583	628	729	810	926	1,080
Total Semiconductor	$733	$788	$908	$1,000	$1,144	$1,325

Figure 1

ESTIMATED MILITARY SEMICONDUCTOR CONSUMPTION
VERSUS U.S. SEMICONDUCTOR CONSUMPTION
(Billions of Dollars)

Source: DATAQUEST
January 1984

Nielsen Dataquest USER UPDATE

SUIS Code: Vol. I Newsletters
No. 83-13

THE 256K DRAM MARKET GAINS MOMENTUM

THE MARKET

Despite suggestions that the upturn in demand for 64K DRAMs might delay acceptance of the next-generation 256K device, indications are that the market for 256K DRAMs is already developing. DATAQUEST estimates that the market for 256K DRAMs will grow from 100,000 units in 1982 to 1 million units in 1983. Table 1 gives our estimates of shipments for 1982 through 1986.

Table 1

ESTIMATED 256K DRAM SHIPMENTS
(Millions of Units)

1982	1983	1984	1985	1986
0.1	1	15	150	600

Source: DATAQUEST
October 1983

The unit price of 256K DRAMs is currently about $50. DATAQUEST expects the price to decline to approximately $40 by the end of 1983. Figure 1 shows a comparison of price per bit for 64K DRAMs and 256K DRAMs. Current estimates suggest that the crossover point will come in mid-1985. Our estimates of 256K DRAM average selling prices (ASPs), as shown in Figure 2, are a classic example of learning-curve pricing.

Figure 1

ESTIMATED PRICE-PER-BIT COMPARISON
FOR 256K AND 64K DRAMS
(Millicents)

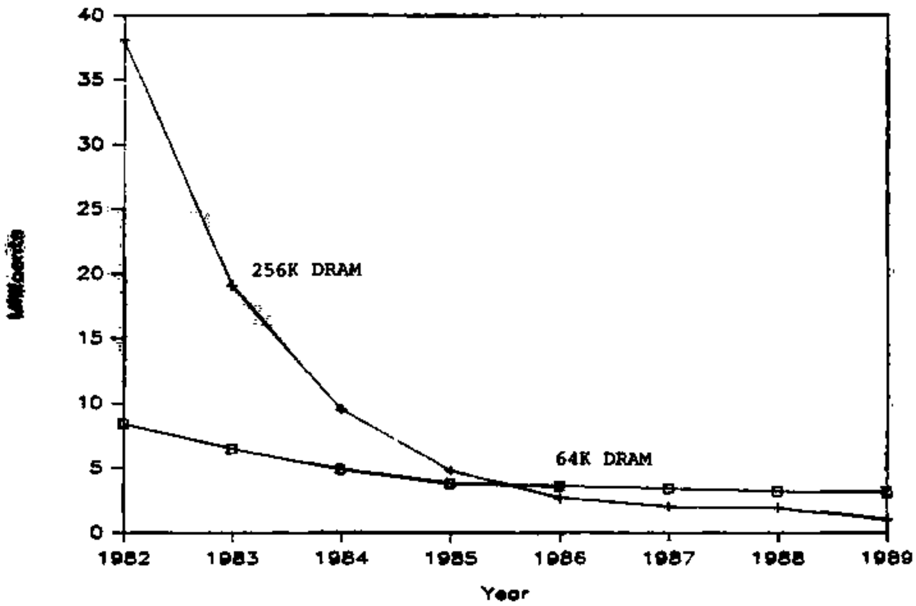
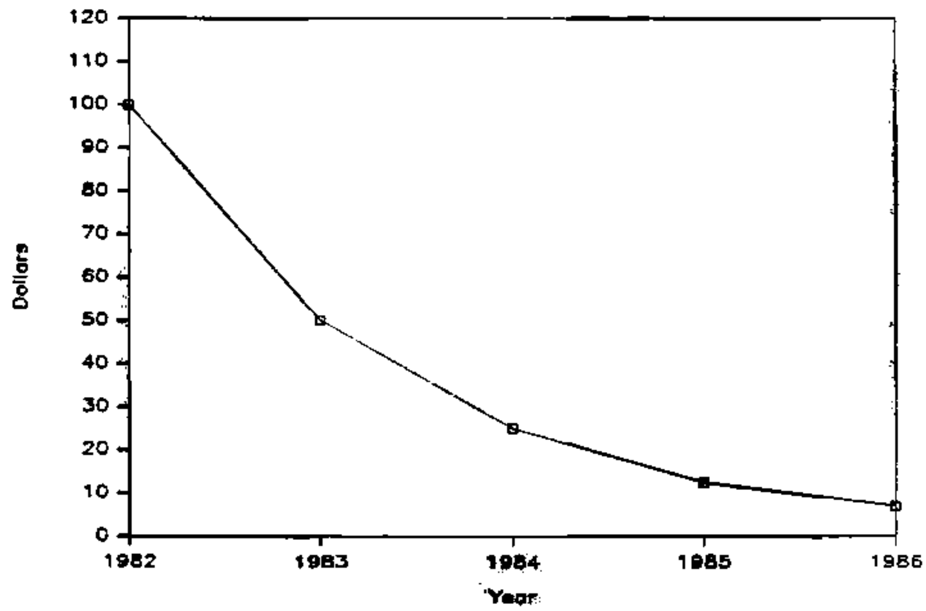


Figure 2

ESTIMATED AVERAGE SELLING PRICES
FOR 256K DRAMS
(Dollars)



Source: DATAQUEST
October 1983

Digital Equipment Corporation recently announced a 768 KByte memory upgrade board for its new Rainbow 100+ microcomputer. The board, which uses 256K DRAMs, is to be sold for $895. The cost of 256K bits of memory on that board (including the board itself and suppport circuits) is less than $40, suggesting that suppliers are committing to a rapid decline in the price of 256K DRAMs.

THE DEVICES

Earlier generations of dynamic RAMs were sold into a fairly homogeneous market. The dominant architecture for 16K DRAMs was x1 and the dominant package was the plastic DIP. With the advent of the 64K DRAM, the market began to fragment. Devices are available in x4 and x8 architectures, and some innovative packaging techniques have been used.

The coming of the 256K DRAM offers the possibility of an even more fragmented market. Although most of the early offerings in the 256K market are currently 256K x1, the market for x4 and x8 products is likely to develop, fueled especially by growth in the market for graphics terminals and video equipment. Texas Instruments is working on a 256K DRAM that can be configured x1 or x4 by changing one mask in the wafer fabrication process (in much the same way that gate arrays are configured).

Packaging alternatives are also expected to be an important issue in the 256K DRAM market. Although plastic DIPs are expected to remain the dominant semiconductor packaging technology, leaded plastic chip carriers are expected to grow at a compound annual growth rate (CAGR) of 137 percent between 1982 and 1987. Another interesting packaging approach is the single in-line package (SIP). Four or eight 64K DRAMs, either in chip form or in a chip carrier package, are mounted on a printed circuit or ceramic substrate. The package is then attached to the circuit board by a single row of pins along one edge.

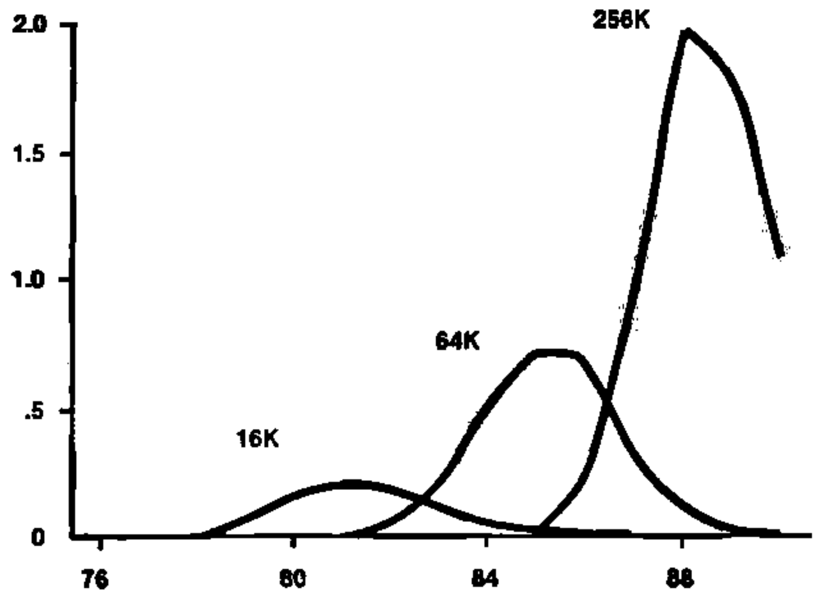
MARKET MECHANICS

Product Life Cycle

Unit consumption of a semiconductor device typically follows a bell-shaped curve over the course of its life. Because of the speed at which each successive generation of semiconductor devices has been developed, the typical life cycle is becoming shorter. Figure 3 shows our estimates of the life-cycles of 16K, 64K, and 256K DRAMs. As the figure shows, we expect unit shipments of 256K DRAMs to exceed those of 64K devices in 1987. The price-ber-bit crossover, however, should come by mid-1985.

Figure 3

WORLDWIDE DYNAMIC MOS RAM SHIPMENTS
(Billions of Units)



Source: DATAQUEST
October 1983

Potential Delaying Factors

There seems to be complete consensus that the semiconductor industry is in an upturn. In previous upturns, new generations of products were often delayed to allow for increased production of existing products. Typically, high production is the focus of the industry during an upturn, and product and technology development is the focus of attention during a recession. However, our discussions with manufacturers suggest that they are pressing ahead with 256K development and production in spite of the current pressure on available capacity. U.S. manufacturers in particular are unwilling to lose potential market share as they did in the early days of the 64K DRAM.

Potential Acceleration Factors

Our price-per-bit and shipment charts (Figures 1 and 3) suggest early acceptance of the 256K DRAM. The potential within the overall 256K market for a number of niche markets based on speed, organization, or special architectural features, should allay manufacturers' concerns about the kind of price pressures experienced on the 64K DRAM.

Two end-use markets that could strongly affect the 256K DRAM are graphics terminals and personal computers. Increasing sophistication of CAD tools will increase demand for high-resolution graphics terminals. A 64K x4 DRAM would be very useful in picture memory applications.

Using 256K DRAMs in personal computers offers the alternatives of increasing memory capacity, or decreasing the number of devices used while maintaining memory capacity. The current interest in portable computers makes the second option especially attractive. Table 2 gives our estimates of personal computer shipments for 1982 through 1986.

Table 2

ESTIMATED U.S. PERSONAL COMPUTER SHIPMENTS
(Thousands of Units)

1982	1983	1984	1985	1986
792	1,764	3,324	4,312	6,002

Source: DATAQUEST
October 1983

THE COMPANIES

Table 3 shows our estimates of 256K DRAM shipments by company in 1982 and the first two quarters of 1983.

Table 3

ESTIMATED 256K DYNAMIC RAM SHIPMENTS
(Thousands of Units)

Company	-1982- YEAR	1983 Q1	1983 Q2
Fujitsu	S	S	10
Hitachi	10	25	50
Mitsubishi			S
NEC		S	S
Oki		S	S
Toshiba		S	S
Western Electric	S	S	S
Total	10	25	60
Percent Change From Previous Quarter			140%

S = Sample

Source: DATAQUEST
October 1983

A number of other suppliers are sampling products or have announced their intentions of entering the market. Table 4 shows information on the estimated sampling and production dates of 256K DRAMs for each company. In some cases, the die size shown in column 4 may be for a preproduction device. Most suppliers are working to shrink their parts so that they will be small enough to offer in plastic packages. Initial introduction in a plastic package saves production cost. Suppliers can also avoid having to requalify with users when making a transition from ceramic to plastic packages.

Nielsen Dataquest

USER UPDATE

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No. 83-12

SIA OUTLOOK '86
SEMICONDUCTORS--THE COMING OF AGE

INTRODUCTION

Nowhere were the effects of the current economic recovery more evident than at the annual Semiconductor Industry Association forecast dinner, held September 29, 1983, in Santa Clara, California. At last year's meeting there was an almost superstitious unwillingness to believe in a recovery after the short-lived upturn in the second quarter of 1982. This year's mood was one of absolute optimism, and forecast presenter Jerry Sanders' statement that boom times are here was greeted with enthusiastic cheers.

FORECAST

The forecast covers the years 1983 through 1986. Worldwide shipments of semiconductors by U.S. and European manufacturers are forecast to rise from $9,374.9 million in 1982 to $10,827 million in 1983, an increase of 15.5 percent. Figure 1 shows SIA estimates for shipments to the four major regions. The SIA anticipates no recession during the period 1984 through 1986.

Traditionally, semiconductor shipments soften in the third quarter of the year. However, 1983 showed no sign of such softening. The industry is expected to return to its traditional seasonal patterns next year. Table 1 shows the quarter-by-quarter comparisons for 1983 and 1984.

Figure 1

ESTIMATED SHIPMENTS OF U.S. AND WEST EUROPEAN SEMICONDUCTOR MANUFACTURERS BY REGION
(Billions of Dollars)

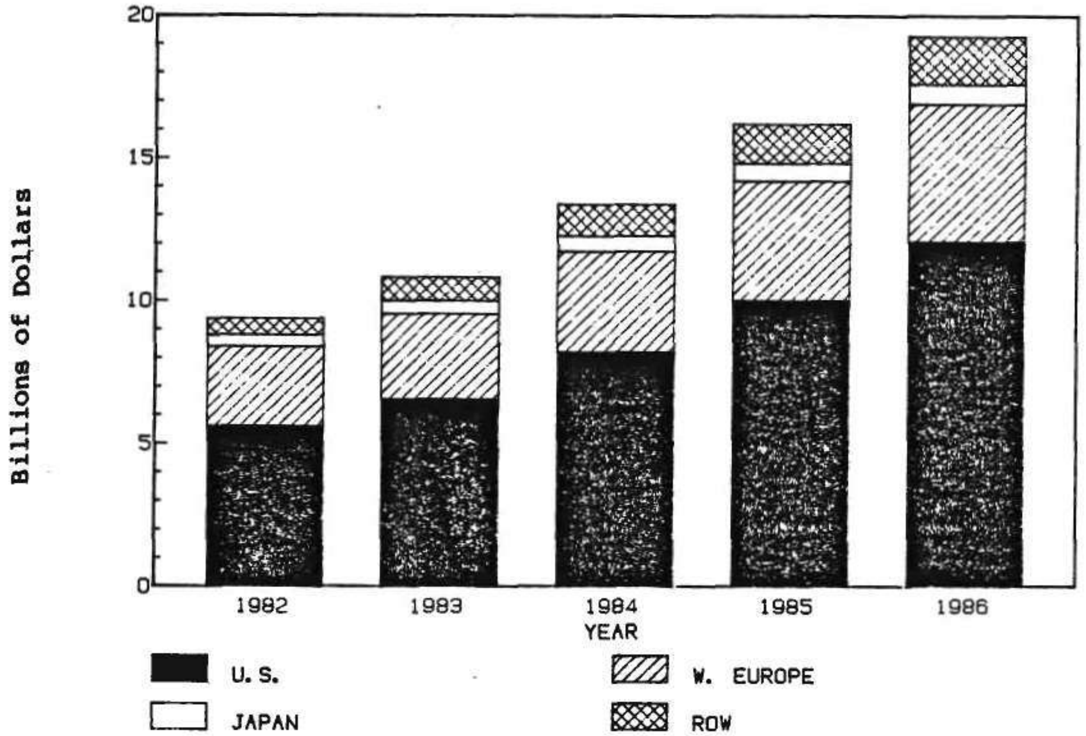

Table 1

QUARTERLY CHANGE IN SEMICONDUCTOR SHIPMENTS BY U.S. AND WEST EUROPEAN SEMICONDUCTOR MANUFACTURERS
(Millions of Dollars)

	First Quarter		Second Quarter		Third Quarter		Fourth Quarter	
	Shipments	Percent Change	Shipments	Percent Change	Shipments	Percent Change	Shipments	Percent Change
1983	$ 2,324	(1)	$ 2,627	13	$ 2,803	7	$ 3,073	10
1984	$ 3,170	3	$ 3,392	7	$ 3,360	(1)	$ 3,455	3

Source: SIA
September 1983

THE PRESENTATIONS

Wilfred Corrigan, President of LSI Logic Corporation, was Master of Ceremonies for the meeting. Mr. Corrigan said that there were several recoveries affecting the semiconductor industry: the business recovery, which has pushed bookings and billings to record highs; the recovery in semiconductor stock prices; and the recovery in initial public stock offerings in the semiconductor industry. Between the third quarter of 1982 and the second quarter of 1983, new equity in semiconductor companies jumped from $92 million to $650 million.

Mr. Corrigan also commented on the high proportion of manufacturers of customized semiconductors that are involved in public offerings.

The new SIA forecast was presented by Jerry Sanders, Chairman, President, and CEO of Advanced Micro Devices, Inc. Looking forward to 1993, Mr. Sanders predicted that total worldwide shipments by U.S. and West European companies would reach $126 billion by 1993.

Semiconductor industry growth in terms of dollars was at a two-year low in 1981 and 1982. During that time, however, manufacturers pursued an aggressive policy of new product development and design-in.

The book-to-bill ratio for the months of June, July, and August has been close to 1.5. In the same period last year, the ratio was below 1. Mr. Sanders suggested that the ratio will begin to moderate as new capacity comes on stream.

Year-to-year growth in the U.S. market is forecast to be 17 percent in 1983 and 25 percent in 1984. The West European market will grow less rapidly, hampered by the relative strength of the U.S. dollar against European currencies. Shipments to Japan by U.S. and West European manufacturers are forecast to increase 13 percent in 1983 over 1982, and 17 percent in 1984 over 1983, reflecting the continuing difficulty of penetrating the Japanese market. The greatest relative strength will be in shipments to the Rest of World segment, forecast to increase by 44 percent in 1983 over 1982 and 35 percent in 1984 over 1983.

Of the various product families, the most spectacular year-to-year growth is forecast in the area of bipolar logic, dominated by the TTL families. Increases of 53 percent in 1983 and 50 percent in 1984 are forecast.

In the MOS area, digital CMOS is expected to show the highest growth of any MOS IC category with 33 percent growth in 1983 over 1982 and 40 percent in 1984 over 1983. By 1986, digital CMOS will account for 13 percent of IC shipments.

Mr. Sanders commented on the great potential of the microprocessor peripheral market, an area in which the United States must strive to maintain its present strong position. He forecast that, by next year, microprocessors (including peripherals) will overtake MOS memory products in terms of percent of total dollars in IC shipments.

Mr. Sanders concluded an extremely optimistic presentation by expressing the belief that the entire industry may be on the threshold of the most exciting growth in his 24 years in the industry.

Dr. Robert N. Noyce, Vice Chairman of the Board of Directors, Intel Corporation, addressed the meeting's theme "Semiconductors--The Coming of Age." In an interesting presentation, documenting the growth of the Semiconductor Industry Association, Dr. Noyce pointed out that the industry has increased in importance to the point where it has become an important indicator of economic health. Electronics and semiconductors have been a fundamental instrument of change in our society.

Since its inception in 1977, the SIA has grown from 7 member companies to 55. In January 1984, Japanese companies will report their shipments to the STSP (Semiconductor Trade Statistics Program) for the first time.

The SIA has an important voice in government and legislative action concerning the semiconductor industry. It was instrumental in demonstrating to the U.S. Government the threat of targeting by Japanese industry.

Future SIA legislative priorities include work on the International Trade and Investment Act, the Export Administration Act, R&D Tax Credits, copyright protection, antitrust exemption for joint R&D, and the elimination of semiconductor duties and tariffs.

CONCLUSION

DATAQUEST estimates of year-to-year growth 1982-83 and 1983-84 (to be published at the end of October) anticipate higher growth than the SIA forecast predicts. DATAQUEST closely predicted this year's upturn and the absence of a summer slump. After a three-year pause, the semiconductor industry seems once again to be entering a period of explosive growth.

Jean Page

Nielsen Dataquest USER UPDATE

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No. 83-11

PURCHASING GATE ARRAYS--A SEMICONDUCTOR USER INFORMATION SERVICE WORKSHOP

INTRODUCTION

Seminars that teach engineers the technical aspects of using gate arrays are widely available, but on July 27, 1983, DATAQUEST offered a gate array workshop with a different slant. The workshop was developed by DATAQUEST's Semiconductor User Information Service and Source III, an independent IC design house. "Purchasing Gate Arrays--The Semicustom Solution from the Purchaser's Perspective" gave purchasing professionals the opportunity to explore their special concerns, such as vendor analysis, contract negotiation, pricing, delivery, and second-sourcing. This newsletter gives a brief overview of the topics covered at the workshop.

THE WORKSHOP

What is a Gate Array?

A gate array is an integrated circuit containing a regular pattern of logic gates processed up to, but not including, the final interconnect layer. The interconnect layer can then be designed to create a unique circuit. This system offers a customized product with many of the advantages of standard products.

The North American market for gate arrays is expected to grow from $90 million in 1980 to an estimated $1,525 million by 1990 as shown in Figure 1. This means that semiconductor purchasers need to be well-informed on the procurement of gate arrays, since they may soon be involved in such a project.

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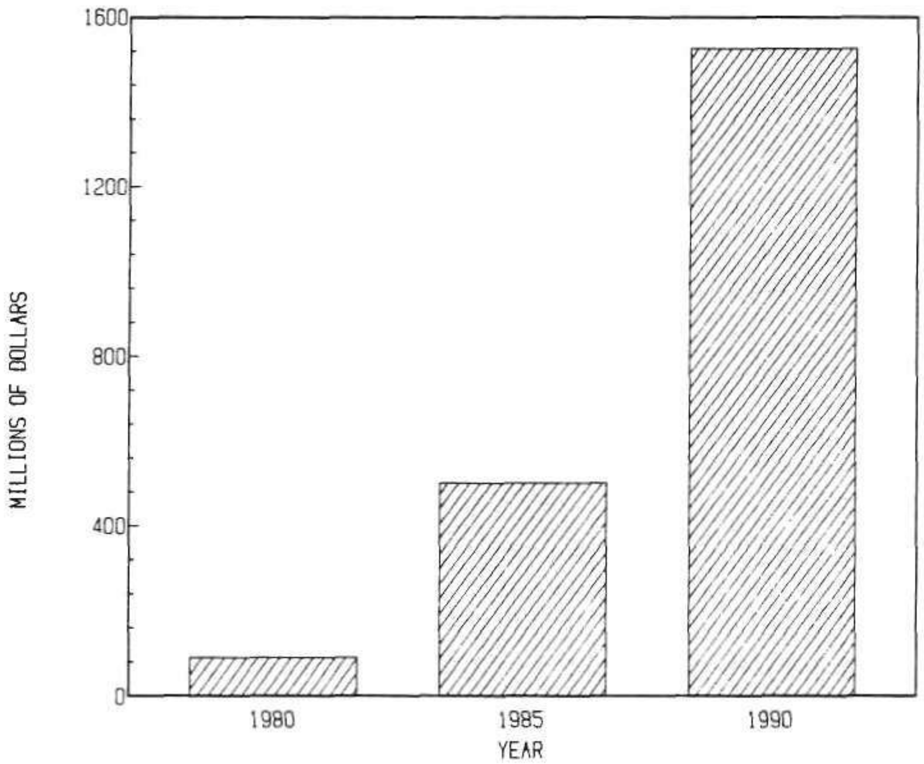
Figure 1

ESTIMATED U.S. MERCHANT MARKET
SALES OF GATE ARRAYS
(Millions of Dollars)



Source: DATAQUEST
September 1983

There are a number of ways to implement logic in a system, including standard products, field programmable logic, gate arrays, standard cells, and full custom devices. The advantages of gate arrays over standard products include total system cost reduction, higher reliability, performance improvement, and design confidentiality. Because only one or two layers of a gate array have to be designed and fabricated, gate arrays offer the advantages of shorter design time, lower design cost, and shorter production time compared to custom products.

Making the decision to use gate arrays is a complex process. First the objectives of the project need to be defined. If these objectives can best be met by a gate array, the next task is selecting the most suitable vendor and device family. A development contract must then be negotiated, the device must be designed and qualified, and the production contract must be negotiated.

Implementing a Project--Case Study

The case study discussed at the workshop was the redesign of an electrostatic plotter. There were three objectives to be met:

- Reduce the number of printed circuits boards from two to one
- Reduce the total manufacturing cost
- Accomplish the redesign in nine months or less

Analysis of the problem showed that gate arrays could meet these objectives effectively. The combination of power, speed, and size requirements made silicon-gate CMOS the most appropriate technology to use. This led to the next stage in the project, vendor selection.

Implementing a Project--Vendor Selection

This part of the workshop was conducted as an interactive problem-solving exercise in which groups of attendees selected the appropriate vendor using company profiles of a representative selection of vendors. An example problem is shown below.

Problem

Background - You are involved in a project that has 750 gates of logic that you would like to integrate into a gate array. Engineering tells you that gate delays of 1.0 ns or less are required. The logic is very random and requires a total of 72 input and output (1/0) pins.

Problem - You want to find the vendor that offers the lowest-cost piece price, and you are willing to place a 10,000 piece order. Which of the seven vendors in the company profiles section should you choose?

Note

In order to simplify the problem, only seven companies were offered as potential vendors. They were:

- Fujitsu
- International Microcircuits, Inc. (IMI)
- Interdesign
- LSI Logic
- Master Logic
- Motorola
- Signetics

Solution - The important points to consider are:

- Number of gates - 750
- Gate delay - 1.0 ns or less
- Number of I/O pins - 72

The fast gate delay speed required (1.0 ns) dictates the choice of ECL. The three vendors that offer ECL are LSI Logic, Motorola, and Signetics. Of these three vendors, only Signetics offers a device with an adequate number of I/O pins.

The problem described above was relatively straightforward, but other problems discussed showed that frequently there is no "right" answer, and that considerations such as prior knowledge of the vendor and the availability of CAD tools can be important factors in the final decision.

Implementing a Project--Design Implementation

Close cooperation between user and vendor is essential for a successful gate array project. Therefore, it is important for the user to have some understanding of the design process so that expectations can be realistic.

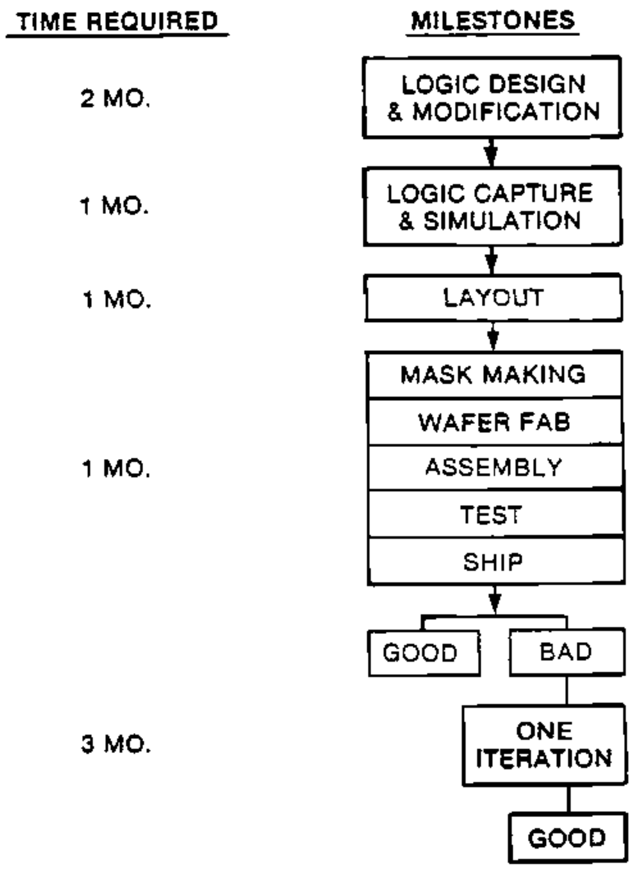
Figure 2 shows the milestones in a typical gate array project together with our estimates of the time required for each step. The logic design step for a gate array is similar to that for a printed circuit board. Design can be done manually or using CAD tools. At the logic capture and simulation stage, the data are entered into a computer and the design is verified. Layout refers to the physical layout of the chip and the design of the interconnect layer. This step can be achieved manually, interactively, or automatically. Manual design is not really effective for devices of more than 1,000 gates. Interactive layout enables the designer to design the interconnect by means of a graphic representation on a CRT screen. Automated design is still relatively new in the merchant gate array market.

When the layout is complete it is digitized, or converted, into computer readable form and a pattern generation (PG) tape is produced from which the mask for the interconnect layer is made. After the parts have been fabricated, assembled, and tested, they are shipped to the user for qualification. Figure 2 shows an allowance for one iteration in case the parts do not work correctly the first time.

The design and layout phases of the process may be accomplished by either the user or vendor, depending on the capabilities of each. Some companies, such as Motorola, offer extensive training but expect their customers to complete the design and layout phases themselves. Other companies will accept logic schematics or even block diagrams and complete the entire process. Another possibility is to subcontract the design and layout to a third-party design house.

Figure 2

GATE ARRAY DESIGN MILESTONES



Source: DATAQUEST
September 1983

Implementing a Project--Development Contract Negotiation

It is in the development contract negotiation stage that the differences between the purchase of standard products and gate arrays becomes most apparent. Gate arrays are customized integrated circuits, but, since only the final interconnect layer is altered, both the design process and the basic devices are standard in nature. The first gate array project undertaken with a vendor usually resembles a custom project. As user and vendor become familiar with each other's needs and capabilities, they interact more effectively and the process becomes standardized. It is, therefore, important for the user and vendor to establish a close and well-defined working relationship. An adversarial relationship between user and vendor which is frequently encountered in standard product purchase negotiations, would be totally out of place and detrimental to the project.

The objectives of a development contract are to establish:

- The purpose of the project
- The time by which it is to be completed
- The cost of development
- The device specifications

The contract should also define the responsibilities of each party and the manner in which the project is to be accomplished. Above all, the contract should be negotiated in a way that creates an attitude of cooperation between those involved in order to get the job done on time and at a reasonable cost.

Development Contract Elements

The contract should establish what is to be accomplished by the project. Specific objectives such as meeting a market window or accomplishing the design using a specific number of packages should be thoroughly explained.

The contract should establish the steps involved in the project and define who is responsible for each step. User and vendor should also be clearly aware of what is involved in the completion of each step.

Development costs should be defined in the contract, both in terms of the basic cost and its components. Agreement must be reached on a payment schedule, responsibility for rework costs, and any performance incentives or penalties to be included in the contract.

The contract should define the development schedule for the project. Key milestones need to be established and the conditions for their completion should be clearly defined. A schedule should be established for any necessary rework. The contract should establish the conditions for prototype acceptance including the documentation to be completed and the specifications to be met.

Second-sourcing should be covered in the contract. A user may not require a second source if the production quantity is relatively small and a one-time buy can be made. However, if a second source is needed, there are two types to consider. One type is a direct second source that uses the same basic process as the primary vendor. The other type is a functional second source or a device that functions in the same way as the original although the design is entirely different.

The contract should establish the conditions for developing a second source. This should involve such considerations as the minimum quantity to be produced by the primary source, or the steps to take if the vendor fails to meet contractual obligations. An important point to establish is ownership of the tooling (such as the PG tape).

Since development pricing is often based on minimum production quantities, the development contract should cover production quantities, pricing, and lead times.

A gate array project is a joint venture and the success of each partner is important to the other. For this reason, a gate array contract should always be negotiated in an atmosphere of mutual cooperation.

Buying Production Quantities

There is very little room for negotiating production pricing in a gate array project compared with purchasing standard product. The buyer is usually in a sole-source or limited second-source situation. Production costs are well-established and are not susceptible to learning-curve declines in the same way as standard semiconductor products.

The user should maintain sufficient inventory to allow time for developing a second source in case of a serious problem.

CONCLUSION

The workshop offered an opportunity for purchasing people to discuss their concerns about gate array projects, and to understand the challenges faced by the other participants in the projects. The workshop was well-received by the participants, who especially enjoyed the interactive format. DATAQUEST's Semiconductor User Information Service plans to offer other workshops and seminars in the future. Please tell us the topics that you would like to see presented.

Jean Page

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U.S. VERSUS JAPANESE SEMICONDUCTOR QUALITY—TWO YEARS LATER

In the spring of 1980, Richard Anderson of Hewlett-Packard caused a controversy in the U.S. electronics industry by announcing the results of a Hewlett-Packard study of the post burn-in quality of 16K D RAMs. According to Mr. Anderson, parts from HP's three U.S. suppliers showed failure rates five to six times as high as parts from its three Japanese suppliers.

Perhaps more than any other single event, this announcement focused U.S. suppliers' concerns on the quality issue. One common perception of the difference between U.S. and Japanese manufacturers was that Japanese manufacturers worked to build quality into the product, while U.S. manufacturers used extensive testing to screen out failures. U.S. manufacturers enhanced their efforts to build in quality and the positive results of their efforts are shown in Table 1. By January of 1982, Mr. Anderson announced that there was virtually no difference in quality between the U.S. and Japanese 16K D RAMs.

The May 1983 meeting of the Santa Clara Valley Reliability Society of the I.E.E.E. again examined the topic of U.S. versus Japanese IC quality. Dick Eichensier of Hewlett-Packard and Roger Dunn of Xerox each discussed his company's recent experiences with IC quality levels. Both men concluded that among their qualified suppliers, there is no consistent significant difference in quality based on supplier nationality.

Increasing use of LSI and VLSI parts, together with price declines, has given a new prominence to the quality issue. Incoming test and burn-in account for a significant proportion of the device cost and users are anxious to develop methods to avoid the need for these procedures. Xerox is employing some interesting systems to achieve this aim.

Initially Xerox burns in and tests all the devices from a supplier and compiles the results on a computerized data base. Information on absolute quality levels and supplier ranking is distributed to suppliers each month. Monthly purchase allocations are made on the basis of quality performance. When a supplier consistently meets the required quality level, Xerox ceases 100 percent test and just samples incoming devices. The company aims to eliminate incoming test completely for its best suppliers.

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Table 1

RESULTS OF HEWLETT-PACKARD'S POST
BURN-IN TESTS OF 16K D RAMS

Supplier	Failures per 10,000 Parts Jan.-June 1980	July-Dec. 1980
U.S. Supplier A	60	35
U.S. Supplier B	120	20
U.S. Supplier C	110	50
Japanese Supplier A	6	4
Japanese Supplier B	13	13
Japanese Supplier C	40	40

Source: DATAQUEST
May 1983

Quality can be simply defined as performance to specification, and reliability is then defined as continued performance to specification over time. As quality improves, the focus of concern shifts to reliability because any decline in quality will show up as early infant mortality. Xerox has adopted a reliability guarantee program with some of its suppliers. Once the supplier has established an adequate reliability record, Xerox establishes an agreement that requires the supplier to monitor and report on his product's reliability and to perform any necessary tests and measurements. Typically this involves a sample of 500 parts per month, per device family.

In 1979 Xerox did 100 percent burn-in for all suppliers. In 1980 one supplier was involved in the guarantee program with an infant mortality rate of 0.3 percent. In 1981 three suppliers were involved and the infant mortality rate was raised to 0.2 percent. In 1982 the rate remained at 0.2 percent and five suppliers were involved in the project. In 1983 the infant mortality rate has been set at 0.15 percent.

Vendor commitment is an essential ingredient of this type of system, and Xerox considers it essential that the monitor/alert program be completely organized and administered by the vendor. So far the program works well with major suppliers that do $3 million or more of business with Xerox. The key to enhanced quality amd reliability lies in constantly improved communication between users and suppliers of semiconductor devices. Feedback on both incoming inspection data and field failures will give the suppliers the data they need to continue to improve their products.

Jean Page

Nielsen Dataquest USER UPDATE

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CHIP-ON-BOARD AND OTHER SURFACE-MOUNTED PACKAGES

SUMMARY

Surface-mounted device technology is currently receiving considerable attention. Some analysts estimate that 60 percent of all electronics manufacturers will be using surface-mounted devices to some extent within the next five years. Many manufacturers of semiconductors and passive components now supply their products in surface-mounted packages, offering substantial savings in size, weight and total cost of materials over conventional package use. Procurement professionals need to be aware of the options available. This Research Newsletter describes the types of packages available; considers the advantages to be gained from using surface-mounted devices; and discusses the technologies appropriate to specific industries. We also include information on companies offering surface-mounted assembly services. The newsletter ends with a discussion of the advantages and disadvantages of moving to surface-mounted technology.

SURFACE-MOUNTED COMPONENTS

As the price per function for integrated circuits has declined to less than 0.1 cent, the focus of attention for cost-saving has shifted from the device itself to the interconnect and packaging technologies. A number of ideas have surfaced, from the extreme of doing away with the package altogether by mounting the chip directly onto a printed circuit board, to a range of innovative package types including small outline integrated circuits (SOICs), leaded and leadless chip carriers, and flat-paks.

Chip-on-Board

Chip-on-board assembly involves attaching an unpackaged integrated circuit directly on a printed-circuit board, wire-bonding it, and usually coating the bonded chip with epoxy. The method is not new. It is widely used in inexpensive digital watch modules and calculators, and it is currently enjoying a revival of interest mainly from video game cartridge manufacturers. The advantages of chip-on-board are space and weight savings and the elimination of package costs. The main disadvantages of the method are problems associated with ensuring the hermeticity of the epoxy coating.

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The main methods for procuring devices for use in chip-on-board products are purchasing tested chips and buying chips already attached and wire-bonded to a printed-circuit board, such as the 32K mask-programmable ROM recently announced by Senitron Corporation. The inherent problems associated with the use of unpackaged chips make it unsuitable for high-reliability applications.

One development in the use of bare chips that deserves some attention is the use of tape automated bonding (TAB) with bare chips. In the TAB process, chips are bonded to the inner leads of patterns that have been etched from a thin layer of copper laminated onto an insulating film. The film with the copper patterns comes in the form of tape, and the whole process is highly automated. This technique replaces the more traditional wire bonding methods. In those areas where chip-on-board technology is appropriate, bare TAB use will probably increase at the expense of wire-bonded bare chips.

Small Outline Integrated Circuits (SOICs)

SOICs were originally developed by N.V. Philips for low-cost watch circuits and subsequently have been widely used in hybrid circuits.

The package is a surface-mounted device approximately 0.155 inches wide and 0.055 inches high; the length varies from 0.196 inches for an 8-pin package to 0.390 for a 16-pin package. Leads are usually on 0.050-inch centers. Because the packages are so small, available products are limited to devices with a chip area of less than 13,000 square mils. Companies are developing wider-bodied packages that will accept larger die. These packages will be available with 18, 20, or 28 pins. Although there is only a limited amount of reliability data for SO packages, manufacturers claim that their reliability is comparable to that of DIPs. The packages are designed to withstand immersion in solder at 260°C for 10 seconds without damage, so that they can be wave-soldered to a printed circuit board.

Most of the products currently available in SO packages are analog or TTL logic. Philips and Signetics also supply CMOS 4000 products in this package and RCA is expected to produce these devices in the near future. Table 1 lists current suppliers of surface-mounted devices.

Although SOICs are currently more expensive than DIPs, the total product cost is less because of the decrease in materials used. SOIC prices are expected to reach parity with DIPs by 1985 at the latest.

Table 1

SUPPLIERS WHO OFFER PRODUCTS IN SURFACE-MOUNTED PACKAGES

Advanced Micro Devices	NEC
American Microsystems	Oki
Amperex	Panasonic
Analog Devices	Philips
Thompson CSF	Raytheon
Exar	RCA
Ferranti	Rohm
Fujitsu	Sescosem
Harris	Silicon General
Holt, Inc	SGS-Ates
Hitachi	Siemens
Hughes Semiconductor	Signetics
International Microcircuits, Inc.	Sprague
Inmos	Texas Instruments
Intel	Toshiba
JRC	TRW
Monolithic Memories	Western Digital Corporation
Mostek	Zilog
Motorola	

Source: AWI and DATAQUEST
March 1983

Chip Carriers

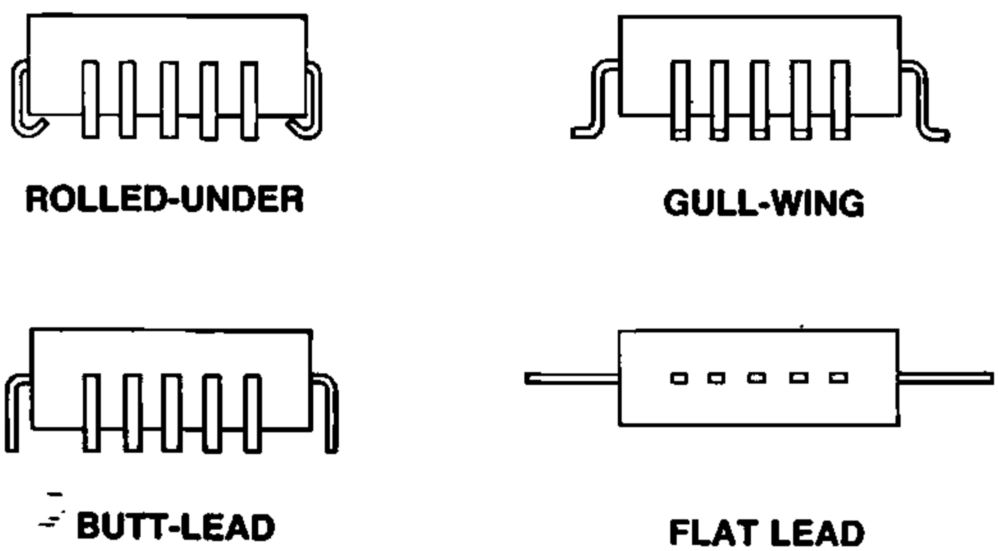
Chip carriers can be either leaded or leadless. They are square packages with connections on all four sides on 0.040-inch or 0.050-inch centers. The packages are one-third or less the size of a DIP with the same pin count. They also offer a viable solution for high-pin-count devices.

Leadless chip carriers are ceramic packages and are usually mounted on ceramic substrates or in sockets on printed circuit boards. They are capable of meeting military specification requirements. Disadvantages of ceramic chip carriers are their high price and the fact that their thermal coefficient of expansion (TCE) differs from that of commonly-used printed circuit boards, causing electrical and mechanical fatigue under heat stress. Although this problem can be overcome by mounting the chip carrier in a socket, the socket causes much of the size advantage to be lost. Ceramic chip carriers will continue to be used, predominantly in the military market, but they will account for a decreasing percentage of total chip carrier use in coming years.

Leaded plastic chip carriers offer good potential as packaging for devices with a pin-count between 20 and 84. The leads from these packages may be formed in four different ways (see Figure 1). The rolled-under form is proving the most popular since this displays the same footprint as a ceramic leadless chip carrier and takes up the smallest amount of board space. The problem of TCE differential between the printed circuit board and the device does not occur because the leads are designed to absorb thermally induced stress.

Figure 1

LEAD FORMS FOR LEADED CHIP CARRIERS



Source: Motorola
March 1983

Discrete Devices

Discrete devices have been available in SOT 23 since 1967 and more recently in the SOT 89 packages. Both packages are suitable for automated surface mounting. Products available in such packages include bipolar and field-effect transistors and switching, zener, and varactor diodes. They offer substantial space savings over conventional discrete package types.

Passive Components

Capacitors and resistors are available in surface-mountable form. This means that boards using 100 percent surface-mounted components are now possible.

USING SURFACE-MOUNTED COMPONENTS

Surface-mounted devices offer a number of advantages to users including:

- Board size reduction up to 75 percent
- Lower overall cost because of decrease in materials used
- Weight reduction of up to 40 percent
- Ease of assembly automation
- Lower parasitic inductance, offering potential for speed improvement
- Ability to be used on a wide range of substrates

Table 2 shows the percentage size reduction, and the following detailed example will demonstrate some of the other advantages. AWI, a Santa Clara company specializing in surface-mounted circuit assembly, replaced a small printed circuit board containing four 14-pin DIPs and six carbon resistors with a miniaturized surface-mounted device version containing four SOICs and six chip resistors (see Figure 2). Table 3 shows the improvements obtained using surface-mounted technology.

Table 2

COMPARISON OF DIPS WITH SOICS AND
CHIP CARRIERS ON 50-MIL CENTERS

Pin Count	DIP (sq. in.)	SOIC (sq. in.)	Chip Carrier (sq. in.)	Reduction in Area
8	0.096	0.030	-	69%
14	0.186	0.053	-	72%
16	0.198	0.061	-	69%
20	0.300	-	0.126	58%
24	0.720	-	0.160	78%
28	0.840	-	0.203	76%

Source: DATAQUEST
March 1983

Table 3

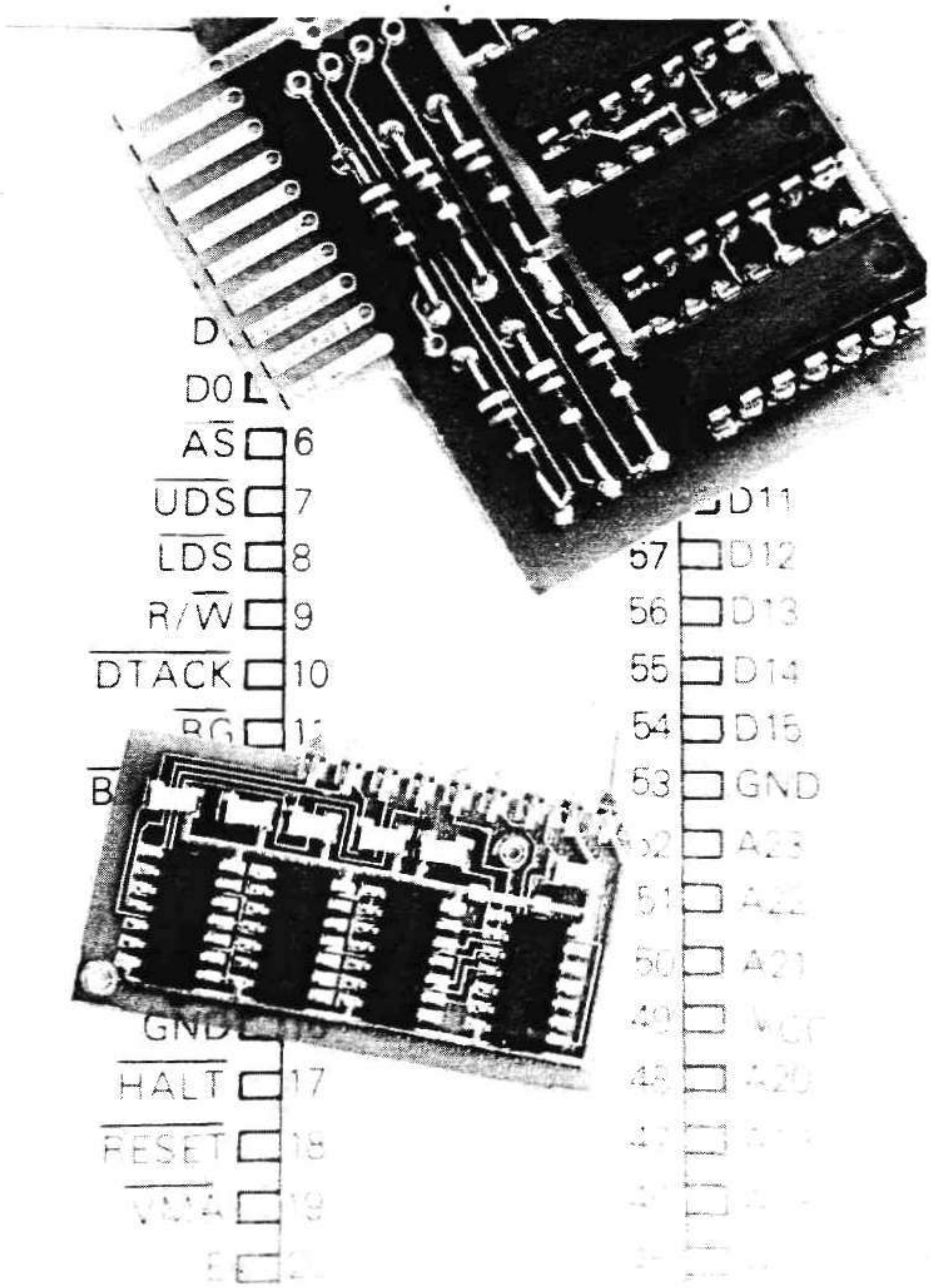
SURFACE-MOUNTED TECHNOLOGY IMPROVEMENTS
OVER CONVENTIONAL PRINTED-CIRCUIT BOARD

Size reduction	60%
Weight reduction	40%
Cost reduction	40%
Speed improvement	20%

Source: AWI
March 1983

Figure 2

COMPARABLE PRINTED CIRCUIT BOARDS USING
CONVENTIONAL AND SURFACE-MOUNTED DEVICES



Source: AWI
March 1983

ELECTRONICS MANUFACTURERS AND SURFACE-MOUNTED TECHNOLOGY

Chip-on-Board

Chip-on-board technology is most attractive to manufacturers of consumer products. Foremost among these products are video game cartridges. Many watch and calculator manufacturers have used chip-on-board in the past and will continue to be attracted by the savings in cost, size, and weight that the method offers.

Surface-Mounted Devices

Surface-mounted devices are attractive wherever size and weight are important considerations. Leadless ceramic chip carriers are gaining wide acceptance in the military market for use in hybrids and on ceramic substrates. SOICs and plastic leaded chip carriers are finding wider applications. Kodak uses a surface-mounted IC and chip capacitors and resistors in its disk camera and is planning to extend its use to other products. The Delco Division of General Motors is making a major commitment to the use of surface-mounted technology, initially with passive components and ultimately with both discrete devices and integrated circuits. Delco has stated plans to implement across-the-board surface mounting for all semiconductors, including ICs, possibly by 1985 and certainly before 1990. Other areas where surface-mounted devices offer significant potential include portable computers and calculators and medical electronics.

Innovative Assembly Methods

Innovative examples of bare-chip assembly methods are used in the HP 9000 32-bit computer and the Honeywell supercomputer. In the HP 9000, IC chips are mounted directly on a Teflon-coated, copper-core circuit board called a finstrate. (Teflon is a trademark of DuPont.) The finstrate technology combines the function of cooling fins and ceramic substrate. The finstrate provides both multilayer electrical connection and a means of heat dissipation. Honeywell used tape automated bonding in an innovative way in its DPS 88 range of supercomputers. After attachment to the TAB frames, the chips are mounted, active side down, on a multilayer ceramic substrate. They are attached to the substrate with an epoxy that conducts heat but not electricity. Each substrate unit is 80 x 80 mm and can hold up to 110 chips. The devices are water-cooled. These are only two examples of how companies are addressing the problems of assembly and interconnect technology.

ASSEMBLY SERVICES FOR SURFACE-MOUNTED DEVICES

Although the advantages of using surface-mounted devices can be readily demonstrated, many companies are deterred from using them by the cost of investing in new assembly equipment. An alternative to this investment is the use of an assembly service specializing in surface-mounted technology. DATAQUEST has identified three companies in the United States that specialize in this area.

AWI

AWI's Micro-Min process is a computer-controlled surface-mounted circuit assembly service. The company maintains a comprehensive data base of all circuits available in surface-mountable form, and will work with customers either to design new products or to redesign products that have been built using conventional packages. AWI also has an in-house CAD system and a staff of trained design engineers.

AWI will also work with companies that wish to establish their own surface-mounted device assembly lines. The company's address is:

AWI
3212 Scott Blvd.
Santa Clara, CA 95050

Telephone: (408) 727 9912

INI

Integrated Networks Inc. (INI) works exclusively with ceramic substrates. The company will perform both design and assembly. Most of the circuits produced by INI are used in personal computer peripheral devices, test equipment, and power supplies. The company's address is:

Integrated Networks Inc.
3185 Airway, Unit G
Costa Mesa, CA 92626

Telephone: (714)641 9250
TWX: 910-596-1382

SMD Technology Center

The SMD Technology Center was established in April 1982 by North American Philips to demonstrate and advance surface-mounted technology. The center offers technology seminars to educate users on all aspects of surface-mounted technology including the devices, packaging, placement, processing, and materials. It also offers assembly services and is willing to work with companies on all aspects of the design and production process. The center can help with new board design from a schematic, redesign of an existing board, and assembly only. It will also work with users to help in the selection of placement equipment from the broad range now available for an in-house assembly line. The SMD Technology Center's address is:

SMD Technology Center
5855 North Glen Park Road
P.O. Box 2087
Milwaukee, WI 53201

Telephone: (414) 228 7632

ADVANTAGES AND DISADVANTAGES OF USING SURFACE-MOUNTED DEVICES

The intial advantages of using surface-mounted devices are the reduction in size and weight, and the total materials cost savings. Using an estimate of $0.17/square inch, and a 60-percent size reduction, cost saving on a 5 x 7-inch board would be $3.57. Since minimal PC board drilling is required for surface-mounted devices, this cost, estimated at $0.001-$0.002 per hole, is also saved. Printed circuit board costs can often be reduced further because the denser wiring pattern that is possible with surface-mounting allows the use of fewer board layers. Surface-mounted circuit boards often show performance improvements over similar conventional circuit boards because lowered parasitic inductance enhances speed. This also reduces the number of components required: for example, damping resistors on memory lines can be eliminated.

The use of surface-mounted devices readily lends itself to assembly automation. A number of equipment manufacturers now offer pick and place equipment for this purpose. Delco is anticipating run rates 70 times faster than with its conventional automated insertion equipment.

The disadvantages associated with the use of surface-mounted devices are typically those associated with the adoption of any new technology. Although the total materials cost of a surface-mounted board is typically lower than that of a comparable conventional board, the individual surface-mounted devices still command a price premium over conventional packages. They are expected to achieve price parity by 1985. Although assembly is easily automated, the equipment cost of establishing an assembly line is substantial. An interim step could be the use of an outside assembly house, such as mentioned earlier in this newsletter, for initial production.

There are currently more than 6,000 different surface-mountable devices available, including both active and passive components, but this still does not compare with the full range of products available in conventional packages. However, pressure from major manufacturers that adopt surface-mounted technology will encourage the expansion of the product range.

Japanese and European electronics manufacturers have adopted the use of surface-mounted devices more readily than their U.S. counterparts. The earliest applications of surface-mounted devices were in areas of consumer electronics- -areas that receive more emphasis in Europe and Japan than in the United States. Our research suggests that Japan is three to five years ahead of the United States in the use of surface-mounted technology and many Japanese companies have completely automated the assembly process. In the long term, this technology will be substantially more cost-effective than current packages, and it deserves careful consideration by electronics manufacturers.

Jean Page

Nielsen Dataquest USER UPDATE

TOPICS:
EEPROMs
Price Trends

SUIS Code: Vol. I Newsletters
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EEPROMS

OVERVIEW

Electrically Erasable Programmable Read Only Memories (EEPROMs) have been available for ten years. Recent technology and design improvements are reducing costs and making the product attractive for a wide range of applications. Demand for EEPROMs will equal that of EPROMs in the future as prices decrease, densities increase, and applications proliferate. This Newsletter will bring you up to date on the status of EEPROMs, suppliers, and future trends.

EEPROM TECHNOLOGY

EEPROM is one of two terms used to describe nonvolatile semiconductor read only memories; the other is EAROM or Electrically Alterable Read Only Memory. Both terms are generally used interchangeably. Where differentiation is made, EAROM refers to the Metal Nitride Oxide Semiconductor (MNOS) technology and its derivatives, and EEPROM refers to the floating gate EPROM-related technology.

Regardless of the terminology used, EEPROM technology is difficult to manufacture. As a result, technology development has been slower than mask programmable ROMs or UV erasable EPROMs. Challenges exist because very thin oxides must be reproduced. Floating gate technology requires oxides less than 200 angstroms thick, while SNOS (a derivative of MNOS) requires 20 angstrom oxide thickness. Manufacturers must also master nitride processes, multilevel interconnect, and high-voltage device fabrication.

EEPROM manufacturers have selected floating gate or SNOS technology based on their prior experience. Companies that originally developed MNOS technology in the early 1970s are using its derivative, SNOS, for EEPROMs. General Instrument, NCR, and Nitron have taken this approach. More recent entrants, including Hitachi and Inmos, also use SNOS. Companies that have developed ultraviolet erasable PROMs first, have selected the floating gate EEPROM technology. Intel, Hughes, Motorola, National, SEEQ, and Xicor have taken this approach. Each of these technologies presents manufacturing challenges that must be overcome to achieve high-volume, low-cost production. The companies manufacturing them have competent, experienced engineering teams. As companies ramp up production of

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high-density EEPROMs in the next nine months, we will see if one technology will be superior to the other. Users should follow the progress of EEPROM manufacturers during this build-up phase to assure themselves adequate supply of product should a particular technology experience volume production problems. Longer-term concerns revolve around the adaptability of each technology to smaller device geometries and related process adjustments. It will be several years before that question is answered. Fortunately for EEPROM users, product specifications will be the same regardless of the technology used to manufacture them.

Applications

EEPROMs open up applications never before possible. Permanently stored programs can be remotely altered or adapted under computer control based on changes in the computer environment. Although, only a few of the opportunities have been identified to date, creative engineers will find many more in the future. Some of the existing applications follow:

- Low-Density EEPROMs (≤4K)
  - Solid state TV tuners
  - Radio tuners
  - Cable TV tuners
  - DIP switch replacement
  - Odometers
  - Counters and timers
- High-Density EEPROM (≥8K)
  - Terrain mapping computers
  - Fire control computers
  - Self-calibrating instruments
  - Self-calibrating machine tools/numerical control machines
  - Point-of-sale terminals/gasoline pumps
  - Remote alterable look up tables
  - Remote firmware
  - Remote diagnostics

One of the existing manufacturers, SEEQ Technology, has applied EEPROM technology for product identification and traceability. The techniques SEEQ uses are called Silicon Signature and Silicon Traceability. The Silicon Signature provides product identification and programming information, and may be used to set up programming machines that are designed to read the information from the chip. Silicon traceability provides information that tells the user detailed manufacturing processing history for each device.

Suppliers and Products

At least 20 companies manufacture or are planning to manufacture EEPROMs. Table 1 lists some of these companies according to technology.

Table 1

EEPROM MANUFACTURERS

Floating Gate Technology	SNOS/MNOS Technology
Hughes Aircraft Company	General Instrument Corporation
Intel Corporation	Hitachi, Ltd.
Motorola, Inc.	Inmos, Ltd.
National Semiconductor Corp.	Matsushita Elec. Industrial Co., Ltd.
NEC Information Systems	Mitsubishi Elec. Industrial, Ltd.
SEEQ Technology	NCR Corporation
Siemens AG	Nitron, Inc.
Xicor, Inc.	Plessey Company
	Toshiba

Source: DATAQUEST
January 1983

Other companies making EEPROMs are Harris Corporation, Panasonic, SGS-ATES, and Sanyo.

Harris Corporation and Hughes Aircraft Company have focused on CMOS technology. Other manufacturers are using NMOS technology. General Instrument Corporation, NCR Corporation, and Nitron, Inc., offer a variety of low-density products that they have developed with the original MNOS technology. National has also entered this low-density area targeting consumer and automotive applications.

Recent new product activities are focusing on higher density EEPROM products, particularly 16K devices and larger. These high-density products are being used for the new applications discussed previously in this newsletter. The first 16K EEPROM was the Intel 2816, introduced in 1980. This device required 21-volt programming voltage, programming pulse shaping, external timing, and latch circuitry. Other manufacturers have followed Intel's lead with pin-compatible products offering improvements over the original design. These products are summarized in Table 2.

Table 2

16K EEPROM PRODUCTS

Company	Type No.	Features
General Instrument	5816	Compatible with 2816
	5916	5-volt only, external interface required
	5716	Interchangeable with 2716 EPROM, pin-compatible with Hitachi 48016P
Hitachi	48016P	Interchangeable with 2716 EPROM, external interface required
Hughes	3316	28-pin, 5-volt programmable, on-chip pulse shaping and interface circuitry
Intel	2816	21-volt programming voltage, pulse shaping, external timing, and latch circuitry
	2815	Low-cost, slow write time (50ms)
	2817	28-pin, 5-volt programmable, on-chip pulse shaping and interface
	2816A	24-pin, 5-volt only, external interface required
	2817A	5-volt only, all interface on-chip
National Semiconductor	2816	Compatible with 2816
	9716	On-chip pulse shaping, 5-volt programming pulse, external interface required
SEEQ	5312	5-volt only, external interface required; compatible with 2816
Xicor	2716A	5-volt programmable, on-chip pulse shaping and interface

Source: DATAQUEST
January 1983

NEW PRODUCT TRENDS

We expect higher density EEPROMs to be introduced during the next several years. EEPROMs of 32K and 64K densities will be introduced in 1983, and by 1985, we expect companies to introduce 128K and 256K EEPROMs. Intel Corporation, Motorola, Inc., NCR Corporation, SEEQ Technology, and Xicor, Inc., have announced plans to introduce 32K and 64K EEPROMs. It is also believed that Advanced Micro Devices, Inc., has a program to develop 32K and 64K EEPROMs in the 1983/1984 time frame. We expect more Japanese companies to begin offering high-density EEPROMs as well. EEPROMs are standard memory products that fit the Japanese strategy of offering products that lend themselves to high-volume production. EEPROMs will achieve the desired volume levels by the late 1980s.

Furthermore, we expect EEPROM technology to be incorporated into microprocessors and other VLSI logic functions. SEEQ and Rockwell International have a cross-licensing agreement that will result in Rockwell producing a single chip microcomputer with the ability to adapt its own program. Texas Instruments plans to incorporate EEPROM memory into its TMS7000 family of microcontrollers. Synertek has also introduced a custom product capability that could include EEPROM on-chip.

PRICE TRENDS

This discussion will focus on price trends for 16K EEPROMs since that is currently the most active area. During 1981 volume prices were in the range of $20. By mid-1983 we expect 25K quantity shipments of commerical 5-volt-only EEPROMs priced at $10. DATAQUEST expects that by the end of 1983 manufacturers will begin shipping product at $5 in volume. These prices will be charged for products with the longest access times. Higher speed devices will sell at a premium.

SUPPLY/DEMAND CONSIDERATIONS

Low-density EEPROM (≤4K) shipments exceeded 40 million units through 1982, while high-density shipments were less than two million, mostly 8K devices. To date, less than 1 million 16K EEPROMs have been shipped, almost all of them in 1982. User demand for 16K units is expected to grow 400 percent in 1983 to 4 million units, and 150 percent in 1984 to 10 million units. Users should carefully track the production capability of manufacturers from whom they are buying. More advanced products like the 5-volt-only type may be more difficult to buy than devices like the original 2816. DATAQUEST will track and report on this in future newsletters.

DATAQUEST believes that manufacturers will set prices of 32K and 64K EEPROMs to be competitive with 16K devices on a per bit basis early in the 32K/64K product life cycle. As a result of this strategy, DATAQUEST expects demand for 16K EEPROMs to peak in 1984 and that 32K and 64K shipments will exceed that of 16K devices in 1985.

SUMMARY

EEPROM technology has entered a period of rapidly increasing acceptance by users and resulting high growth in demand. Rapid improvement of the technology is producing many new products that will quickly obsolete existing generations of products. As a result, users should carefully track product development and long-term pricing trends. New system designs should use those products that will provide the lowest overall cost over the manufacturing life of the system.

Since EEPROM technology is difficult to manufacture, users should expect short-term delivery problems as production volumes ramp up. Manufacturers will be increasing production at the same time they are solving technology-related processing problems. DATAQUEST will track this technology closely and report on important developments as they happen.

PRICE TRENDS—THE QUARTER AND THE YEAR

In the last Price Trends Newsletter, published 30 September 1982, we based our estimates on our expectations of a slight economic recovery in 1982 and a substantial economic upturn in mid-1983. The 1982 improvement was slight indeed and, although there are definite signs of improved activity in 1983, the expectations of most of those surveyed have moderated to some extent. The following overview of semiconductor price trends was compiled from interviews with a wide range of semiconductor users, suppliers, and distributors.

MICROPROCESSORS

After a relatively stable period for pricing, most 8- and 16-bit microprocessors are experiencing renewed price pressure. In the last quarter of 1982, 16-bit microprocessor prices were flat or down by less than 5 percent. All the manufacturers participating in the market are anxious to establish a strong market position. One way of achieving this is by price-cutting, especially for large-volume purchases. Over the coming year, DATAQUEST anticipates price declines of approximately 5 to 10 percent per quarter.

Prices for the older 8-bit microprocessors, such as the Z80, 6502, and 8085, are expected to remain relatively stable as they near the low price point in their life-cycles. Newer 8-bit devices, such as the 6809 and the 8085, are beginning to experience the same kind of price pressure as 16-bit devices as they enter volume production and as more second sources join the market.

The 32-bit microprocessor has yet to establish a substantial market presence. As more samples become available the prices are expected to move sharply down the learning curve.

Microprocessor Peripherals

Microprocessor peripherals are experiencing price pressure for the first time in several months. In our last Price Trends Newsletter we stated that local area network (LAN) and Winchester disk control chips would artificially support the average selling price (ASP) of microprocessor peripheral chips. While this has been true to some extent, delays in volume production of these devices have moderated their effect on the ASP. Prices for Serial I/O chips and CRT controllers are expected to decline dramatically—perhaps as much as 50 percent by the end of 1983. The reasons for such a sharp price decline for these devices are the increase in the number of manufacturers competing in that market, and the rapid growth in volume production, which is fueled in part by the burgeoning personal computer market.

Microcomputers

Prices for both 4- and 8-bit single-chip microcomputers declined substantially in 1982. We expect prices to remain stable over the first quarter of 1983 and to decline slowly during the rest of 1983. Average selling prices for 4- and 8-bit microcomputers will be sustained to some extent by relatively high prices of the newer 4K and 8K internal ROM devices such as the 8051 and 8052.

The latest entrants in the microcomputer market, 16-bit devices such as the 9940 and the 8096, are expected to show stable pricing for the whole of 1983. These devices will find a ready market in the area of robotics.

MEMORY DEVICES

Memory device prices are currently under pressure, except in a few high-performance niche markets where only one or two suppliers are offering parts. We expect price declines to continue throughout the first half of 1983, and possibly on into the second half.

Dynamic RAMs

The market for 4K dynamic RAMs is declining rapidly, and most manufacturers remaining in this market are expected to offer end-of-life buys by the middle of 1983. Prices are flat to up slightly. Prices for 16K dynamic RAMs are stable and expected to remain so as a number of manufacturers leave the market. The market for 5-volt-only 16K dynamic RAMs is still strong. However, prices are expected to decline by 10 to 15 percent in 1983 and to continue to decline into 1984.

Price pressure on 64K dynamic RAMs will continue into mid-1983 and possibly beyond, depending largely on the rate at which demand builds. The price for volume purchases declined by more than 15 percent between the last quarter of 1982 and the first quarter of 1983, and we expect prices to decline a further 25 percent by mid-1983. We do not expect the price to stabilize later in the year as it did in 1982, although the rate of decline may slow.

Static RAMs

We expect the slight overall price decline in 1K and 4K static RAMs to continue. High-performance parts continue to command a premium over low-performance parts and their prices are correspondingly more stable. Prices for 16K static RAMs continue their rapid decline although the relatively small market for high-speed (45ns) devices is more stable. Prices for 2Kx8 16K static RAMs are declining as more manufacturers become competitive in that market. We expect these prices, which have declined steadily over the past year, to decline up to 20 percent more by the end of 1983. Currently, the high-speed parts (less than 100ns) command a price differential of 2 to 1, but this is expected to erode during 1983, and by the end of 1983 the premium is likely to be about 60 percent. Very high-performance parts (less than 55ns) can often command an additional 50 to 100 percent premium.

ROMs

Many manufacturers originally saw the ROMs market as extremely attractive, but concerns that the video games market may not be as vast as was originally anticipated have resulted in excess capacity. The natural result of such a situation is price pressure. The price of 32K ROMs declined 35 percent in the last 5 months of 1982, and the price of 64K ROMs declined by 25 percent in the same time frame. At present, CMOS devices command a 20 to 30 percent premium but we expect this premium to decline as more suppliers offer CMOS products.

EPROMs

EPROMs have been under extreme price pressure in recent months although prices for 16K devices are now stabilizing. Prices for 32K EPROMs are expected to decline approximately 10 to 15 percent over the next 6 months. The market for 64K EPROMs is extremely competitive, as slackened growth in the games market has also affected this area, causing considerable price pressure on these devices. Intel is the major supplier of 128K EPROMs and is rapidly bringing down the price of these devices. Intel has the stated objective of making the 128K device the lowest price-per-bit EPROM by April 1983, and is expected to achieve this objective. Other manufacturers, including AMD, Fujitsu, and Hitachi, are expected to begin volume production of these parts early this year.

Bipolar PROMs

Unit demand for PROMs has been flat to slightly down since 1980 and is not expected to grow dramatically in the near future. For this reason, DATAQUEST believes that manufacturers are no longer pursuing market share by cutting prices, instead they are endeavoring to maintain revenues by keeping prices relatively steady. We expect prices for bipolar PROMs to decline only 5 to 10 percent by the end of 1983.

LOGIC

Manufacturers of bipolar logic are still experiencing some price pressure, although it is not as strong as in 1982. Typically, prices for the more mature families such as standard TTL and Schottky TTL are expected to remain relatively stable in the next quarter, while prices for ALS and FAST are expected to decline by 3 to 5 percent. Over the course of 1983, ALS and FAST prices are expected to decline more rapidly than we had originally anticipated. By then the price premium for ALS over LS should be down to 50 percent, as should the premium for FAST over S. This rapid decline is mainly due to aggressive price policies being pursued by manufacturers of the advanced products to encourage users to include the new products in future designs.

ECL logic prices are also expected to decline, with 10K prices declining more rapidly than we had previously expected, possibly by as much as 8 percent per quarter during 1983.

LINEAR

The lack of standardization in the linear market makes it less price-competitive than other IC markets. However, we anticipate some continuing price erosion in the linear market over the coming year. Price declines are expected to average 5 percent in the first half and to become more stable in the second half. Commodity products such as operational amplifiers will probably decline more than the average, but data acquisition circuits should be more stable.

Assuming an improvement in the economy by mid-year, two factors should affect the stabilization of linear pricing—increased demand and the probability that some linear commodity manufacturers will drop their less profitable lines, leaving those who remain in the market in a stronger position.

Stan Bruederle
Jean Page