European Semiconductor Industry Service Newsletters

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Research *Newsletter*

PRELIMINARY 1990 EUROPEAN SEMICONDUCTOR MARKET SHARE ESTIMATES: PHILIPS BUCKS THE TREND

INTRODUCTION

Dataquest has completed its preliminary estimates of calendar year 1990 European semiconductor market shares. In a year of very low worldwide growth, there are a few success stories. This newsletter records the main results of this survey:

- Philips continues as the number one semiconductor vendor in Europe, with sales of $1,104 million. This represents a growth of 14.5 percent. LSI Logic achieved the highest growth rate of Europe's top 20 companies with 24.7 percent. Europe's top 6 ranking companies remain the same as in 1989.
- For the first time since 1978, European-owned companies increased their worldwide market share, as shown in Figure 1, from 9.5 percent in 1989 to 10.5 percent in 1990. This is mainly as a result of an increase in share in domestic markets.
- The 1990 European semiconductor market grew by 9.6 percent when measured in US dollars, to $10,693 million, as shown in Table 1. In local currency however, this positive growth rate is reversed due to the weakening US dollar. The European market when measured in European currency units (ECUs) declined by 4.7 percent (Table 2).
- European-owned companies' share of the European market increased by 1.7 percentage points, as shown in Table 3 and Figure 2. In 1990 these companies captured 38.2 percent of the European market.
- North American–owned companies' share also grew by 0.6 percentage points, and they now control 41.9 percent. This is mainly due to their strength in the MOS microcomponents market, which grew by 26.2 percent in US dollars.
- The increased share of European- and North American–owned companies was at the expense of Japanese and Rest of World (mainly Korean and Taiwanese) companies. The Japanese companies now account for 17.8 percent of the European total available market (TAM), and ROW vendors account for 2.1 percent.

For product definitions and footnotes to the tables, see the Appendix.

PRELIMINARY EUROPEAN MARKET RESULTS

Product Growth Trends

Our preliminary estimates of 1990 product growths in Europe are given in Tables 1 and 2. Table 1 gives the European market in dollars and Table 2 in ECUs. Expressed in dollars the European market grew by 9.6 percent over 1989 reaching $10,693 million. However, true market performance is revealed when the revenue is expressed in ECUs. As Table 2 shows, the European market actually declined by 4.7 percent reaching a revenue of ECU 8,554 million.

Of the major product markets, Europe's analog, MOS microcomponent and discrete categories showed the strongest growth. The growth in analog was due in part to Dataquest's reclassification of mixed analog/digital ICs in the analog category. As a result, some vendors' sales, which had previously been reported in MOS logic and bipolar logic, were transferred to analog. However, the analog market did experience some strong organic growth. Growth in consumer and telecommunication ICs

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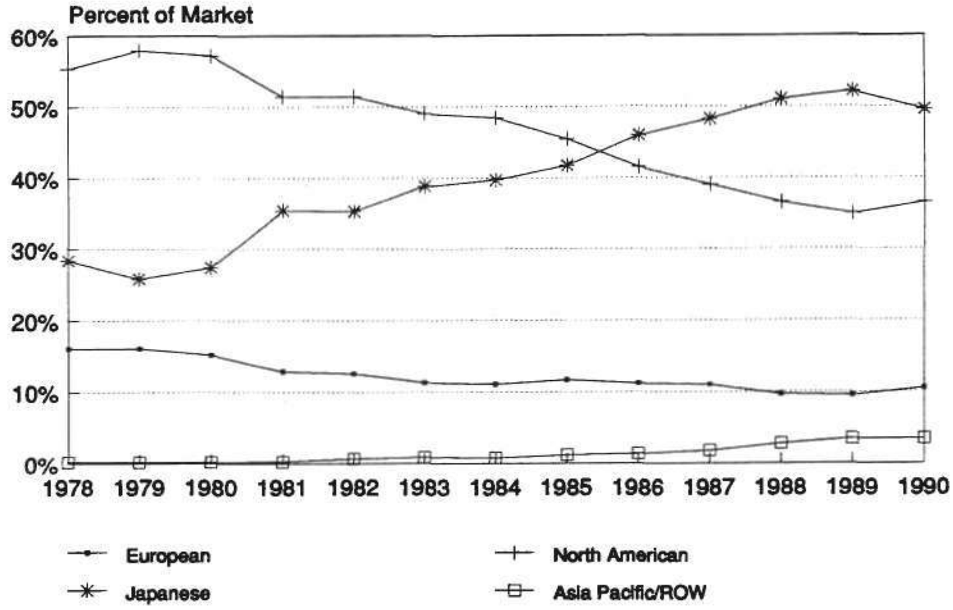
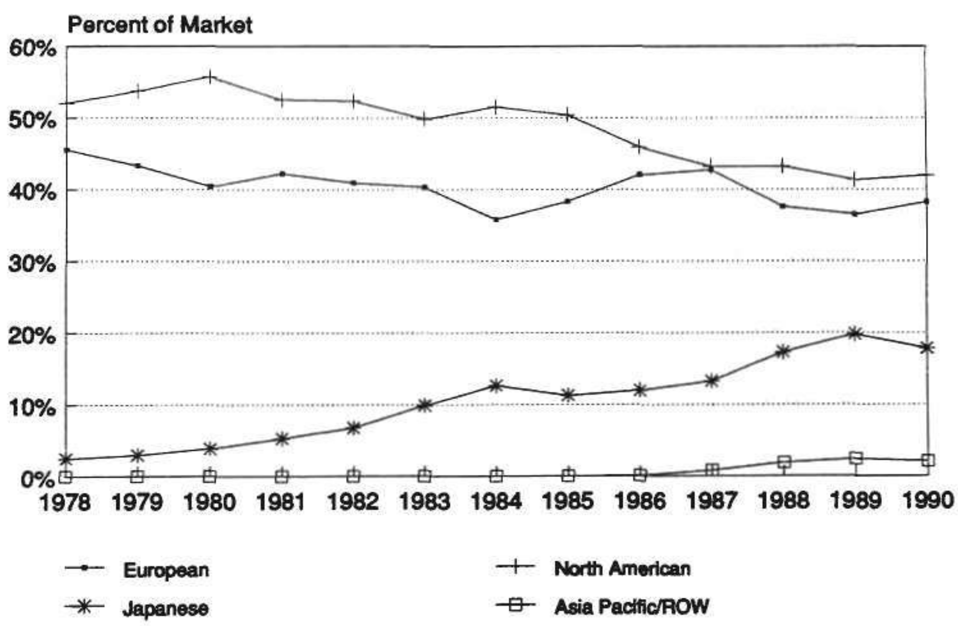
FIGURE 1
Worldwide Semiconductor Market Share by Vendor Base



Source: Dataquest (January 1991)

FIGURE 2
European Semiconductor Market Share by Vendor Base



Source: Dataquest (January 1991)

was driven by demand from TVs, VCRs, and central exchanges. The high growth in MOS microcomponents was based on strong sales of microcontrollers and 16/32-bit microprocessors. The unit growth came from consumer, telecommunications, automotive, and PCs.

Some of the profitable discrete growth came from power semiconductors, which found increasing application in electric trains for public transport systems, uninterruptible power supplies for computer systems, and AC motors for various industrial applications.

The MOS memory market declined by a staggering 22.1 percent in ECUs over 1989. The severe price decline in DRAMs, which represents over 60 percent of the MOS memory market was the major factor. Other memory areas such as SRAM and EPROM also saw price erosion. The combination of these negative factors affected vendors who derived a large percentage of their revenue from this segment.

The weakest product area was bipolar digital. This is a mature product area. Most of the product families in the largest subcategory, standard logic, are in decline as they are being replaced by ASICs, and application-specific standard products (ASSPs), such as PC chip sets. This was the third successive year of decline in bipolar digital.

Preliminary 1990 European Market Share Vendor Analysis

Total Semiconductor

Unlike 1989, Dataquest's preliminary estimates of European market share rankings for 1990 reveal no great surprises. The key points are that:

- Europe's big three—Philips, Siemens and SGS-Thomson—consolidated their top three positions, as shown in Table 4.
- Companies which derive a large percentage of their revenue from MOS memory saw their sales decline, or at best remain flat.

Philips retained the top position in Europe in 1990. Annual sales of $1,104 million represented a healthy 14.5 percent growth over 1989. Key to Philips' growth was good demand from TV and VCR manufacturers in Europe, including its own consumer division. This led to good sales growth in the company's microcomponent, analog and discrete products.

Siemens' 3.0 percent growth in 1990 reflected the large revenue the company derives from its DRAM business. Excluding MOS memory from its sales, the remainder of its semiconductor business grew by 14.6 percent. Two factors were of particular importance to Siemens in 1990: the strong business relationship it built with some major multinational computer companies; and the success of its telecoms division.

SGS-Thomson. European sales growth provided most of this company's worldwide increase in 1990. Key growth came from central exchanges, TV, VCR and automotive segments. As with Philips, microcomponents, analog and discretes were SGS-Thomson's key growth products. Although it has limited exposure to the DRAM market, it managed to overcome the price declines in the SRAM and EPROM markets by concentrating on the high-speed, high-density portion of the market.

Like SGS-Thomson, **Motorola** only has limited DRAM sales, but Motorola had one of the highest MOS memory growth rates in Europe last year, actually increasing both its SRAM and its DRAM businesses, although this was from a relatively small base. However, the main driving factor behind this company's respectable 17.2 percent growth last year was microcomponents, which represented 30 percent of its total sales and grew by about 30 percent. A factor behind its performance was the success of its mobile communications division, which procures semiconductors locally.

Texas Instruments (TI) falls into the group of vendors with high exposure in the MOS memory market. Due to its product mix in DRAMs and EPROMs, its revenue declined by 28 percent in this sector. Bipolar logic sales, which represented 22 percent of its European revenue last year, also declined by 3 percent. The positive side of the company's business was the success of its applications processor business in microcomponents, which grew by a massive 65 percent. Like other vendors in the analog IC market, TI benefited by growing this business at 25 percent.

Intel grew by nearly twice the market average in 1990. A 25 percent growth in microcomponent sales was balanced with an 11 percent decline in the MOS memory business. Naturally, with 84 percent of its sales coming from microcomponents (42 percent of this being microprocessors), this was the major driving force. Increased European procurement by PC manufacturers combined with a shift in demand from 80286- to 80386-based machines was key to growth in the company's revenues from microprocessors. In MOS memory, its declining sales revenue reflected the significant price erosion that took place in high-density EPROMs during 1990.

Toshiba defied the rule books in 1990. Despite deriving 50 percent of its revenue from MOS memory, the company managed a 23.9 percent growth in European sales in 1990. This success was due to a threefold strategy: firstly maximizing DRAM and SRAM average selling prices (ASPs); and secondly gaining more revenue from direct shipments to multinational computer companies and a number of Japanese equipment manufacturers which have set up in Europe. Some of these sales were booked in Japan and shipped direct to Europe. Finally, Toshiba also grew by rapid diversification away from MOS memory into other areas, such as MOS micro which saw 80 percent growth, MOS logic with 44 percent growth, analog with 32 percent growth and discretes with 50 percent growth.

NEC grew its European revenue by under 2 percent in 1990, well below market average. Of the MOS memory vendors, NEC was one of the worst-affected by the prevailing market conditions. MOS memory was 45 percent of its total sales, and it declined by 16 percent. The company minimized the overall impact of this by growing its MOS micro business by 24 percent. However, this was too little to save it dropping one place in the European rankings. NEC also benefited from increasing direct shipments from Japan to Japanese OEMs in Europe.

National Semiconductor's sales across all the major product categories was virtually flat in 1990. Analog, which represents 42 percent of its total revenue and is by far its largest product area, grew by 2 percent. Its other major business areas were bipolar digital, MOS logic and MOS micro, which represented 20, 16 and 12 percent of its total sales, respectively. Key markets for National were the telecoms and consumer segments, which gave the company its strongest growth in telecoms and consumer ICs, and microcontrollers.

AMD displaced Hitachi as Europe's tenth-largest semiconductor vendor in 1990, returning to Europe's top 10. However, its sales actually declined by over 2 percent. While its EPROM, MOS micro and analog businesses all grew, bipolar digital, which represents 25 percent of its European sales, declined by 27 percent pulling its overall result down. Two key factors that impacted AMD's bipolar PAL business were price erosion coupled with replacement by CMOS equivalents.

Among the other top 20 semiconductor vendors **Hitachi, Samsung, Fujitsu,** and **Mitsubishi** revenues all contracted due to prevailing market conditions in MOS memory. **GEC Plessey Semiconductors** emerged at number 14 following the merger of MEDL and Plessey Semiconductors. Despite good growth in European TV production, **ITT Intermettal's** sales declined, while **Telefunken's** sales increased due to the same factor. **Harris** consolidated its position following its merger with GE in 1989. Finally, **Analog Devices** and **LSI Logic** entered Europe's top 20 through strength in precision analog and CMOS ASICs, respectively.

Integrated Circuits

IC market rankings changed considerably in 1990. With the microcomponent market increasing and the memory market declining, this was to be expected. Philips fought back aggressively to regain the number one position in ICs due to its relatively low exposure in the MOS memory market, and growth in MOS microcomponents. Indeed, because of the market conditions in DRAMs, Siemens' negative IC sales meant this company fell to third position. The small negative growth was due to the positive results it achieved in MOS logic and analog, which came from telecommunications and automotive applications.

SGS-Thomson took second place, growing 22.8 percent over 1989, strengthened by analog IC sales to the telecommunications and consumer segments. The company also experienced growth in nonvolatile memory of 28.8 percent, although its SRAM sales have fallen from 1989.

Intel again outgrew the market by 9.5 percent and consequently rose one position to number four, displacing TI into fifth position. Intel's lower memory sales were counterbalanced by its huge increase in MOS microcomponents, where it consolidated its number one position. Motorola remained in sixth position despite growing its IC revenue by 20.2 percent. TI, NEC, Mitsubishi, ITT, National, and Telefunken all lost their previous slots, as shown in Table 5.

Bipolar Digital

The market continued to decline in 1990 with a 12.2 percent fall from 1989, as shown in Table 6. However, some companies such as Fujitsu and Motorola are experiencing positive growth with advanced ECL products. TI retains the number one position, and increased its market share from

22.2 percent on 1989 to 24.6 percent in 1990. This comes from its strong portfolio in bipolar standard logic, which has declined by less than the segment average.

MOS Digital

In 1990, Motorola was the fastest-growing vendor in the top 10, growing by 24.6 percent on 1989, and consequently jumped four places to number three. Intel remain the leading vendor in this category, having increased its market share to 11.2 percent. Toshiba climbed three places, while both TI and NEC fell, by three and two positions respectively. Philips' growth of 18.4 percent was not enough for it to change its ranking, but the company did gain 0.8 percent in market share to 5.7 percent. North American-owned companies grew quickest in this segment, increasing their market share to 43.0 percent.

MOS Memory

Siemens suffered heavily in this segment, with a decline of 17.8 percent, but still maintained its lead as the number one MOS memory supplier to Europe. Mitsubishi fell from the top 10 vendor ranking, with declining revenue of 26.0 percent over 1989. TI suffered the worst from the DRAM price erosion. Its revenue fell by 27.6 percent, enabling Toshiba, NEC and Samsung to leapfrog above it. Samsung has now developed a very strong base in Europe, supplying four generations of DRAM, from 64K to 4M. SGS-Thomson moved up one place on 1989 to number six on the strength of its EPROM sales, while Hitachi slipped a place.

On a brighter side, some vendors managed to grow well in excess of the market average, and in Motorola's case experienced very high positive growth. This came from increasing sales in its SRAM and DRAM businesses. European-owned companies' share rose by 1.5 percentage points to 21.9 percent; Japanese-owned companies' share fell from 44.3 percent in 1989 to 41.3 percent, while North American-owned vendors gained slightly, and Rest of World companies increased share by 0.5 percent to 8.7 percent.

MOS Microcomponent

MOS microcomponents saw the largest growth of all the main MOS product segments in 1990, growing by 26.2 percent. European companies grew the quickest at a rate of 35.5 percent, and subsequently control 19.4 percent of the market. Intel consolidated its number one position with an unassailable lead in this segment, with revenue that is more than twice the size of its nearest competitor, Motorola, as shown in Table 7. Intel's growth has been based on the success of the 80386 processor. Motorola gained market share in 1990, and now controls 12.5 percent of the market; this growth has come mainly from its microcontroller sales. Philips and Toshiba showed the largest growth in the top 10, and both climbed two places due to their strength in the controller and peripheral business. TI also climbed two places in the ranking, from eight to six, with increasing sales coming from its application-specific processor and DSP.

MOS Logic

The MOS logic market declined in 1990 over 1989, as shown in Table 8, but part of this was due to some logic devices being reclassified by Dataquest and now included in the analog IC segment under mixed signal devices. Four of the top 10 companies are European-owned, five are US-owned, and only one is Japanese. European-owned companies control 46.4 percent of this market, which represents a fall from 1989; North American-owned companies control 42.4 percent of the market and Japanese-owned companies 11.0 percent.

SGS-Thomson fell four places in the ranking, but this decline comes from the reclassification of products. Toshiba climbed six places, with a growth rate of 44.2 percent; this growth comes mainly from the strength of its MOS ASIC and, in particular, gate array sales. Although Philips' revenue declined it still retains the number one position, while Siemens retains second place. Motorola climbs two places, and GEC Plessey Semiconductors (GPS) "enters" the top 10 ranking list at number six.

Analog ICs

The analog IC market grew by a staggering 35.1 percent on 1989, as shown in Table 9. However, the above-mentioned product reclassification accounted for some of this. European-owned companies have increased their market share in this sector by 2.6 percent, and now control 50.7 percent. North American-owned vendors' share fell by 5.1 percent to 43.0 percent while Japanese-owned companies' share rose slightly to 6.0 percent.

There has been no change in the market positions of the top 7 vendors. Philips grew by 19.3 percent on the strength of its consumer business. SGS-Thomson grew a massive 54.9 percent, due to its strong product portfolio aimed at the telecommunications and consumer business. ITT, GPS and Mietec all enter the top 10 list for analog ICs for the first time. Sony's analog sales grew by 850 percent, but this was from a low base. Consumer IC products were the main reason for this, and consequently Sony has climbed 18 positions to number 14.

Discrete Devices

The 1990 European discrete market grew by 20.1 percent on 1989 and is now worth $1,915 million, as shown in Table 10. There was no change in the top five rankings, as Philips maintains its number one position with more than $100 million over its nearest competitor. However, the top six companies—Motorola, SGS-Thomson, Siemens, ITT and Telefunken—all grew below the average market rate of 20.1 percent. Telefunken climbs one place to number six, while Eupec enters the ranking at number seven for the first time as a new European company. European-owned companies increased their market share to 56.5 percent from 54.1 percent in 1989, while North American–owned vendors' market share fell to 32.4 percent. Japanese-owned companies gained slightly.

Optoelectronic Devices

The optoelectronic market grew by 9.0 percent over 1989 to $400 million, as shown in Table 11. European-owned companies' share fell slightly to 46.8 percent from 48.0 percent in 1989, as did North American–owned vendors' share. Japanese-owned companies increased their market share by 2.1 percent to 13.5 percent. In 1990, Hewlett-Packard fell two places from its 1989 number one position, as both Siemens and Telefunken achieved growth above the market average. Siemens controls 18.8 percent of this market segment. Most companies saw either flat or positive growth, the exceptions being Philips, TI and Motorola.

European-Owned Companies' Worldwide Market Performance

European vendors saw worldwide growth of 13.0 percent, well above the market average of 2.0 percent. They consequently increased their worldwide market share from 9.5 percent in 1989 to 10.5 percent in 1990.

Table 12 shows European vendors' worldwide sales. Philips, Europe's largest vendor, saw growth of 13 percent worldwide, due in part to healthy growth in its own consumer electronics business, and it experienced very strong growth in its analog sales and MOS microcontroller sales. The company's sales also grew in EPROM, diodes and transistors. SGS-Thomson experienced growth in sales of 12 percent, coming mainly from its analog ICs and more specifically those aimed at telecommunications, transportation and automotive electronics. The majority of SGS-Thomson's growth was due to its European market strength. Siemens' worldwide revenue was heavily impacted by the declining ASP of MOS DRAMs, and consequently the company's total worldwide revenue only grew by 2 percent.

Two new European companies were added to Dataquest's 1990 survey: Eupec and Zetex. Eupec was formed from the merger of AEG's and Siemens' power semiconductor operations. Europe's worldwide sales in 1990 are estimated at $96 million. Zetex, the former discrete division of Plessey Semiconductors, is also included and has worldwide sales of $24 million, $13 million of which are in Europe.

During 1989 Plessey Semiconductors merged with Marconi Electronic Devices Ltd, giving the merged company worldwide sales of $386 million in 1990. For comparison purposes, the combined revenue in 1989 was $300 million, giving an annual growth of 28.7 percent. This would have made it the fastest growing company of the top 20 in 1990. Matra-MHS experienced growth in 1990 of 17.6 percent to $100 million, with increasing sales in MOS ASIC, SRAMs and microcontrollers. Telefunken experienced growth worldwide of 10.4 percent, with its optoelectronic devices growing by 15.4 percent, discretes by 5.3 percent and integrated circuits by 11 percent.

James Heal
Jim Eastlake

TABLE 1
Estimated Preliminary European Semiconductor Shipments
(Millions of US Dollars)

Segment	1989	1990	1989-90 Annual Growth
Total Semiconductor	9,755	10,693	9.6%
Total Integrated Circuit	7,794	8,378	7.5%
Bipolar	640	562	-12.2%
MOS	5,458	5,524	1.2%
MOS Memory	2,548	2,283	-10.4%
MOS Microcomponent	1,469	1,854	26.2%
MOS Logic	1,441	1,387	-3.7%
Analog	1,696	2,292	35.1%
Discrete	1,594	1,915	20.1%
Optoelectronic	367	400	9.0%

Source: Dataquest (January 1991)

TABLE 2
Estimated Preliminary European Semiconductor Shipments
(Millions of ECUs)

Segment	1989	1990	1989-90 Annual Growth
Total Semiconductor	8,975	8,554	-4.7%
Total Integrated Circuit	7,170	6,702	-6.5%
Bipolar	589	450	-23.6%
MOS	5,021	4,419	-12.0%
MOS Memory	2,344	1,826	-22.1%
MOS Microcomponent	1,351	1,483	9.7%
MOS Logic	1,326	1,110	-16.3%
Analog	1,560	1,834	17.5%
Discrete	1,466	1,532	4.5%
Optoelectronic	338	320	-5.2%

Source: Dataquest (January 1991)

TABLE 3
Estimated European Semiconductor Market
Preliminary 1990 Sales by Company Base
(Millions of US Dollars)

Company Base	European Sales	Share of European Market
North American	4,483	41.9%
European	4,083	38.2%
Japanese	1,899	17.8%
Rest of World	228	2.1%
Total	10,693	100.0%

Source: Dataquest (January 1991)

TABLE 4
Preliminary 1990 European Market Share Estimates
Total Semiconductor
(Millions of US Dollars)

1989 Rank	1990 Rank	Change in Rank	Ranked Companies	1989 Sales ($M)	1990 Sales ($M)	1989-90 Annual Growth (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Sum (%)
1	1	0	Philips	964	1,104	14.5%	1,104	10.3	10.3
2	2	0	Siemens	937	965	3.0%	2,069	9.0	19.3
3	3	0	SGS-Thomson	751	908	20.9%	2,977	8.5	27.8
4	4	0	Motorola	658	771	17.2%	3,748	7.2	35.1
5	5	0	Texas Instruments	648	637	-1.7%	4,385	6.0	41.0
6	6	0	Intel	530	620	17.0%	5,005	5.8	46.8
8	7	1	Toshiba	423	524	23.9%	5,529	4.9	51.7
7	8	(1)	NEC	429	436	1.6%	5,965	4.1	55.8
9	9	0	National Semiconductor	381	389	2.1%	6,354	3.6	59.4
11	10	1	AMD	287	280	-2.4%	6,634	2.6	62.0
10	11	(1)	Hitachi	291	274	-5.8%	6,908	2.6	64.6
12	12	0	ITT	250	242	-3.2%	7,150	2.3	66.9
13	13	0	Telefunken	215	240	11.6%	7,390	2.2	69.1
	14		GEC Plessey Semiconductors	NA	206	NA	7,596	1.9	71.0
14	15	(1)	Samsung	201	190	-5.5%	7,786	1.8	72.8
16	16	0	Fujitsu	198	180	-9.1%	7,966	1.7	74.5
17	17	0	Harris	145	166	14.5%	8,132	1.6	76.0
15	18	(3)	Mitsubishi	201	154	-23.4%	8,286	1.4	77.5
21	19	2	Analog Devices	95	103	8.4%	8,389	1.0	78.5
23	20	3	LSI Logic	73	91	24.7%	8,480	0.9	79.3
			Total All Companies	9,755	10,693	9.6		100.0	
			Total North American	4,032	4,483	11.2		41.9	
			Total Japanese	1,924	1,899	-1.3		17.8	
			Total European	3,562	4,083	14.6		38.2	
			Total Rest of World	237	228	-3.8		2.1	

NA = Not Applicable
Source: Dataquest (January 1991)

TABLE 5
Preliminary 1990 European Market Share Estimates
Total Integrated Circuits
(Millions of US Dollars)

1989 Rank	1990 Rank	Change in Rank	Ranked Companies	1989 Sales ($M)	1990 Sales ($M)	1989-90 Annual Growth (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Sum (%)
2	1	1	Philips	649	754	16.2%	754	9.0	9.0
4	2	2	SGS-Thomson	574	705	22.8%	1,459	8.4	17.4
1	3	(2)	Siemens	707	703	-0.6%	2,162	8.4	25.8
5	4	1	Intel	530	620	17.0%	2,782	7.4	33.2
3	5	(2)	Texas Instruments	610	606	-0.7%	3,388	7.2	40.4
6	6	0	Motorola	460	553	20.2%	3,941	6.6	47.0
9	7	2	Toshiba	358	426	19.0%	4,367	5.1	52.1
7	8	(1)	NEC	410	406	-1.0%	4,773	4.8	57.0
8	9	(1)	National Semiconductor	376	382	1.6%	5,155	4.6	61.5
10	10	0	AMD	287	280	-2.4%	5,435	3.3	64.9
11	11	0	Hitachi	278	261	-6.1%	5,696	3.1	68.0
12	12	0	Samsung	198	186	-6.1%	5,882	2.2	70.2
	13		GEC Plessey Semiconductors	NA	176	NA	6,058	2.1	72.3
14	14	0	Fujitsu	170	154	-9.4%	6,212	1.8	74.1
17	15	2	Harris	117	138	17.9%	6,350	1.6	75.8
13	16	(3)	Mitsubishi	181	134	-26.0%	6,484	1.6	77.4
15	17	(2)	ITT	145	131	-9.7%	6,615	1.6	79.0
18	18	0	Analog Devices	95	103	8.4%	6,718	1.2	80.2
21	19	2	LSI Logic	73	91	24.7%	6,809	1.1	81.3
19	20	(1)	Telefunken	82	90	9.8%	6,899	1.1	82.3
			Total All Companies	7,794	8,378	7.5		100.0	
			Total North American	3,325	3,711	11.6		44.3	
			Total Japanese	1,714	1,641	-4.3		19.6	
			Total European	2,523	2,814	11.5		33.6	
			Total Rest of World	232	212	-8.6		2.5	

NA = Not Applicable
Source: Dataquest (January 1991)

TABLE 6
Preliminary 1990 European Market Share Estimates
Total Bipolar Digital
(Millions of US Dollars)

1989 Rank	1990 Rank	Change in Rank	Ranked Companies	1989 Sales ($M)	1990 Sales ($M)	1989-90 Annual Growth (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Sum (%)
1	1	0	Texas Instruments	142	138	-2.8%	138	24.6	24.6
3	2	1	National Semiconductor	79	76	-3.8%	214	13.5	38.1
2	3	(1)	AMD	97	71	-26.8%	285	12.6	50.7
5	4	1	Philips	66	61	-7.6%	346	10.9	61.6
7	5	2	Motorola	48	52	8.3%	398	9.3	70.8
6	6	0	Siemens	51	50	-2.0%	448	8.9	79.7
8	7	1	NEC	28	26	-7.1%	474	4.6	84.3
	8		GEC Plessey Semiconductors	NA	19	NA	493	3.4	87.7
9	9	0	Fujitsu	13	14	7.7%	507	2.5	90.2
14	10	4	STC	4	10	150.0%	517	1.8	92.0
10	11	(1)	Hitachi	8	8	0.0%	525	1.4	93.4
13	12	1	Telefunken	5	7	40.0%	532	1.2	94.7
11	13	(2)	Raytheon	7	5	-28.6%	537	0.9	95.6
12	14	(2)	Mitsubishi	7	5	-28.6%	542	0.9	96.4
15	15	0	SGS-Thomson	4	5	25.0%	547	0.9	97.3
16	16	0	Toshiba	2	2	0.0%	549	0.4	97.7
18	17	1	AT&T	2	2	0.0%	551	0.4	98.0
17	18	(1)	Goldstar	2	2	0.0%	553	0.4	98.4
19	19	0	Matsushita	1	1	0.0%	554	0.2	98.6
4			Plessey Semiconductors	66		-100.0%	554	0.0	98.6
			Total All Companies	640	562	-12.2		100.0	
			Total North American	379	352	-7.1		62.6	
			Total Japanese	59	56	-5.1		10.0	
			Total European	200	152	-24.0		27.0	
			Total Rest of World	2	2	0.0		0.4	

NA = Not Applicable
Source: Dataquest (January 1991)

TABLE 7
Preliminary 1990 European Market Share Estimates
MOS Microcomponent
(US Dollars)

1989 Rank	1990 Rank	Change in Rank	Ranked Companies	1989 Sales ($M)	1990 Sales ($M)	1989-90 Annual Growth (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Sum (%)
1	1	0	Intel	416	519	24.8	519	28.0	28.0
2	2	0	Motorola	179	232	29.6	751	12.5	40.5
3	3	0	NEC	122	151	23.8	902	8.1	48.6
4	4	0	SGS-Thomson	101	126	24.8	1,028	6.8	55.4
7	5	2	Philips	62	109	75.8	1,137	5.9	61.3
8	6	2	Texas Instruments	60	99	65.0	1,236	5.3	66.6
6	7	(1)	Siemens	67	83	23.9	1,319	4.5	71.1
5	8	(3)	Hitachi	75	77	2.7	1,396	4.2	75.3
11	9	2	Toshiba	35	63	80.0	1,459	3.4	78.7
10	10	0	National Semiconductor	45	46	2.2	1,505	2.5	81.2
12	11	1	AMD	34	40	17.6	1,545	2.2	83.4
14	12	2	Harris	21	31	47.6	1,576	1.7	85.1
9	13	(4)	Mitsubishi	48	28	-41.7	1,604	1.5	86.6
13	14	(1)	Western Digital	23	26	13.0	1,630	1.4	88.0
15	15	0	Matra-MHS	20	24	20.0	1,654	1.3	89.3
17	16	1	ITT	18	21	16.7	1,675	1.1	90.4
18	17	1	VLSI Technology	17	20	17.6	1,695	1.1	91.5
19	18	1	Zilog	16	20	25.0	1,715	1.1	92.6
16	19	(3)	Oki	18	19	5.6	1,734	1.0	93.6
23	20	3	LSI Logic	6	17	183.3	1,751	0.9	94.5
			Total All Companies	1,469	1,854	26.2		100.0	
			Total North American	890	1,141	28.2		61.5	
			Total Japanese	310	352	13.5		19.0	
			Total European	265	359	35.5		19.4	
			Total Rest of World	4	2	-50.0		0.1	

NA = Not Applicable
Source: Dataquest (January 1991)

Table 8
Preliminary 1990 European Market Share Estimates
MOS Logic
(US Dollars)

1989 Rank	1990 Rank	Change in Rank	Ranked Companies	1989 Sales ($M)	1990 Sales ($M)	1989-90 Annual Growth (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Sum (%)
1	1	0	Philips	185	179	-3.2	179	12.9	12.9
2	2	0	Siemens	117	138	17.9	317	9.9	22.8
5	3	2	Motorola	74	79	6.8	396	5.7	28.5
10	4	6	Toshiba	52	75	44.2	471	5.4	33.9
6	5	1	LSI Logic	67	74	10.4	545	5.3	39.2
	6		GEC Plessey Semiconductors	NA	71	NA	616	5.1	44.3
3	7	(4)	SGS-Thomson	114	70	-38.6	686	5.0	49.3
7	8	(1)	AMD	63	64	1.6	750	4.6	53.9
9	9	0	Texas Instruments	58	63	8.6	813	4.5	58.4
8	10	(2)	National Semiconductor	62	62	0.0	875	4.5	62.9
13	11	2	Harris	48	53	10.4	928	3.8	66.7
15	12	3	VLSI Technology	37	53	43.2	981	3.8	70.5
14	13	1	Austria Mikro Systeme	47	37	-21.3	1,018	2.7	73.2
17	14	3	NEC	24	29	20.8	1,047	2.1	75.3
16	15	1	Matra-MHS	25	26	4.0	1,073	1.9	77.2
4	16	(12)	ITT	91	25	-72.5	1,098	1.8	79.0
22	17	5	ES2	17	24	41.2	1,122	1.7	80.7
19	18	1	ABB-HAFO	21	21	0.0	1,143	1.5	82.2
20	19	1	Fujitsu	18	19	5.6	1,162	1.4	83.6
21	20	1	Hitachi	17	19	11.8	1,181	1.4	85.0
			Total All Companies	1,441	1,387	-3.7		100.0	
			Total North American	588	588	0.0		42.4	
			Total Japanese	125	153	22.4		11.0	
			Total European	722	643	-10.9		46.4	
			Total Rest of World	6	3	-50.0		0.2	

NA = Not Applicable
Source: Dataquest (January 1991)

TABLE 9
Preliminary 1990 European Market Share Estimates
Analog
(US Dollars)

1989 Rank	1990 Rank	Change in Rank	Ranked Companies	1989 Sales ($M)	1990 Sales ($M)	1989-90 Annual Growth (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Sum (%)
1	1	0	Philips	316	377	19.3	377	16.4	16.4
2	2	0	SGS-Thomson	226	350	54.9	727	15.3	31.7
3	3	0	National Semiconductor	160	163	1.9	890	7.1	38.8
4	4	0	Siemens	134	154	14.9	1,044	6.7	45.5
5	5	0	Texas Instruments	100	125	25.0	1,169	5.5	51.0
6	6	0	Motorola	99	111	12.1	1,280	4.8	55.8
7	7	0	Analog Devices	89	97	9.0	1,377	4.2	60.0
13	8	5	ITT	27	75	177.8	1,452	3.3	63.3
	9		GEC Plessey Semiconductors	NA	73	NA	1,525	3.2	66.5
	10		Mietec	NA	66	NA	1,591	2.9	69.4
8	11	(3)	Telefunken	62	65	4.8	1,656	2.8	72.2
9	12	(3)	Harris	47	51	8.5	1,707	2.2	74.4
10	13	(3)	Burr Brown	39	49	25.6	1,756	2.1	76.5
32	14	18	Sony	4	38	850.0	1,794	1.7	78.2
11	15	(4)	Ericsson	35	35	0.0	1,829	1.5	79.7
27	16	11	Rockwell	7	32	357.1	1,861	1.4	81.1
12	17	(5)	Precision Monolithics	29	30	3.4	1,891	1.3	82.4
18	18	0	Allegro MicroSystemes	17	30	76.5	1,921	1.3	83.7
14	19	(5)	Toshiba	22	29	31.8	1,950	1.3	85.0
15	20	(5)	AMD	22	24	9.1	1,974	1.0	86.0
			Total All Companies	1,696	2,292	35.1		100.0	
			Total North American	778	986	26.7		43.0	
			Total Japanese	91	138	51.6		6.0	
			Total European	816	1,161	42.3		50.7	
			Total Rest of World	11	7	-36.4		0.3	

NA = Not Applicable
Source: Dataquest (January 1991)

TABLE 10
Preliminary 1990 European Market Share Estimates
Total Discrete
(US Dollars)

1989 Rank	1990 Rank	Change in Rank	Ranked Companies	1989 Sales ($M)	1990 Sales ($M)	1989-90 Annual Growth (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Sum (%)
1	1	0	Philips	294	331	12.6	331	17.3	17.3
2	2	0	Motorola	193	214	10.9	545	11.2	28.5
3	3	0	SGS-Thomson	177	203	14.7	748	10.6	39.1
4	4	0	Siemens	162	187	15.4	935	9.8	48.9
5	5	0	ITT	105	111	5.7	1,046	5.8	54.7
7	6	1	Telefunken	66	78	18.2	1,124	4.1	58.8
	7		Eupec	NA	78	NA	1,202	4.1	62.9
6	8	(2)	International Rectifier	70	77	10.0	1,279	4.0	66.9
9	9	0	Toshiba	46	69	50.0	1,348	3.6	70.5
8	10	(2)	Semikron	55	66	20.0	1,414	3.4	73.9
12	11	1	General Instrument	33	52	57.6	1,466	2.7	76.6
11	12	(1)	Powerex	33	50	51.5	1,516	2.6	79.2
10	13	(3)	ABB-IXYS	40	47	17.5	1,563	2.5	81.7
	14		GEC Plessey Semiconductors	NA	30	NA	1,593	1.6	83.3
14	15	(1)	Harris	24	24	0.0	1,617	1.3	84.6
24	16	8	NEC	14	24	71.4	1,641	1.3	85.9
13	17	(4)	Siliconix	25	23	-8.0	1,664	1.2	87.1
17	18	(1)	Fagor	22	22	0.0	1,686	1.1	88.2
15	19	(4)	Texas Instruments	23	21	-8.7	1,707	1.1	89.3
18	20	(2)	Matsushita	21	21	0.0	1,728	1.1	90.4
			Total All Companies	1,594	1,915	20.1		100.0	
			Total North American	558	621	11.3		32.4	
			Total Japanese	168	204	21.4		10.7	
			Total European	863	1,082	25.4		56.5	
			Total Rest of World	5	8	60		0	

NA = Not Applicable
Source: Dataquest (January 1991)

TABLE 11
Preliminary 1990 European Market Share Estimates
Total Optoelectronics
(US Dollars)

1989 Rank	1990 Rank	Change in Rank	Ranked Companies	1989 Sales ($M)	1990 Sales ($M)	1989-90 Annual Growth (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Sum (%)
2	1	1	Siemens	68	75	10.3	75	18.8	18.8
3	2	1	Telefunken	67	72	7.5	147	18.0	36.8
1	3	(2)	Hewlett-Packard	79	63	-20.3	210	15.8	52.6
5	4	1	Toshiba	19	29	52.6	239	7.3	59.9
	5		Honeywell	NA	20	NA	259	5.0	64.9
4	6	(2)	Philips	21	19	-9.5	278	4.8	69.7
7	7	0	TMS	6	14	133.3	292	3.5	73.2
6	8	(2)	Texas Instruments	15	10	-33.3	302	2.5	75.7
15	9	6	AT&T	3	8	166.7	310	2.0	77.7
9	10	(1)	ABB-HAFO	6	6	0.0	316	1.5	79.2
8	11	(3)	Fujitsu	6	6	0.0	322	1.5	80.7
10	12	(2)	NEC	5	6	20.0	328	1.5	82.2
11	13	(2)	Motorola	5	4	-20.0	332	1.0	83.2
13	14	(1)	Hitachi	4	4	0.0	336	1.0	84.2
12	15	(3)	Sharp	4	4	0.0	340	1.0	85.2
14	16	(2)	Harris	4	4	0.0	344	1.0	86.2
17	17	0	Matsushita	2	3	50.0	347	0.8	87.0
16	18	(2)	Sanyo	2	2	0.0	349	0.5	87.5
	19		Zetex		1	NA	350	0.3	87.8
			Total All Companies	367	400	9.0		100.0	
			Total North American	149	151	1.3		37.8	
			Total Japanese	42	54	28.6		13.5	
			Total European	176	187	6.3		46.8	
			Total Rest of World		8	NA		2	

NA = Not Applicable
Source: Dataquest (January 1991)

TABLE 12
Preliminary 1990 Estimated Worldwide Sales of European-Owned Vendors
(Millions of US Dollars)

Ranking	Company	1989	1990	1989-90 Annual Growth
1	Philips	1,716	1,932	12.6%
2	SGS-Thomson	1,301	1,463	12.5%
3	Siemens	1,194	1,221	2.3%
4	GEC-Plessey Semiconductors	NA	386	NA
5	Telefunken	99	330	10.4%
6	Semikron	95	108	13.7%
7	Matra-MHS	85	100	17.6%
8	Eupec	NA	96	NA
9	Mietec	52	92	76.9%
10	AMS	56	59	5.4%
11	ABB-IXYS	50	58	16.0%
12	Ericsson	54	56	3.7%
13	TMS	45	45	0.0%
14	ABB-HAFO	37	42	13.5%
15	Eurosil	30	39	30.0%
16	Fagor	29	30	3.4%
17	ES2	18	27	50.0%
18	TAG	22	25	13.6%
19	STC	19	24	26.3%
20	Zetex	NA	24	NA

NA=Not Applicable
Source: Dataquest (January 1991)

APPENDIX

Dataquest Semiconductor Product Category Definitions

Total Semiconductor	(IC + Discrete + Optoelectronic)
Total Integrated Circuit	(Digital Bipolar + Digital MOS + Analog)
Bipolar Digital	(Memory + Microcomponent + Logic)
Memory	Includes ECL RAM, ROM, and PROM
Microcomponent	Microprocessor + Microcontroller + Microperipherals
Logic	(ASIC + Standard Logic + Other Logic)
ASIC	(Gate Arrays + PLDs [Programmable Logic Devices] + CBICs [Cell-Based ICs] + Full-Custom)
Standard Logic	Includes TTL, ECL and other family logic with fewer than 150 gates. [TTL-compatible SSI, MSI, LSI; Standard, AS, FAST, LS, ALS lines. ECL-compatible SSI, MSI, LSI. Also RTL and DTL].
Other Logic	Includes Application-specific standard products (ASSPs), bipolar bit-slices (e.g. 2900, 29300 families), ALU, control units, multipliers, floating-points, digital filters.
MOS	(Memory + Microcomponents + Logic)
Memory	(DRAM + SRAM + EPROM + Other Nonvolatile + Other MOS memory)
DRAM	Dynamic RAM and Video RAM
SRAM	Fast and slow static RAM, pseudo-SRAM [PSRAM]
EPROM	EPROM
Nonvolatile	Includes ROM, PROM, EEPROM, flash
Other MOS Memory	Specialty MOS memory, including dual-port RAM, content-addressable memory, cache-tag RAM, FIFO, LIFO.
Microcomponents	(MPU + MCU + MPR)
Microprocessor	(MPU) All microprocessors, both CISC and RISC architectures.
Microcontroller	(MCU) Single chip controllers such as Intel 8051 and Motorola 68HC11, and digital signal processors (DSPs).
Microperipheral	(MPR) Microprocessor support chips used in system support (e.g. timer, interrupt control, DMA, MMU), peripheral controllers (e.g. disk, graphics display, CRT, keyboard controllers), communications controllers (e.g. UART), chip sets for microprocessor support, LAN coprocessors, accelerator coprocessors (e.g. floating point unit, graphics coprocessor, image processor).

Logic	(ASIC + Standard Logic + Other Logic)
ASIC	(Gate Arrays + PLDs [Programmable Logic Devices] + CBICs [Cell-Based ICs] + Full-Custom)
Standard Logic	MOS family logic such as HC, HCT, and FACT lines, with fewer than 150 gates.
Other Logic	ASSPs, e.g. motor control ICs. Also, MOS ALC, MAC, digital filters, barrel shifters and other building blocks
Analog (Linear)	(Monolithic + Hybrid)
Monolithic	Includes amplifiers, regulators, reference ICs, converters, interface ICs, comparators, consumer ICs, telecommunication ICs, special function ICs, automotive ICs, linear arrays, switch/multiplexer chips, disk drive ICs, and mixed signal ASICs. Includes traditional linear and mixed signal ICs.
Hybrid	All semiconductor hybrids sold by the semiconductor division or sector of a company.
Total Discrete	(Transistor + Diode + Thyristor + Other Discrete)
Total Optoelectronic	LED lamp and display, optocoupler, CCD, laser diode, photosensor, and solar cell.

Description of Tables

Column 1	shows market share rank in 1989
Column 2	shows market share rank in 1990
Column 3	shows change in rank between 1989 and 1990
Column 4	shows the ranked company
Column 5	shows company's 1989 revenue
Column 6	shows company's 1990 revenue
Column 7	shows the company's revenue growth between 1988 and 1989
Column 8	shows ranked companies' cumulative revenue
Column 9	shows the company's percent market share
Column 10	shows ranked companies' cumulative percent market share

Footnotes

European Companies

Eupec	Eupec's revenue was formerly included in the European Others category.
GEC Plessey Semiconductors	GEC Plessey Semiconductors was formed in 1989 from the merger of Marconi Electronic Devices Ltd, and Plessey Semiconductors.
Zetex	Zetex's revenue was formerly included in the European Others category.

North American Companies

Allegro MicroSystemes	Allegro MicroSystemes was formerly called Sprague.

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Research Newsletter

EUROPEAN SEMICONDUCTOR PROCUREMENT SURVEY 1990 TREND ANALYSIS

INTRODUCTION

This research newsletter analyses the results of Dataquest's annual European semiconductor procurement survey, conducted by the European Components Group. The survey serves two major purposes. Firstly, it indicates key trends in semiconductor procurement from the purchasing community, which is used as an input to modelling future semiconductor demand by product category. Secondly, it provides an insight into the buying habits of the purchasing community in different equipment sectors.

OVERVIEW—THE CUSTOMER IS STILL ALWAYS RIGHT

The issues most frequently cited by buyers are quality, on-time delivery and price. This newsletter shows that a huge gap remains between the requirements of the buying community and the performance of major vendors in meeting these requirements. Dataquest believes that as the new decade advances, service will become a major battleground; it will be used increasingly by buyers to differentiate between otherwise successful vendors. This, together with buyers' desire to reduce the number of vendors they use, will require vendors to carefully balance their future investment between R&D, manufacturing and customer service. Customer service includes electronic data interchange (EDI) for purchase orders, invoicing, and order acknowledgement, technical and application support, and logistic planning of purchases through to final, timely delivery at the specified quality and price.

SURVEY RESULTS

Data Processing—Europeans Need to Adapt Internationally

In our survey, all purchasing executives of the data processing segment indicated that purchasing of semiconductors in 1990 was reduced by a factor of at least 10 percent, compared with 1989. Their 1991 semiconductor spend is expected to recover to the 1989 level.

In the mainframe sector, more than 50 percent of the revenue from ICs purchased is accounted for by memory devices, followed by 21 percent ASICs and 20 percent microcomponents. Of the ASICs purchased, 50 percent are standard cells, 40 percent gate arrays and 10 percent programmable logic. Discrete devices comprise the smallest spend at 3 percent.

In the personal computer sector, 50 percent of revenue from ICs purchased is from memory devices, 25 percent from ASICs, followed by 20 percent from microcomponents. Of the ASICs purchased, 70 percent are gate arrays and 20 percent standard cells.

Dataquest found some major differences in the purchasing methods between certain computer manufacturers, namely: North American–owned multinationals and European-owned companies. While North American computer manufacturers hardly used any distribution suppliers, European computer manufacturers purchased up to 10 percent of their semiconductor supply from distributors. This suggests that European inventory control is inadequate, occasionally relying on the spot market for top-ups.

North American multinationals ran the tightest inventory, currently carrying 2 weeks stock with a goal to reduce to 1 week. Their European

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counterparts carry an inventory of 5 weeks with a long way to go for a desired goal of 1 week. One leading North American multinational in Ireland has a current inventory of 8 days with a goal to reduce it to 4 days. A sizeable European computer company is carrying 50 days of inventory, with a goal to reduce this in the long term, but does not expect it to change in 1991.

European computer companies' usage of ASICs is relatively low compared with the North American multinationals. Clearly, one area that European computer manufacturers need to address immediately is their purchasing strategies. In 1990, most multinational computer companies decreased their semiconductor spending, and some European companies increased their spending. This indicates that European companies either lack the bargaining power associated with volume purchases, or increase inventory after misreading price trends.

Buyers' overall concerns in the data processing sector are volatility of memory prices and the large number of vendors they currently do business with.

Communications—Consistent Growth

This was the most optimistic and buoyant of all the end-user segments surveyed. Purchasers in this segment increased their 1990 semiconductor spend by up to 10 percent. Most expect this to increase in 1991 by between 12 and 20 percent.

Currently, the switching market is the most dynamic sector. This is due to the success of major telecoms vendors in their export markets, some of which include Eastern Europe. Transmission is another strong area, consuming more discrete components than the switching sector; consumption of these areas are 25 percent and 10 percent, respectively. The switching sector uses a large percentage of ASIC devices (72 percent of total ICs used) of which 50 percent are gate arrays and 30 percent full-custom. This sector has a relatively low penetration rate for standard cells and programmable logic. In the transmission sector, of the ASICs purchased, 50 percent are standard cells and 40 percent gate arrays.

It is interesting to note that while vendors of semiconductor memory devices continue to focus on the highly volatile EDP market, buyers in the communications sector indicated that their third-largest purchase is memory devices. In the transmission sector, 30 percent of all ICs purchased are memory-based, while in switching, 16 percent are memory-based.

In the cellular communications sector, buyers expect a growth in semiconductor spend of 15 percent in 1991, compared with a growth of 18 percent in 1990. The survey shows that 33 percent of semiconductors purchased in this sector are discrete, with RF components being the most expensive items. The next-largest product group is ASICs at 20 percent of total expenditure, of which 60 percent are gate array, 30 percent are full-custom, and less than 5 percent are programmable logic.

The communications segment has come a long way in managing its inventory. Equipment manufacturers from this segment currently carry two to four weeks of inventory, with a goal of reducing this to between one and two weeks.

Users' major concerns in this segment are product obsolescence, the reduction of vendor base, increased quality and on-time delivery.

Industrial—A Mixed Bag of Surprises

Up to 50 percent of semiconductor consumption in the industrial segment is in discrete devices. Next in rank are commodity analog at 25 percent, followed by memory and logic devices accounting for another 25 percent collectively.

This segment has the lowest penetration of ASIC products. Most purchasers indicated that less than 10 percent of their spend was in ASICs, and 40 percent of this is programmable logic due to relatively short production runs.

Inventory levels vary considerably between companies. The highest level recorded was 10 weeks, with a plan to reduce this to 6 weeks. The lowest level was 4 weeks with a goal to reduce to 2 weeks.

This remains a good segment for semiconductor distributors, with up to 30 percent of purchases made via distribution channels, which is the highest percentage across all segments. The bad news is that many respondents indicated that they plan to reduce the number of distributors they trade with.

Overall, the industrial users who were surveyed increased their semiconductor purchasing by 8 percent in 1990. The majority of respondents indicated an expected or planned increase of 11 percent in 1991. The major concerns in this segment are the reduction of vendor base, implementation of EDI, pricing and inventory cost control.

Consumer—Linked to Local Economies

It was difficult to get an adequate snapshot of this segment due to a low response level to the survey. The inputs of the few that responded suggest that spending in this segment will decline by 10 percent in 1991, with 1990 being flat compared to 1989.

This segment still uses a large percentage of discrete devices, amounting to about 35 percent of total expenditure. Many consumer segment OEMs have offshore purchasing offices, mainly in the Far East, which may affect the potential of European IC demand. Between 10 and 15 percent of purchases are placed with local distributors.

Inventories are currently running at three weeks and are expected to remain the same in 1991. Major concerns in this sector are quality, packaging, price and on-time deliveries.

Military—*Perestroika* Strikes a Blow

Of all the segments surveyed, the military segment was the most pessimistic. Some purchasers recorded as much as a 50 percent decrease in semiconductor spending for 1990, although some end users in France maintained their spend at the same level as 1989. Most purchasers expect 1991 to remain flat, or with a slight growth, depending partly on the outcome of the Gulf crisis which may drive up the replacement market.

A large percentage of military standard parts are procured through distribution channels—as much as 40 percent for sonar equipment and 20 percent for aerospace equipment. The general downturn in this segment is also affecting the purchasing organization of these companies. With recent cutbacks, many new purchasing executives have had to go through a learning curve, which disrupts traditionally long-established relationships between the manufacturer and the vendor.

Inventories are difficult to measure in this sector, but most respondents indicated a desire to reduce them by 30 percent. Major concerns include the reduction of vendor base, product obsolescence and the general health of the military equipment industry.

Automotive—Shining Light and Example for the Future

This segment currently carries the leanest inventory level in the industry, with typically two weeks of supply in stock. The goal for most automotive segment buyers is to reduce to one week. These buyers regard their vendors' current performance of just-in-time delivery, quality and pricing as insufficient to achieve this goal.

Trends in product consumption, across different automotive segment buyers, vary considerably due to the range of end products manufactured. In Germany, up to 25 percent of semiconductor consumption in this segment is in discrete components and 38 percent in ASICs, of which almost all are full-custom designs. Meanwhile, in Italy, only 17 percent of semiconductor spend is in discrete components, but on the other hand these users spend 66 percent in ASICs, of which 70 percent are cell-based designs. Microcontrollers account for 40 percent of semiconductor demand in Germany, while in Italy only 7 percent of the demand is in microcontrollers. Across the automotive segment there is relatively low demand for commodity analog or logic devices.

This segment increased its semiconductor purchase by 12 to 15 percent in 1990. Due to recessionary fears, buyers expect to increase their purchase by only 8 to 10 percent in 1991. Major concerns in the segment are on-time delivery, quality and price.

DATAQUEST PERSPECTIVE

One of the key issues this survey has brought to the fore is that OEMs, in most segments, wish to reduce the number of vendors with whom they do business. The motivation is to minimize unnecessary paperwork and maximize large-volume discounts. Buyers are generally becoming more strategic in their purchasing plans, thereby reducing short-term spot market and distribution purchases. The emphasis is on building up strong relationships with key vendors.

Table 1 summarizes the factors that will determine the success or failure of vendors in the 1990s. These include on-time delivery, quality, and pricing. It is clear that vendors must refocus on service as well as price in order to win their customers' loyalty. Many OEMs evaluating the total cost of ownership of a product realize that unit price is just the tip of an iceberg.

Bipin Parmar
Byron Harding

TABLE 1
Summary of Respondents' Issues

Application Segment	Data Processing	Communications	Industrial	Consumer	Military	Automotive
Respondent's Expectations						
Growth 1989-1990	-10%	+10%	+8%	No Change	-30%	+12-15%
Growth 1990-1991	+10%	+12-20%	+11%	-10%	No Change	+8-10%
Present Inventory Level (Weeks)	1-7	2-4	4-10	3	Indefinite	2
Target Inventory Level (Weeks)	0.5-2	1-2	2-6	3	Indefinite	1
Procurement Issues						
1 = Weakest Issue						
10 = Strongest Issue						
ASICs	4	7	5	5	8	3
Availability	7	10	8	NA	4	2
Cost Control	5	6	6	NA	3	7
Fluctuating Exchange Rates	5	4	3	NA	2	4
Forecasting	7	6	8	NA	6	5
Inventory Control	5	6	7	5	7	7
Memories	6	6	7	5	6	2
Product Obsolescence	7	7	4	NA	5	3
Offshore Procurement	4	6	2	NA	1	2
On-Time Delivery	8	7	9	5	7	5
Pricing	8	8	9	5	9	9
Quality and Reliability	8	8	9	5	10	10
Reduce Vendor Base	6	7	9	5	9	4
Second Sourcing	4	6	6	NA	7	5
Surface Mounts	3	8	8	NA	1	4
Other Issues	NA	NA	9	NA	5	NA

NA = Not Available
These results reflect the views of respondents to the procurement survey and are not aggregated to reflect total market statistics.
Source: Dataquest (January 1991)

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Research Newsletter

EUROPEAN DRAM PRICE HIKE

INTRODUCTION

Market prices for DRAMs in Europe have taken a sudden jump upwards in the last few weeks. Dataquest believes this rise to be related to the new DRAM reference prices (RPs) released by the European Commission. These RPs set floor prices for Japanese-manufactured DRAMs and are revised each quarter. The reference price agreement has now been in operation for one year. Further details can be found in ESIS newsletters 1990-4 "European Commission DRAM Reference Price Agreement," and 1990-17 "European Commission DRAM Reference Prices Behind the Scenes."

IMMEDIATE IMPACT

A summary of the effects of the new reference prices are provided below:

- Prices for Japanese DRAMs have increased at most densities.
- Many non-Japanese DRAM suppliers have also increased their prices.
- Europe is no longer the cheapest region for DRAMs.
- The ratio between 4M and 1M DRAM prices has dropped.

For the first quarter of 1991, DRAM RPs are believed to have increased over those of the fourth quarter of 1990 at all densities. The net effect has been an immediate increase in booking prices for all Japanese-sourced DRAMs, which at the 1M density have been around 15 percent. As it is estimated that Japanese companies supply approximately 50 percent of all DRAMs purchased in Europe, the effect on the market has been substantial. It is understood that non-Japanese DRAM suppliers have taken this opportunity to increase their DRAM prices too, although maintaining their prices just below RPs to remain competitive against Japanese companies. Figure 1 shows historical and projected European DRAM billing prices.

CAUSE AND EFFECT

European Commission DRAM RPs have increased because of cutbacks in Japanese production during the lull in demand in the third quarter of 1990. This led to higher unit costs and affected the projected cost of sales for the fourth quarter; these are used to calculate DRAM RPs for the first quarter of 1991. It is this delay in cause and effect that has taken DRAM buyers by surprise.

Japanese DRAM suppliers should not be so surprised, and indeed are expected to take full advantage of the situation that has arisen. The reference price of the 4M DRAM has experienced a small rise as it has been increasing in production. This means that the ratio between 4M and 1M RPs is significantly less than in the last quarter and will certainly make the adoption of the 4M a more attractive proposition. The changeover from 1M to 4M is very important to Japanese DRAM suppliers as they urgently need to differentiate themselves from their competitors. The ratio is now believed to be under four.

BUYERS' VIEWPOINT

Throughout the second half of 1990, DRAM pricing in Europe was lower than in any other world region. This was believed to have been caused by the leakage of the DRAM RPs to buyers, who would then accept no other price than the absolute minimum price available, which was none other than the reference price. In this way, non-Japanese DRAM suppliers knew how they could go

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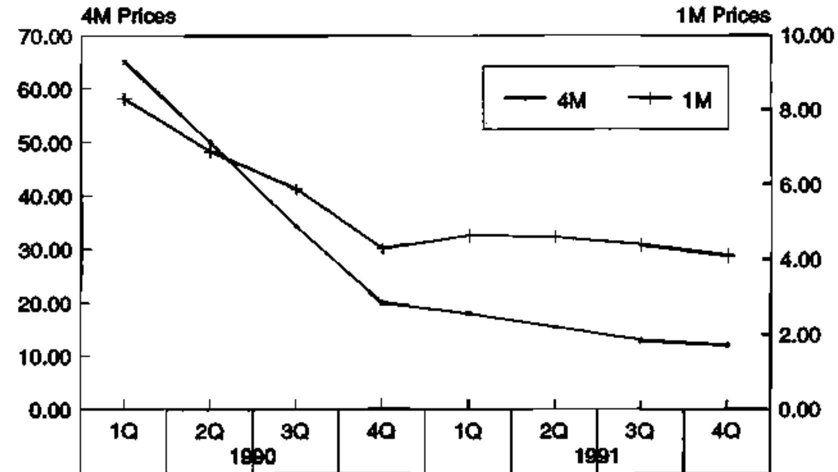
FIGURE 1
Estimated European DRAM Billings ASPs, 1M×1 80ns SOJ
(US Dollars)



	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
	1990				1991			
4M	65.00	50.00	34.20	20.00	18.00	15.50	13.00	12.00
1M	8.30	6.90	5.90	4.30	4.65	4.60	4.40	4.10
Ratio	7.83	7.25	5.80	4.65	3.87	3.37	2.95	2.93

Source: Dataquest (January 1991)

one better, and sold at just below the reference price. This has worked in the buyer's favor as the market price for DRAMs came down.

However, reference prices can go up as well as down. It is no longer a buyer's market in Europe because it is now the vendor who sets the price. Non-Japanese suppliers are understood to have raised their prices in order to take advantage of the situation. This has driven the market price upwards and has made Europe one of the most expensive markets in the world. The buyer has now to determine the benefits of procuring outside Europe. Table 1 shows last month's DRAM prices compared with this month's prices.

DATAQUEST ANALYSIS

Japanese DRAM vendors have taken a decisive step in ramping down 1M production. The increase in the 1M RP is a direct result of this action, and Japanese companies have accepted the risk of losing 1M sales to vendors not bound by this lower price limit. This is a terminal condition as any loss of 1M sales will result in higher costs and therefore an even higher reference price. In the second quarter of 1991 Dataquest expects to see an increase in DRAM reference prices at every density except 4M.

TABLE 1
Contract Booking Prices for 1M DRAM (1M×1 80ns SOJ)

Market	Dec 14, 1990	Jan 14, 1991	Change
Europe	\$4.10	\$4.70	15% up
United States	\$4.58	\$4.50	2% down
Japan	\$5.07	\$4.92	3% down
South Korea	\$5.15	\$5.15	Flat
Taiwan	\$4.85	\$4.40	9% down
Hong Kong	\$4.60	\$4.60	Flat

Source: DQ Monday Report, Dataquest (January 1991)

DRAM buyers in Europe will need to determine whether or not now is the time to move up to 4M. Second-generation versions of the 4M are becoming available in volume. These have a 300 mil outline instead of 350 mil, which is the same footprint as the 1M device. With the cost per bit of the 4M now bordering on parity with that of the 1M, it would appear that the era of the 4M has come at last.

Byron Harding

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Research *Bulletin*

VLSI TECHNOLOGY AND ES2 COMBINE STRENGTHS: THE WINDS OF CHANGE FOR ASICs?

SUMMARY

A licensing agreement has just been announced between VLSI Technology and European Silicon Structures (ES2) giving an indication of some fundamental changes taking place in the ASIC market. The number of designs is less than expected, production volumes are lower, the cost of building a manufacturing plant is higher, and the importance of getting a product quickly to market is greater. This bulletin identifies these changes and shows how the licensing agreement can help VLSI Technology and ES2 to adapt their strategies.

THE AGREEMENT

VLSI Technology has licensed its gate array design software and its 1.5- and 1.0-µm gate arrays to ES2. This company will manufacture these gate arrays at the prototype and low-volume stage for its own customers; in return, VLSI Technology will benefit from the speed with which ES2 manufactures prototypes. The agreement provides a route to high-volume production for ES2's customers who choose to use the VLSI Technology gate arrays.

THE COMPANIES

ES2 was originally set up to serve the needs of the low-volume and prototype ASIC market in Europe. It built a factory specifically for producing prototypes and low-production volumes cheaply, using the then commercially unproven electron beam (e-beam) machine to replace the masks normally used in IC manufacture. ES2 concentrated on cell-based ICs (CBICs), as it felt this gave the flexibility needed by the ASIC user.

The future for ES2 is dependent on high growth in the number of ASIC designs. One source of growth could come from ASIC users making prototypes several times before becoming committed to volume production. ES2 would make the prototypes at a significantly lower cost than existing suppliers of volume ASICs by using its e-beam machine. These lower costs would then attract more equipment manufacturers and thus help grow the ASIC market. When finally going to volume, ES2 could exercise its agreement with Philips Semiconductor to use its volume manufacturing capability to deliver customers' parts.

VLSI Technology is one of the original pioneers among ASIC suppliers. It is a conventional supplier and competes in the ASIC market for volume orders. For VLSI, making prototypes is expensive and time-consuming; it also disrupts the normal flow of production in the factory. VLSI sells both gate arrays and CBICs, together with a set of design tools which it developed itself to make complex ASIC design easier, and to reduce total design time. VLSI Technology aims its products at the experienced ASIC user who needs advanced processes and high-density gate arrays or CBICs. It has two factories for the manufacture of volume ASICs.

BEHIND THE AGREEMENT

All ASIC suppliers need to have their products made somewhere. Many established IC manufacturers such as Texas Instruments or National Semiconductor use their factories to make both standard products and volume ASICs. For these suppliers the making of ASIC prototypes is a necessary process which cannot be avoided. But because of time and expense involved, they aim to go to high-volume production with few designs.

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The newer IC companies such as LSI Logic and VLSI Technology, which specialize in ASICs, have built factories for the sole purpose of producing them in volume. However, they suffer as much as the standard product suppliers from the problems involved when making prototypes. In addition, they have the cost of building and running a modern submicron factory. This cost is high and difficult to cover by volume ASIC business alone.

MARKET TRENDS

The semiconductor industry expected to see 10,000 ASIC designs by 1992, but the real figures are now likely to be a fraction of this. Modern design tools ensure that the design works first time, so the device is unlikely to be made as a prototype more than once. In addition to this, the development of programmable gate arrays (PGAs) can now be used to prove that a concept works in its silicon form, without the cost and risk associated with ASICs. The manufacturing time scales are much shorter for PGA when compared with the time taken to make a prototype gate array. Both these factors have contributed to the reduction in the number of gate array and CBIC prototypes.

The ASIC market has had high growth, but the cost of building and running a fabrication plant has increased at a faster rate. The volume of ASIC business is not sufficient to cover the cost of the plant, so extra revenue needs to be generated. The ups and downs of the semiconductor market have also had a big impact on the running of these factories, which have not reached capacity and so operational costs are higher.

The lifetime of electronic equipment is falling and new products are constantly being introduced as suppliers fight to gain market share. Product life cycles are decreasing along with the time available to get a product to market. Equipment suppliers therefore need access to ASIC design and manufacturing in order to build products cost-effectively, but also need fast manufacturing to reach the market first. Gate arrays have increased their gate count capabilities significantly, and so can offer the complexity needed by most products at a lower price than CBICs. In addition, gate arrays are quicker to manufacture than CBICs because they need fewer mask layers in the final stages, providing more time to get the product to market. Gate arrays are therefore replacing CBICs in most digital applications.

DATAQUEST CONCLUSIONS

Both ES2 and VLSI Technology have adapted to the changing face of the ASIC market. The number of designs is much lower than was first expected, which could have spelt catastrophe for ES2. But this was anticipated and so ES2 had time to adapt and formed alliances to let it manufacture other suppliers' ASIC prototypes. ES2's manufacturing capability allows it to make prototypes and low-volume ASICs more quickly and cheaply than anyone else. It is therefore more capable of responding to future product needs than most manufacturers. ES2 has also acknowledged the need for gate arrays as the fastest and most cost-effective solution to many applications.

VLSI Technology has identified the need to provide a fast turnaround of prototypes and low-production volumes to its customers. The agreement with ES2 ensures that it can still offer this without making the large investment needed to provide the service. VLSI has also developed high-value standard products for key applications such as mobile phones or PC chip sets. These application-specific standard products (ASSPs) have provided the additional revenue needed to cover the high cost of managing a fabrication plant. The applications chosen for these ASSPs have also suffered less from the ups and downs of the semiconductor industry, providing a more stable source of income to cover the fixed cost of the factories.

Another way of avoiding the growing costs of IC manufacture for the new ASIC suppliers is to provide ASIC design tools and use foundry agreements with other IC manufacturers. However, these "fabless" ASIC suppliers do lose some control over monitoring manufacturing costs.

VLSI Technology is already the number one supplier of digital CBICs in Europe and can build on this success by adapting to market conditions through access to ES2's fast prototype and low-volume manufacturing. The combination of VLSI Technology's design tools and advanced gate arrays with ES2's fast manufacturing should provide a formidable opponent to other ASIC suppliers. These suppliers may excel in some areas of ASIC design and manufacture, but the VLSI and ES2 relationship addresses all aspects. It now remains for the two companies to make the agreement work without ending up in the courts as some agreements between competing IC suppliers have already done.

Mike Glennon

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Research Newsletter

EUROPEAN MOS ASIC 1990 DESIGN STARTS ANALYSIS

SUMMARY

The number of European MOS cell-based IC (CBIC) and gate array ASIC design starts grew by 15.1 percent in 1990, a lower growth than in previous years. The slowing in design starts growth is due partly to the introduction of programmable gate arrays, and partly to the increase in the number of gates that can be integrated onto a single chip. Designs which once required two or more ASICs can now be integrated onto a single device.

The complexity of average ASICs has increased, but this is not reflected in the profile of gate utilization. The average number of gates used in a gate array design has increased because of a combination of:

- The rising use of programmable gate arrays for low gate count designs.
- The increase in the number of usable gates on gate arrays.

The average gate count for cell-based designs has remained constant, mainly because of the increase in the use of analog cells in cell-based ASICs.

This newsletter presents the results of Dataquest's third annual European ASIC design starts survey. Analysis of the data is given, highlighting key trends.

INTRODUCTION

The future trends of the ASIC market can be foreseen if the number and type of new designs captured are monitored. This design start data can provide valuable insight into trends in the complexity and applications of gate array and CBICs, and can also show changes in the preference for either gate array or CBIC.

According to Dataquest, a design start occurs when a nonrecurring engineering (NRE) fee for an ASIC is billed to the customer. The definitions used for the purpose of this newsletter are as follows:

- **ASIC**: A single-user integrated circuit that is manufactured using vendor-supplied tools and/or libraries.
- **Gate Array**: An ASIC device that is customized using the final layers of interconnect. Included in this category are generic base wafers that include embedded functions such as static random access memory.
- **CBIC**: An ASIC device that is customized using a full set of masks, and that uses automatic placement of cells and automatic routing.
- **Mixed Signal**: An ASIC device with both digital and analog signal input or output (excluding line driver outputs, and single comparator and Schmitt trigger inputs).

DESIGN STARTS

The growth for MOS gate array and MOS CBIC design starts is slowing, with the sharpest decline in MOS gate array. Gate array's share of the total ASIC design starts is therefore falling. Table 1 shows the estimated European ASIC design starts for the period 1987 to 1990 for MOS gate arrays and MOS CBICs, while Figure 1 shows the relative sizes of gate array and CBIC design starts. A large percentage of the CBIC design starts are manufactured by European Silicon Structures (ES2), and this can have quite a distorting influence in CBIC trends and analysis. However, removing the ES2 design starts shows no significant changes in application, regional or growth

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trends, indicating that the design starts analysis reflects the whole of the ASIC industry. The ES2 design starts are included in the numbers for CBIC and gate array design starts.

APPLICATIONS

The application split of ASIC designs has changed since 1988. Table 2 and Figures 2 and 3 show the share of applications for both gate array and CBIC for 1988 and 1990. From this it can be seen that the greatest number of new designs is in the communications segment, followed closely by data processing. There was a marked difference in CBIC and gate array applications in 1988, but this difference is less apparent in 1990. The major application for CBIC in 1988 was communications, with 37 percent of the MOS CBIC design starts. By 1990 the dominance had shifted to industrial applications for MOS CBIC, with 28 percent of all MOS CBIC design starts.

The decline in the communications segment for CBIC is a reflection of the higher level of integration into single ASICs. The complexity of the systems is increasing, but the number of chips required to implement the design is lower because of this greater level of integration. Similarly, the communication segment's share of gate array design starts has fallen, also partly due to the number of gates that can be integrated into a single chip. The growth of CBIC design starts in the industrial segment comes from the industrial user realizing the benefits of mixing analog and digital components on a single chip. Gate arrays are not able to give a similar level of flexibility, so the number of gate array designs by industrial users has declined. The falling share of gate array design starts by the industrial segment is also partly due to the growing use of field-programmable gate arrays (FPGAs), as these offer significant advantages in

TABLE 1

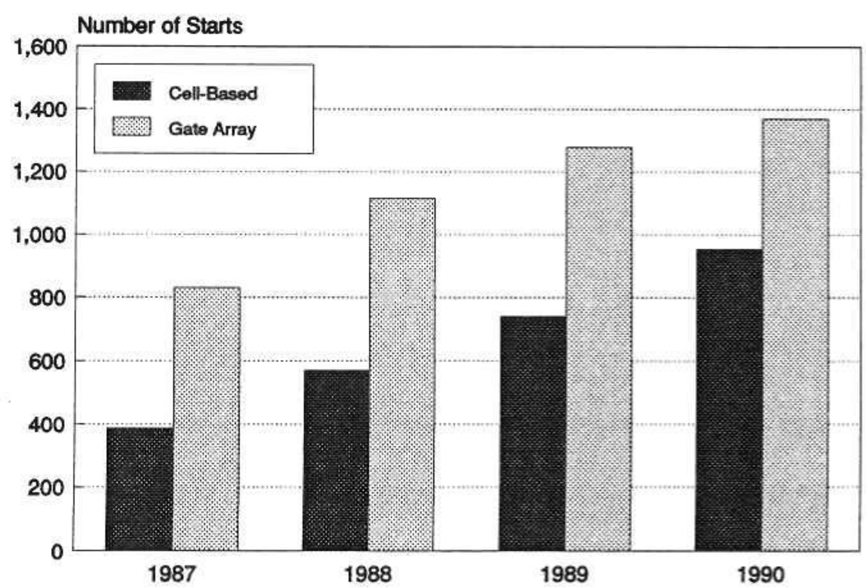
Estimated European MOS Gate Array and MOS CBIC Design Starts

Product Type	1987	1988	1989	1990
MOS Gate Array	830	1,116	1,279	1,369
MOS CBIC	385	570	740	954
Total MOS	1,215	1,686	2,019	2,323

Source: Dataquest (March 1991)

FIGURE 1

European ASIC Design Starts



Source: Dataquest (March 1991)

TABLE 2
European MOS CBIC and Gate Array Design Starts by End Use

	CBIC			Gate Array		
Application	1988	1989	1990	1988	1989	1990
Data Processing	14%	19%	19%	37%	34%	26%
Communications	37%	31%	23%	26%	31%	26%
Industrial	19%	19%	28%	25%	21%	17%
Military	13%	13%	14%	5%	5%	9%
Transport	7%	8%	4%	1%	2%	6%
Consumer	10%	10%	12%	6%	7%	16%

Source: Dataquest (March 1991)

cost and design time over gate arrays for low-volume applications.

The change in gate array applications has not been as great as for CBICs. In 1988 the largest use of new gate array designs was for data processing, with 37 percent of all MOS gate array design starts. This share has declined, again because the greater integration capabilities of gate arrays have reduced the number of different devices needed to implement a system. By 1990, the communications and data processing applications had the largest share, with 26 percent each of all MOS gate array applications. The consumer segment has grown its share of gate array design starts significantly, as the benefits of custom-designed parts are realized in more consumer products. The use of gate array rather than CBIC for consumer users is due to the faster prototype and production time scales for gate array when compared to CBIC, and their lower cost. Consumer products have a short product lifetime, so time-to-market is important, and cost is also a sensitive issue for these products.

REGIONAL USE

Table 3 and Figures 4 and 5 show the European regional share of design starts for both gate array and CBIC for 1988 and 1990. The regional share of design starts has shown a decline in the dominance of CBIC designs by Germany; 1990 showed a fairly even split of use between Germany, the United Kingdom and Eire, and France for CBIC design starts, with Germany just taking the lead. Italy has shown the biggest reduction in design starts in 1990, falling from 18 percent in 1988 to just 8 percent in 1990. Previously in Italy there had been a large number of designs for data processing applications, as new products were developed; these products have now gone into production, and the number of new designs has thus fallen. The apparent growth in the UK market share of CBIC design starts is mainly due to the slow adoption of CBIC by UK equipment manufacturers, resulting in a smaller share for the United Kingdom than would have been expected. These manufacturers have now adopted CBIC with the same vigor as other European regions.

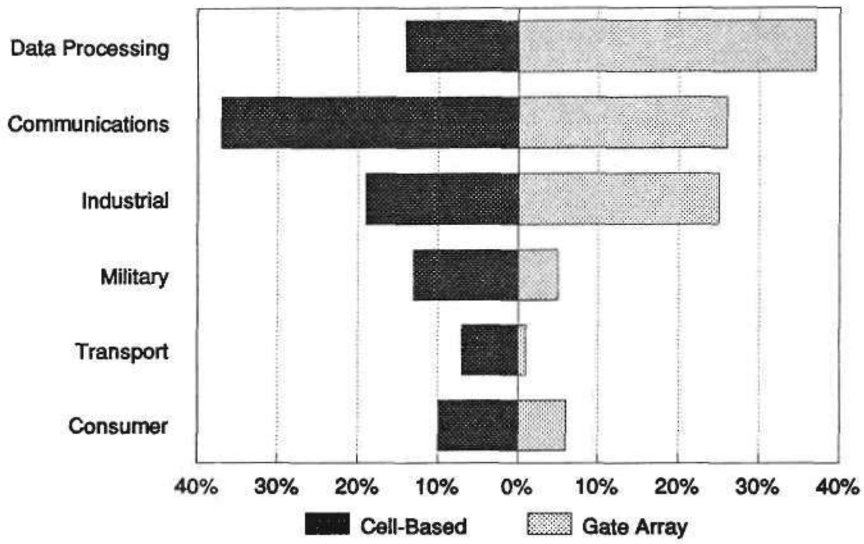
TABLE 3
Estimated European MOS CBIC and Gate Array Design Starts by Region

	CBIC			Gate Array		
Country	1988	1989	1990	1988	1989	1990
Benelux	1%	2%	8%	3%	5%	4%
France	28%	32%	22%	16%	19%	16%
Italy	18%	17%	8%	23%	18%	12%
Scandinavia	2%	3%	6%	6%	7%	8%
UK and Eire	9%	14%	22%	21%	21%	23%
Germany	36%	28%	26%	28%	26%	31%
Rest of Europe	6%	4%	6%	3%	4%	6%

Source: Dataquest (March 1991)

FIGURE 2

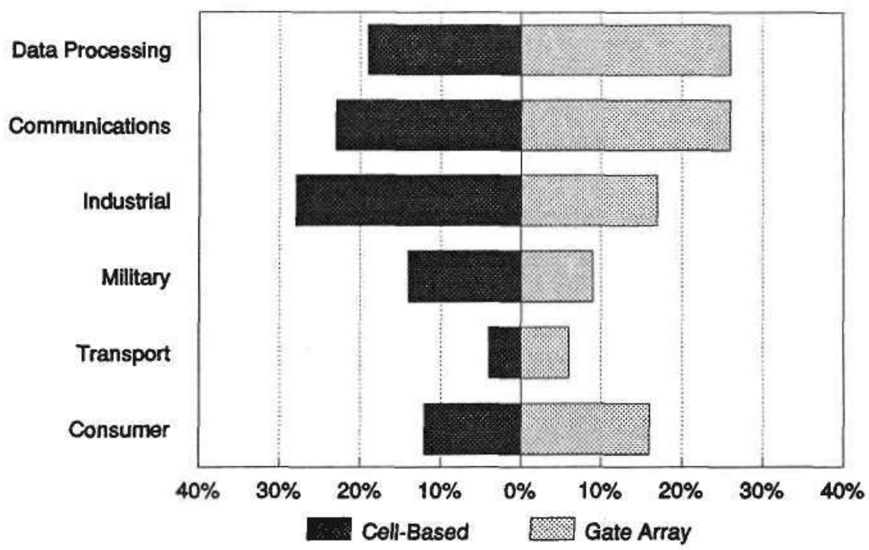
European ASIC Design Starts
1988 Percent Share by Application



Source: Dataquest (March 1991)

FIGURE 3

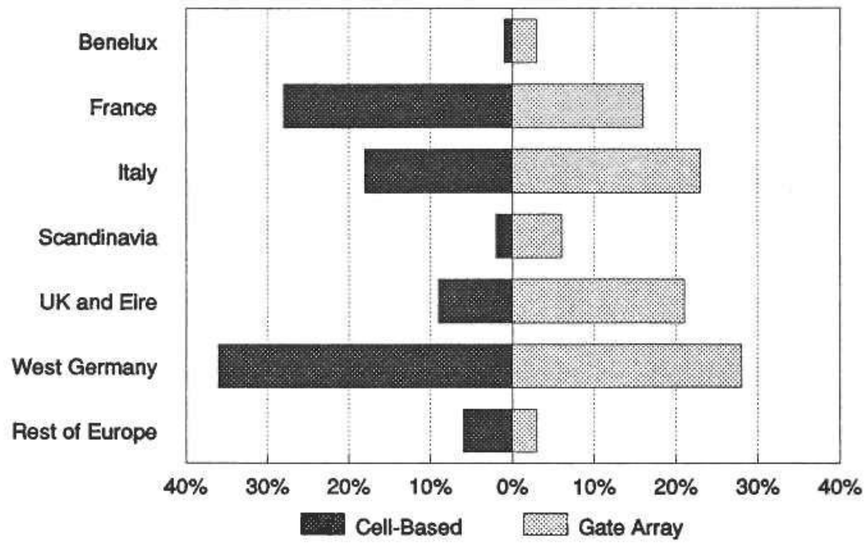
European ASIC Design Starts
1990 Percent Share by Application



Source: Dataquest (March 1991)

FIGURE 4

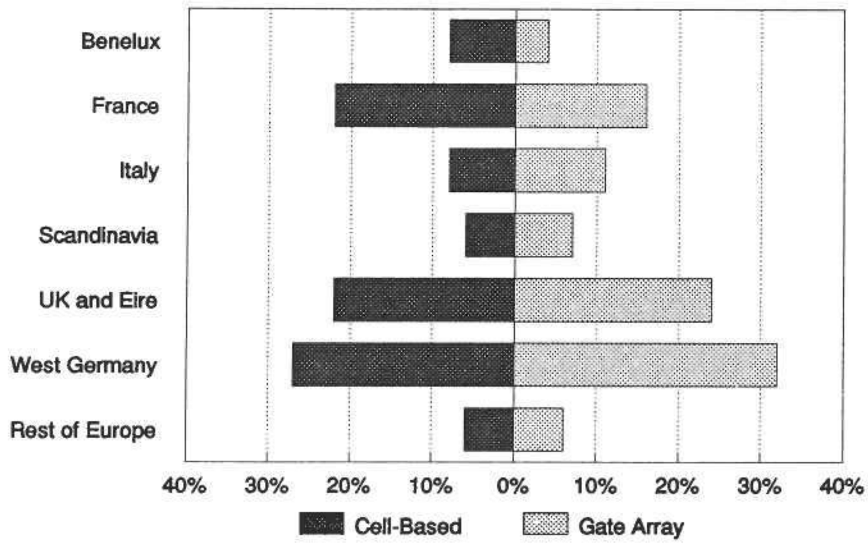
European ASIC Design Starts
1988 Percent Share by Country



Source: Dataquest (March 1991)

FIGURE 5

European ASIC Design Starts
1990 Percent Share by Country



Source: Dataquest (March 1991)

The regional use of gate arrays has seen little change, with the exception of Italy, whose share has declined from 23 percent in 1988 to 12 percent in 1990. Again, this is due to the ending of the design phase for a large number of data processing products.

The majority of gate array design starts was in West Germany, with 31 percent of all MOS gate array design starts. As West Germany is the largest market in Europe for gate arrays, it is no surprise to see the largest share of design starts is also in this country. West Germany has increased its share of the total number of MOS gate array design starts in Europe, rising from 28 percent in 1988, at the expense of Italy.

DATAQUEST CONCLUSIONS

The slowing of design start growth is a reflection of the increase in the complexity of ASIC designs. The large number of usable gates now available on gate arrays allows the integration of a design into one ASIC, when two or more ASICs would have been required previously. Many applications still require fewer than 9,000 gates, but these are within the capabilities of programmable gate arrays, and this is often the more cost-effective solution. The increased use of programmable gate arrays by low gate count designs is reducing the growth of masked gate array design starts. This preference for programmable gate arrays also increases the average gate count on masked gate arrays, as the low gate counts which pull down the masked array average are removed.

The increase in the use of analog cells in CBICs has resulted in higher complexity, but this is not apparent from the number of gates which are integrated into the device. Some analog cells use large areas of silicon, and this leaves less area for use by the digital cells. The inclusion of analog cells on the ASIC can also reduce the need for some digital cells, again reducing their gate count. From this point of view, measuring the complexity of CBICs by counting the number of gates used can give misleading results, especially when comparing their complexity with that of gate array designs.

The greater use of higher-level tools, which are able to simulate several ASICs working together, means more ASICs will work first time in the system they are designed for. This is different from the number of ASICs which work first time in accordance with their specification. Most ASIC manufacturers ensure the ASICs work in accordance with the specification the customer has given, but the specification of the ASIC has not always been adequate to meet the demand of the customer's system. The increase in the use of system design tools has thus enabled an improvement in the specification of the ASICs in the system, and reduced the number of ASICs which need redesigning because of errors in the specification, and hence the total number of ASIC designs.

The majority of ASIC designs in the past have used MOS as the manufacturing technology. The development of BiCMOS for gate arrays and CBICs means the emphasis may change. BiCMOS is more suited to high-performance and high-density designs, and is particularly suitable for analog cells. The use of BiCMOS for ASICs will impact the applications mix, and should increase the use of ASICs for higher-performance analog circuits. However, BiCMOS is expensive to manufacture at the moment, and so will only be used in applications that merit the high cost.

The increase in complexity of designs means design centers will need greater resources allocated to them, even though the number of new designs is falling. More complex designs require better hardware and software tools, and a greater level of design expertise. The level of investment in design centers therefore needs to rise to maintain the effectiveness of these centers.

Mike Glennon

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Research Newsletter

EUROPEAN CAE MARKET—A USER'S VIEW

SUMMARY

The European computer-aided engineering (CAE) market has, for many years, been dominated by three suppliers, Mentor Graphics, DAZIX, and Valid Logic. Over the past few years their development of proprietary design tools has changed; they have been forced to develop more open systems because of demand from CAE users, and the example set by the smaller CAE suppliers. Now all CAE vendors are developing more open hardware systems, and a common software framework that is enabling simple interfacing between a variety of CAE tools. Smaller software vendors who provide tools for very specialized applications have benefited greatly from this. Dataquest believes these open systems will make an important contribution to the success of both large and small vendors, as long as they wholly embrace it.

This newsletter looks at the growth of the major CAE vendors, and their impact on the CAE market. It also looks at the growth of the smaller, specialized CAE tool supplier, and how the introduction of open standards can help in the growth of both large and small suppliers.

INTRODUCTION

The CAE industry has changed enormously in the past two decades, as the needs of CAE users have moved in line with the demands of the electronics industry. In the 1970s the need was for CAE tools to perform a specific task, such as schematic capture, or IC layout. The major vendors were companies such as Applicon, Calma, and Computervision. The 1980s saw the growth of the workstation-based suppliers such as Daisy (now DAZIX), Mentor Graphics, and Valid Logic. These companies provided well-integrated tools that covered the basic CAE needs of schematic capture, simulation and layout on a single workstation. The DAZIX and Valid Logic workstations were proprietary machines, developed by the CAE suppliers, while Mentor Graphics used Apollo workstations exclusively. In the 1990s, CAE vendors are entering a new stage in their development, responding to a more sophisticated demand for open tools and hardware.

DEFINITIONS

Dataquest uses the following definitions:

- EDA (electronic design automation): Composed of CAE design tools, printed circuit board (PCB) design tools, and integrated circuit layout design tools
- CAE tools: Composed of tools for the schematic capture and simulation of integrated circuits and PCBs
- PCB tools: Composed of tools for interactive and automatic layout of printed circuit boards
- IC layout tools: Composed of tools for the physical layout of integrated circuits

MAJOR SUPPLIERS

Analysis of Dataquest's revenue estimates shows that Mentor Graphics, DAZIX and Valid Logic are now joined by Racal-Redac as the top CAE software suppliers in the European market. These top four suppliers in 1990 have 45.5 percent of the European market, compared with the 55.1 percent of the market they controlled in 1989. Tables 1 and 2 (at the end of this newsletter) show Dataquest's preliminary estimates of 1990 European software and hardware revenue for the CAE vendors, and the relative positions of the companies and applications for 1990.

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Mentor, DAZIX and Valid have all lost market share, and this can be attributed to DAZIX's precarious financial position. The uncertainty about the company's future had caused CAE users to delay the purchase of their major systems as they waited to see the ultimate outcome. Mentor grew its CAE software revenue in 1990 although with below-average growth, but suffering less than DAZIX and Valid. Racal-Redac gained market share in 1990, and this has positioned it with the other three major suppliers.

The stranglehold the three major suppliers had on the CAE market has now loosened, but there are still over 50 other suppliers sharing the remaining 45 percent of the software market. The dominance by Mentor, DAZIX and Valid was due to their early entry into the CAE market, but the growth of the smaller suppliers is clearly starting to have a significant effect. This decline in share by the big three may only be a blip, though, as the recent purchase of DAZIX by Intergraph has resolved the uncertainty about DAZIX's future. The major purchases delayed from 1990 may now appear in 1991.

As mentioned, Racal-Redac has joined the three major suppliers with a jump to the number two position in the software suppliers ranking. The company has enjoyed growth of 120 percent for its software revenue, well above average, and is the largest European-based CAE software supplier. Racal has not suffered from the same uncertainty about DAZIX as the other suppliers, and is seen as a stable force in the EDA market. Racal also has a large installed base of EDA users, and was able to ship its CAE tools into this broad user base during 1990.

The dominance of the European CAE software market by US suppliers is still massive, even though DAZIX, Mentor and Valid have lost share. Together, all the US-based suppliers control 75 percent of the CAE software market in Europe, a fall from the 86 percent they controlled in 1989.

STRUCTURAL CHANGES

Both DAZIX and Valid have had similar development patterns, initially with growth coming from their own product development successes in the EDA market. Both companies then expanded their EDA tool range by each acquiring a software company which specialized in the development of PCB tools, adding to the growth of both companies. Valid Logic and Telesis merged to form the new Valid Logic, with Telesis combining its PCB tools with Valid's CAE tools in this merger. Daisy bought Cadnetix in a hostile takeover, merging Daisy's CAE and PCB tools with Cadnetix's PCB tools, to form DAZIX. The new company incurred large debts partly as a result of this purchase, which it was unable to support, culminating in DAZIX's takeover by Intergraph. Intergraph has considerable expertise in mechanical CAD (MCAD) and geographical information systems (GIS), and is using the purchase of DAZIX to enter the CAE market. Valid Logic was more successful in its acquisitions, and retained its position in the market as one of the major suppliers.

Mentor Graphics in the past attempted to grow by developing in-house expertise, but it was not able to gain the necessary expertise fast enough, so has also turned to acquisition to maintain its market lead.

The technical requirements of integrated software tools is changing, as new and more sophisticated tools are demanded by CAE users. The demand for logic synthesis and hardware description languages (HDLs), for example, is allowing the smaller CAE suppliers who provide these tools to gain a toehold into the CAE market with these more specialized products. However, these smaller companies are either being acquired by the larger vendors, who want to gain their expertise, or are acquiring each other to form new, stronger companies with a broader range of products. Some of these smaller vendors have remained independent, though, and may become major CAE vendors. Figure 1 shows the consolidation of some of these companies, as the major vendors have tried to put together product portfolios which will ensure future revenue growth. In at least one case a major new vendor, Cadence, has emerged from these mergers.

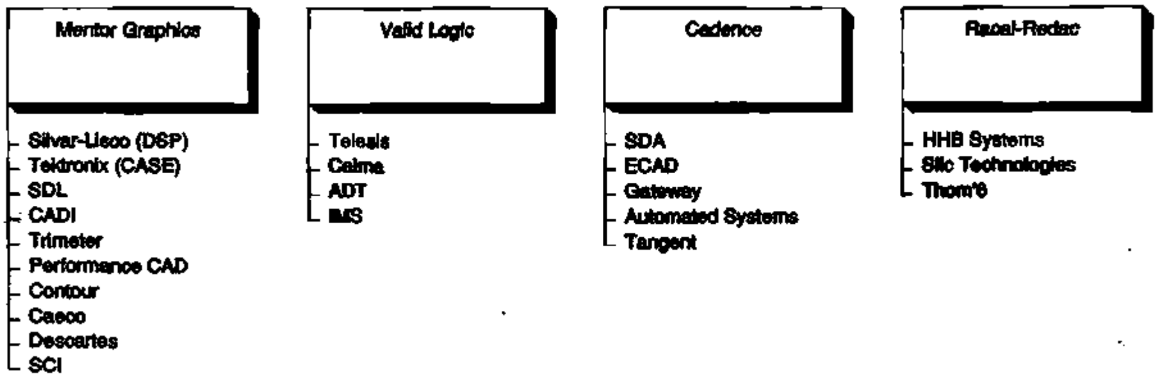
CHANGING NEEDS OF USERS

The use of CAE ranges from simple design documentation to high-level modelling, simulation and logic synthesis. The basic tools of schematic capture and simulation are no longer sufficient for many users, for the reasons outlined below.

The product lifetime for many electronic products is falling, so the time taken to develop them also needs to fall if manufacturers are to maximize profit during this shorter time. The rise in complexity of ASICs has increased ASIC design time, while improvements in manufacturing have reduced the time required to make the prototypes

FIGURE 1

CAE Consolidation



Source: Dataquest (March 1991)

and pilot production devices. This has increased the share of product development that is attributed to the design phase for an ASIC. In order to reduce the time to market for these devices, the design time needs to be reduced, as this has become a major factor in the total development time for a product. Design productivity needs to be improved to reduce the design time, and this improvement comes from the use of tools such as logic synthesis, or high-level simulators.

The equipment manufacturer is constantly trying to develop new products, to gain market share. The performance and integration capabilities of ICs are improving so fast that the design tools are not able to make full use of these capabilities. A good example here is the growth in the number of logic gates available to the ASIC user. The simulators are unable to simulate very large gate counts at the gate level, and so different strategies are needed to simulate whole ASIC designs.

The designer is developing more specialized demands as the drive to produce differentiated products grows. For example, the telecoms market is very strong in Europe, and this market has a need for high-speed switching, and mixed analog and digital circuitry. The integration of analog and digital circuitry onto a single chip requires new design tools to develop these products. The design of these products demands significant expertise from the designer, as sufficiently robust tools are not yet available.

WORKSTATION HARDWARE

The 1980s have seen the change away from workstation hardware manufactured by the EDA vendor, towards hardware platforms manufactured by independent workstation manufacturers such as Sun Microsystems and Hewlett-Packard/Apollo. The growth in the use of Sun workstations has been meteoric, and the Sun is fast becoming a de facto standard platform. DAZIX and Valid started on proprietary platforms, only to change to Sun workstations at a later date. Even Mentor Graphics, which had a lifelong commitment to Apollo workstations, has announced its tools will be ported to Sun workstations as well.

CAE users are beginning to realize the benefit of open hardware systems, and Sun Microsystems' support of UNIX as the standard operating system has helped its success as the preferred hardware vendor. Sun has been very aggressive in the development of its hardware, and has developed its own microprocessor to improve the performance of its workstations. The company has licensed the manufacture of this microprocessor to several semiconductor suppliers, in a move to get it adopted as an industry standard.

The takeover of DAZIX by Intergraph could have meant that Intergraph would impose its proprietary workstation onto DAZIX. Intergraph is a major supplier of proprietary workstations, mainly into MCAD and GIS markets. However, Intergraph has seen the example set by Mentor and other CAE vendors in the adoption of the Sun workstation as a platform, and has committed to maintain support of Sun workstations. Intergraph will still use its own workstation for other CAD applications such as GIS or MCAD, and will port DAZIX's design tools onto its own workstation for existing customers.

The weakness of Digital Equipment in the workstation market can be attributed partly to its failure to adopt UNIX as an operating system at an early date, and partly to its late entry with a competitive workstation. However, Digital has a large installed base of workstations among CAE users, but these users are poorly served by the CAE vendors. The Digital workstation is often one of the last workstations onto which the independent software vendors interface their tools.

Development of Frameworks

In the past the specialized needs of the CAE users have not been met by the major CAE vendors, so the larger users have developed some of their own tools and tried to interface them to the major vendors' tools. As a result of the difficulties in interfacing their tools, they are now asking for the "openness" being adopted with the hardware to be adopted for the CAE software as well.

CAE software vendors are answering these demands with the introduction of design tool frameworks—backbone tools that provide a set of common interfaces to the user, and allow access to the design database through the framework. This framework allows design tools to slot in, and perform a variety of tasks on the data in the design database. The tools provided by the CAE vendor perform tasks such as schematic capture and simulation, but tools to perform other tasks can be written, then interfaced to the framework, using the interface routines provided by the CAE vendor.

The introduction of these frameworks is the first step towards open software tools, but the CAE vendors are nervous about the potential loss of revenue if the CAE user buys a major vendor's framework, and then buys the CAE tools from other vendors. CAE vendors are divided into two camps in their support of framework standards, with Mentor supporting its own Falcon framework, and most of the other suppliers supporting the Digital Equipment Powerframe framework standard. A common framework initiative has started, though, with the purpose of helping in the definition of framework standards. This initiative is mainly US-driven, with some input from other countries. There is also a European research project funded by JESSI, and the intention is to ensure a European advantage in framework technology. The project is coordinated by Nixdorf Computer (now part of the Siemens group), and the start-up phase should reach completion by mid-1991, by which time a prototype framework should be available.

An alternative method for interfacing different CAE tools together is through the use of the electronic data interchange format (EDIF)—a language that defines a common format for various levels of design data. It is used to allow the translation of design data from one design tool to another, through the commonly defined format. The introduction of a common framework initiative would make translation between databases unnecessary, and could spell the death of EDIF as a common interchange format. However, CAE users are pressing for the development of an EDIF standard, because this allows designs to be archived in EDIF, and extracted at a later date for use with future EDIF-compatible tools; this should ensure the CAE suppliers will evenutally develop EDIF interfaces.

Major Applications

The main uses of EDA tools are for PCB design and ASIC design. EDA vendors have addressed these markets with differing degrees of success.

The leading vendors for PCB design and layout tools are Racal-Redac, Mentor Graphics and Valid Logic. The key trends for PCB software are the development of better tools for modelling transmission lines, manufacturing interfaces, and tools for the thermal management of a populated board. Developments in multichip modules are also opening new areas for the tools.

The development of ASIC design tools has followed one of two routes; ASIC vendor-dependent tools, and ASIC vendor-independent tools. In the first case, the ASIC manufacturers have developed their own in-house tools, tied closely to their ASIC manufacturing process. The second route is to use commercially available CAE tools, and provide the manufacturing data needed by these tools in the form of libraries of cells with relevant layout, schematic capture and simulation data. Both options have their merit, and meet the demands of different types of ASIC designer.

The development of ASIC system design tools has also followed the same two development paths, with vendor-dependent and vendor-independent tools. However, the system designer is usually looking for manufacturer independence when performing system design, so that the choice of implementation of the ASIC can be made as late as possible. This takes advantage of the different capabilities offered by each ASIC supplier, and has resulted in a greater success for the manufacturer-independent system tools. The same benefits of better matching to the manufacturing process and improved silicon performance still exists, though, when using vendor-dependent tools, and there will be system designers who want these benefits.

CAE design tools have had a big boost from the development of HDLs, and these tools are mainly used for ASIC design at the moment. The US Department of Defense (DoD) defined a hardware description language called VHDL, as a documentation standard to enable a clear definition of the equipment it was purchasing, and to make equipment maintenance easier. This standard has been adopted by many EDA vendors, who have taken what was originally a documentation standard and developed synthesis and simulation tools for subsets of the standard. Prior to this some vendors were developing their own synthesis and simulation tools. The introduction of VHDL by the DoD has benefited in the consolidation of these tools towards a common standard.

The introduction of VHDL has benefited the ASIC designer enormously, and most ASIC and CAE vendors are rushing to offer VHDL capability. The other major HDL-based environment is Verilog, from Gateway Design Automation, now part of Cadence. This was previously a proprietary system design tool, but is now in the public domain. Verilog had wide acceptance among system designers, and is a contender for the HDL standard. There are also indications that the Japanese-sponsored UDL/I will gain acceptance in view of its greater suitability for logic synthesis; interest is growing in this standard from US CAE vendors.

DATAQUEST ANALYSIS

Three factors are driving the structural changes in CAE. Firstly, basic schematic capture and simulation tools are experiencing slowing growth, with CAE users now asking for specialized tools to fulfil a specific design need. These users already have enough schematic capture tools in-house. The reduction in demand has forced CAE vendors to diversify into new application areas, and the vendors' growth has often been fuelled by the acquisition of smaller, specialized CAE vendors.

The second factor is the growing dissatisfaction with being tied to one CAE vendor. The adoption of an open systems strategy by the hardware suppliers has had a positive feedback effect on the demand for a choice of tools from a variety of vendors. User demands are sufficiently diverse to be satisfied with products offered by the smaller vendors. The fragmentation of CAE users' needs has also driven the growth of the smaller, specialized CAE companies, which are now developing products to meet a specific requirement. As a result, the worldwide nature of the CAE market is taking on regional differences; for example, the specialized needs of European companies can now be met with software tools which may have a lower demand outside Europe. Smaller companies are better able to support the niche requirements of European companies, as they can thrive in a limited market.

Thirdly, hardware and software tools are evolving rapidly. The development of reduced instruction-set computing (RISC) microprocessors, and their introduction into workstations has significantly improved the performance of these machines.

A wider range of tools is now available, capable of performing some very specialized tasks. The pressure for open systems came orginally from CAE users who wished to integrate their own software into CAE vendors' tools. This pursuaded the vendors to open their systems to their users. The niche CAE vendors were then able to enter the market by taking advantage of the opening of the major suppliers' CAE tools to provide their own specialized software products. The more specific need which comes from the CAE users is now driving the development of these tools.

This open systems strategy will help both larger and smaller CAE vendors. The large vendor can use its strength in the basic CAE tools such as schematic capture or PCB layout to win the main CAE sale. It can use compatability with the smaller vendors' specialized tools to help in the sale of the framework. Service and support from the major CAE vendor will become the major issue for CAE users. At the same time, the smaller CAE vendor can use specialized features of tools, and compatibility with the appropriate framework, to win the specialized tool sale; the relationship between larger and smaller vendors then becomes mutually beneficial. Success in the CAE market is assured because of the win–win situation for both types of supplier.

Mike Glennon
Jim Tully

Table 1
Preliminary European Electronic CAE Software Revenue

1990 Rank	1989 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989-90 Growth (%)	1990 Cum. Sum ($M)	1990 Share (%)	1990 Cum. Sum (%)
1	1	0	Mentor Graphics	34	40	18.3%	40	22.8%	22.8%
2	4	2	Racal-Redac	7	15	120.0%	55	8.8%	31.5%
3	3	0	Valid Logic	16	13	-19.5%	69	7.5%	39.0%
4	2	-2	DAZIX	18	11	-36.2%	80	6.4%	45.4%
5	-	NA	EEsof	0	7	NA	87	3.9%	49.3%
6	9	3	Teradyne	3	7	106.3%	93	3.8%	53.1%
7	5	-2	Autodesk	5	5	17.4%	99	3.1%	56.1%
8	12	4	Aucotec	3	5	100.0%	104	3.0%	59.1%
9	14	5	Hewlett-Packard	2	5	112.5%	109	2.9%	62.0%
10	11	1	Cadence	3	5	70.4%	114	2.6%	64.6%
11	7	-4	VLSI Technology	3	4	26.5%	118	2.4%	67.1%
12	-	NA	AnaCAD	0	4	NA	122	2.2%	69.3%
13	8	-5	LSI Logic	3	4	9.1%	125	2.0%	71.3%
14	10	-4	Ziegler	3	4	28.6%	129	2.0%	73.4%
15	-	NA	Synopsis	0	4	NA	133	2.0%	75.4%
16	-	NA	ABB Cade International	0	3	NA	136	1.8%	77.2%
17	17	0	Intergraph	2	3	63.2%	139	1.8%	79.0%
18	13	-5	Genrad	2	3	25.0%	142	1.7%	80.7%
19	-	NA	Analogy	0	3	NA	145	1.6%	82.3%
20	6	-14	Xilinx	4	3	-34.1%	147	1.5%	83.8%
21	-	NA	Viewlogic Systems	0	3	NA	150	1.4%	85.3%
22	-	NA	Logic Automation	0	2	NA	152	1.4%	86.6%
23	16	-7	Computervision	2	2	4.5%	155	1.3%	87.9%
24	-	NA	Altera	0	2	NA	157	1.3%	89.2%
25	18	-7	Assigraph	2	2	46.7%	159	1.3%	90.4%
26	19	-7	ALS Design	1	2	72.7%	161	1.1%	91.5%
27	-	NA	Calay	0	2	NA	163	1.1%	92.6%
28	20	-8	Data I/O	1	2	60.0%	164	0.9%	93.5%
29	22	-7	Serbi	1	1	0.0%	165	0.6%	94.1%
30	-	NA	Test Systems Strategies	0	1	NA	166	0.6%	94.7%
31	-	NA	Vantage Analysis Systems	0	1	NA	167	0.6%	95.2%
32	23	-9	Dassault	1	1	0.0%	168	0.5%	95.7%
33	-	NA	Ikos Systems	0	1	NA	169	0.5%	96.2%
34	-	NA	Aucos Elektronische Gerate	0	1	NA	170	0.4%	96.6%
35	-	NA	DAT Standard Information Sys.	0	1	NA	170	0.4%	97.0%
36	-	NA	Micrograph	0	1	NA	171	0.4%	97.4%

(Continued)

TABLE 1 (Continued)
Preliminary European Electronic CAE Software Revenue

1990 Rank	1989 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989-90 Growth (%)	1990 Cum. Sum ($M)	1990 Share (%)	1990 Cum. Sum (%)
37	-	NA	Caditron	0	1	NA	172	0.3%	97.7%
38	21	-17	rotring euroCAD	1	0.4	-60.0%	172	0.2%	97.9%
39	24	-15	Silvar-Lisco	1	0.4	-20.0%	172	0.2%	98.1%
-	15	NA	Silicon Compiler Systems	2	0	-100.0%	172	0.0%	98.1%
			Other Companies	16	3	-79.6%	176	1.9%	100.0%
			All Companies	136	176	29.3%			
			Total North American	117	133	0.1%		75.6%	
			Total Asia	0	0	NA		0.1%	
			Total European	19	43	1.3%		24.3%	

Numbers may not add due to rounding.
NA = Not Applicable
Source: Dataquest (March 1991)

TABLE 2
Preliminary European Electronic CAE Hardware Revenue

1990 Rank	1989 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989-90 Growth (%)	1990 Cum. Sum ($M)	1990 Share (%)	1990 Cum. Sum (%)
1	1	0	Hewlett-Packard	31	62	103.3%	62	24.9%	24.9%
2	6	4	Compaq	12	39	226.3%	101	15.4%	40.3%
3	3	0	Sun	25	27	6.4%	128	10.7%	51.0%
4	2	-2	Digital	27	27	-1.8%	154	10.6%	61.6%
5	12	7	IBM	1	15	978.6%	169	6.0%	67.6%
6	4	-2	Mentor Graphics	21	12	-45.3%	181	4.6%	72.2%
7	8	1	Intergraph	6	10	61.7%	191	3.9%	76.1%
8	-	NA	ABB Cade International	0	6	NA	197	2.6%	78.7%
9	7	-2	Valid Logic	8	6	-22.4%	203	2.4%	81.0%
10	5	-5	DAZIX	18	6	-67.8%	209	2.3%	83.3%
11	10	-1	Computervision	4	4	4.8%	213	1.8%	85.1%
12	11	-1	Aucotec	2	4	105.0%	217	1.6%	86.7%
13	9	-4	Zycad	6	4	-34.5%	221	1.4%	88.1%
14	13	-1	Apple Computer	1	2	46.2%	223	0.8%	88.9%
15	-	NA	Ikos Systems	0	2	NA	225	0.8%	89.7%
16	-	NA	Quickturn Systems	0	1	NA	226	0.4%	90.1%
17	-	NA	Calay	0	1	NA	227	0.4%	90.5%
18	21	3	Racal-Redac	0	1	400.0%	228	0.4%	90.9%
19	-	NA	Research Machines	0	1	NA	229	0.4%	91.3%
20	17	-3	Genrad	1	1	50.0%	230	0.4%	91.7%
21	16	-5	Westward	1	1	28.6%	230	0.4%	92.0%
22	-	NA	Micrograph	0	1	NA	231	0.3%	92.3%
23	-	NA	Caditron	0	1	NA	232	0.2%	92.6%
24	-	NA	Solbourne	0	1	NA	232	0.2%	92.8%
25	19	-6	LSI Logic	0	1	25.0%	233	0.2%	93.0%
26	14	-12	rotring euroCAD	1	1	-58.3%	233	0.2%	93.2%
27	18	-9	Intercad	1	0.4	-20.0%	234	0.2%	93.4%
28	15	-13	Secmai	1	0	-100.0%	234	0.0%	93.4%
			Other Companies	30	17	-43.9%	250	6.6%	100.0%
			All Companies	196	250	28.1%		100.0%	100.0%
			Total North American	189	233	23.1%		93.0%	
			Total Asia	0	0	NA		0.0%	
			Total European	6	17	173.4%		7.0%	

Numbers may not add due to rounding.
NA = Not Applicable
Source: Dataquest (March 1991)

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Research Newsletter

EXCHANGE RATE NEWSLETTER

FINAL 1990

Dataquest's European exchange rate tables include data from all Western European countries, each of which has different and variable exchange rates against the US dollar. Where applicable, Dataquest's estimates are prepared in terms of local currencies before conversion (where necessary) to US dollars. Dataquest uses exchange rates taken from the *Wall Street Journal*, which are in turn taken from the Bankers Trust Co. All exchange rates previous to 1990 were sourced from the International Monetary Fund (IMF).

All forecasts are prepared using fixed exchange rates based on the last complete historical quarter (currently the fourth quarter of 1990). To maintain consistency across all its analyses, Dataquest makes ongoing adjustments to its forecasts for these currency changes during the year. As a result of this policy, forecast growth rates can become distorted when comparing dollar growth rates with European currency growths.

Effective exchange rates for the current year are calculated each month and are then used to assess the local currency's impact on US dollar forecasts. The purpose of this newsletter is to record these changes, and thus allow the reader to make any necessary adjustments when interpreting regional data. For each European region, Table 1 gives the local currency per US dollar for 1989, the third quarter of 1990, and the fourth quarter of 1990, together with the final estimate for the whole of 1990. Also shown, for reference purposes, are the same figures for the Japanese yen. As can be seen from this table, the Semiconductor Industry Weighted Average (SIWA) for all the European currencies for 1990 has increased 12.61 percent with respect to the US dollar, compared with 1989. This represents a 5.2 percent increase in the exchange rate from the third quarter of 1990 to the fourth quarter. Table 2 shows the 1990 quarterly values for the same regions.

Table 3 illustrates how to interpret the effect of the currency shifts on Dataquest's forecast numbers. For example, the table shows that the constant dollar forecast (based on final 1989 exchange rates) of $9,344 million for the 1990 total European semiconductor market becomes $10,693 million when adjusted for changes in European currencies. Table 4 shows this effect on Dataquest forecasts in European Currency Units (ECUs).

Table 5 shows the 1990 monthly values of local currency per US dollar for each Western European country and Japan. Included in the tables is the European Currency Unit. This unit, established in March 1979, is a weighted average of the currencies of all member countries of the European Community (EC). It is calculated by the IMF from each country's gross national product (GNP) and foreign trade.

Also included is the aforementioned SIWA. This unit is based on the semiconductor consumption of each European country featured here (EC and non-EC members), and uses the base year 1980 equal to 100 as a reference point. The SIWA is useful for interpreting the effect of European currency fluctuations against the US dollar, specifically for the European semiconductor industry.

Dataquest's European local currency forecasts and historical data have previously been recorded using the SIWA as a measure of local currency. Since September 1990 we have changed to using ECUs. As it is becoming increasingly common for companies to publish their annual reports in ECUs, all future local currency forecasts prepared by Dataquest will be published in ECUs. This change in policy has little effect on the local currency market growth rates, as can be seen by comparing Table 3 and Table 4.

James Heal

ESIS Newsletters 1991-7

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Table 1
European Currencies—1989 to 1990
(Local Currency per US Dollar)

Region	1989	3Q90	Percent Change 3Q90-4Q90	4Q90	1990	Percent Change 1989-90
Austria	13.24	11.21	6.00	10.54	11.36	14.17
Belgium	39.44	32.81	5.70	30.93	33.41	15.30
Denmark	7.32	6.08	5.50	5.74	6.18	15.54
Finland	4.30	3.75	4.30	3.59	3.82	11.16
France	6.39	5.34	5.40	5.05	5.44	14.84
Ireland	0.71	0.59	5.60	0.56	0.60	14.85
Italy	1,373.60	1,176.27	4.20	1,126.28	1,197.22	12.84
Luxembourg	39.44	32.81	5.70	30.93	33.41	15.30
Netherlands	2.12	1.80	5.90	1.69	1.82	14.15
Norway	6.91	6.15	4.90	5.85	6.25	9.53
Portugal	157.62	140.62	6.00	132.22	142.40	9.66
Spain	118.55	98.60	3.80	94.85	102.03	13.93
Sweden	6.45	5.86	4.50	5.60	5.92	8.15
Switzerland	1.64	1.33	5.00	1.27	1.39	15.40
United Kingdom	0.61	0.54	4.30	0.51	0.56	7.41
West Germany	1.88	1.59	6.10	1.50	1.62	14.10
ECU	0.92	0.77	5.30	0.73	0.79	14.19
SIWA (Base 1980 = 100)	130.20	111.06	5.20	105.26	113.78	12.61
Japan	138.07	145.07	10.00	130.50	144.71	(4.81)

Source: Dataquest (March 1991)

TABLE 2
European Currencies—1990 by Quarter
(Local Currency per US Dollar)

Region	1Q90	2Q90	3Q90	4Q90	Total Year 1990
Austria	11.90	11.80	11.21	10.54	11.36
Belgium	35.29	34.60	32.81	30.93	33.41
Denmark	6.52	6.39	6.08	5.74	6.18
Finland	3.99	3.96	3.75	3.59	3.82
France	5.74	5.64	5.34	5.05	5.44
Ireland	0.64	0.63	0.59	0.56	0.60
Italy	1,254.66	1,231.66	1,176.27	1,126.28	1,197.22
Luxembourg	35.29	34.60	32.81	30.93	33.41
Netherlands	1.91	1.89	1.80	1.69	1.82
Norway	6.53	6.49	6.15	5.85	6.25
Portugal	148.86	147.90	140.62	132.22	142.40
Spain	109.08	105.60	98.60	94.85	102.03
Sweden	6.15	6.08	5.86	5.60	5.92
Switzerland	1.51	1.44	1.33	1.27	1.39
United Kingdom	0.61	0.60	0.54	0.51	0.56
West Germany	1.69	1.68	1.59	1.50	1.62
ECU	0.83	0.82	0.77	0.73	0.79
SIWA (Base 1980 = 100)	120.18	118.61	111.06	105.26	113.78
Japan	147.92	155.35	145.07	130.50	144.71

Source: Dataquest (March 1991)

Table 3
Effect of Changes in European Currencies per US Dollar on Dataquest Forecasts—1989 versus 1990 (Millions of US Dollars)

	1989	1990	Percent Change 1989-1990
European Semiconductor Consumption (At constant 1989 exchange rates)	$9,755	$9,344	(4.2)
Weighted European Currency (Assumed) (Base 1980 = 100)	130.2	130.2	NM
Weighted European Currency (SIWA) (Latest Estimates)	130.2	113.78	12.6
Effective Consumption (At December YTD exchange rates)	$9,755	$10,693	9.6

NM = Not Meaningful
Source: Dataquest (March 1991)

Table 4
Effect of Changes in European Currencies per US Dollar on Dataquest Forecasts—1989 versus 1990 (Millions of ECUs)

	1989	1990	Percent Change 1989-1990
European Semiconductor Consumption (At constant 1989 exchange rates)	$9,755	$9,182	(5.9)
Weighted European Currency (Assumed) (Base 1980 = 100)	0.92	0.92	NM
Weighted European Currency (ECU) (Latest Estimates)	0.92	0.79	14.1
Effective Consumption (At December YTD exchange rates)	$9,755	$10,693	9.6

NM = Not Meaningful
Source: Dataquest (March 1991)

Table 5
European Currencies—1990 by Month
(Local Currency per US Dollar)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1990	1989	Percent Change 1989-90
Austria	11.90	11.80	12.00	11.86	11.71	11.84	11.55	11.05	11.04	10.73	10.43	10.46	11.36	13.24	14.2
Belgium	35.46	35.01	35.39	34.87	34.33	34.59	33.78	32.39	32.27	31.40	30.58	30.80	33.41	39.44	15.3
Denmark	6.56	6.46	6.53	6.43	6.34	6.41	6.24	6.00	5.99	5.82	5.68	5.73	6.18	7.32	15.5
Finland	4.00	3.95	4.02	3.99	3.92	3.96	3.84	3.70	3.70	3.62	3.55	3.59	3.82	4.30	11.2
France	5.76	5.69	5.76	5.66	5.60	5.66	5.50	5.27	5.25	5.11	4.99	5.05	5.44	6.39	14.8
Ireland	0.64	0.63	0.64	0.63	0.62	0.63	0.61	0.59	0.58	0.57	0.55	0.56	0.60	0.71	14.8
Italy	1,262.59	1,244.04	1,257.34	1,237.69	1,221.84	1,235.45	1,201.37	1,155.49	1,171.96	1,142.96	1,114.93	1,120.96	1,197.22	1,373.60	12.8
Luxembourg	35.46	35.01	35.39	34.87	34.33	34.59	33.78	32.39	32.27	31.40	30.58	30.80	33.41	39.44	15.3
Netherlands	1.91	1.89	1.92	1.90	1.87	1.89	1.85	1.77	1.77	1.72	1.67	1.68	1.82	2.12	14.2
Norway	6.54	6.46	6.58	6.54	6.45	6.47	6.30	6.08	6.06	5.92	5.79	5.83	6.25	6.91	9.5
Portugal	149.20	147.49	149.90	148.99	146.66	148.05	144.20	138.91	138.75	134.75	130.58	131.34	142.40	157.62	9.7
Spain	109.60	108.29	109.35	108.90	103.97	103.93	100.50	96.89	98.41	95.72	93.78	95.04	102.03	118.55	13.9
Sweden	6.17	6.11	6.18	6.11	6.05	6.09	5.95	5.78	5.86	5.64	5.55	5.60	5.92	6.45	8.2
Switzerland	1.52	1.49	1.51	1.49	1.42	1.42	1.39	1.31	1.30	1.28	1.25	1.27	1.39	1.64	15.4
United Kingdom	0.61	0.59	0.62	0.62	0.60	0.59	0.55	0.53	0.53	0.51	0.51	0.52	0.56	0.61	7.4
West Germany	1.69	1.68	1.71	1.69	1.66	1.68	1.64	1.57	1.57	1.52	1.48	1.49	1.62	1.88	14.1
ECU	0.83	0.82	0.84	0.83	0.81	0.82	0.79	0.76	0.76	0.74	0.72	0.73	0.79	0.92	14.2
SWA (Base 1980 = 100)	120.39	118.82	121.33	120.07	117.62	118.15	114.07	109.50	109.61	106.30	104.17	105.31	113.78	130.20	12.6
Japan	145.08	145.71	152.96	158.38	153.90	153.76	149.16	147.65	138.40	129.69	128.77	133.03	144.71	138.07	(4.8)

Source: Dataquest (March 1991)

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Research Newsletter

LOCAL CURRENCY METHODOLOGY

INTRODUCTION

As the European Community (EC) moves towards a system of closer monetary ties through the Exchange Rate Mechanism (ERM), Dataquest's European Semiconductor Group has changed its local currency forecast methodology. This will also tie in with company accounting procedures, as the use of a single currency measure in published balance sheets becomes more widely used. This newsletter summarizes the effect this has on our European semiconductor market history data in local currency terms.

METHODOLOGY

For the past 10 years all of Dataquest's European local currency forecasts have been prepared using Dataquest's own Semiconductor Industry Weighted Average (SIWA) currency. This unit was based on the semiconductor consumption of the major European countries (both EC and non-EC members), and used 1980 as the base year equal to 100. From 1991 onwards all local currency forecasts will be prepared using the European Currency Unit (ECU) as our measure of local currency, in place of the SIWA, which will no longer be calculated.

Table 1 shows the historical semiconductor consumption in Europe for all products and technologies in millions of US dollars, SIWA, and ECUs. Table 2 shows the corresponding growth rates for each of these currencies, and Figure 1 shows these growth rates in graphical form.

As Figure 1 shows, there is little deviation in the local currency growth rates when using either the SIWA or the ECU as the measure of local currency. However, the ECU growth rate tends to accentuate the peaks and troughs in the market.

James Heal

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TABLE 1
Estimated European Semiconductor Consumption History
(US Dollars and Local Currency)

		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Total Semiconductor	$M	3,018	3,686	3,041	3,167	3,370	4,805	4,720	5,532	6,355	8,491	9,755	10,693
	SIWA (M)	3,068	3,686	3,761	4,475	5,311	8,556	8,718	8,071	7,977	10,313	12,701	12,166
	ECU (M)	2,082	2,801	2,798	3,230	3,774	6,102	6,183	5,643	5,529	7,132	8,975	8,447
Total IC	$M	1,747	2,333	1,892	1,988	2,323	3,634	3,556	4,088	4,693	6,669	7,794	8,378
	SIWA (M)	1,776	2,333	2,340	2,809	3,661	6,471	6,568	5,964	5,891	8,100	10,148	9,532
	ECU (M)	1,205	1,773	1,741	2,028	2,602	4,615	4,658	4,170	4,083	5,602	7,170	6,619
Bipolar Digital	$M	390	510	454	434	483	724	709	782	725	772	640	562
	SIWA (M)	396	510	562	613	761	1,289	1,310	1,141	910	938	833	639
	ECU (M)	269	388	418	443	541	919	929	798	631	648	589	444
MOS Digital	$M	781	1,139	882	948	1,227	2,092	1,953	2,280	2,753	4,364	5,458	5,524
	SIWA (M)	794	1,139	1,091	1,340	1,934	3,725	3,607	3,326	3,456	5,301	7,106	6,285
	ECU (M)	539	866	811	967	1,374	2,657	2,558	2,326	2,395	3,666	5,021	4,364
MOS Memory	$M	367	543	426	469	581	995	750	822	838	1,797	2,548	2,283
	SIWA (M)	373	543	527	663	916	1,772	1,385	1,199	1,052	2,183	3,317	2,598
	ECU (M)	253	413	392	478	651	1,264	982	838	729	1,509	2,344	1,804
MOS Micro	$M	125	189	149	168	239	465	485	578	794	1,212	1,469	1,854
	SIWA (M)	127	189	184	237	377	828	896	843	997	1,472	1,913	2,109
	ECU (M)	86	144	137	171	268	591	635	590	691	1,018	1,351	1,465
MOS Logic	$M	289	407	307	311	407	632	718	880	1,121	1,355	1,441	1,387
	SIWA (M)	294	407	380	439	641	1,125	1,326	1,284	1,407	1,646	1,876	1,578
	ECU (M)	199	309	282	317	456	803	941	898	975	1,138	1,326	1,096

(Continued)

TABLE 1 (Continued)
Estimated European Semiconductor Consumption History
(US Dollars and Local Currency)

		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Analog	$M	576	684	556	606	613	818	894	1,026	1,215	1,533	1,696	2,292
	SIWA (M)	586	684	688	856	966	1,457	1,651	1,497	1,525	1,862	2,208	2,608
	ECU (M)	397	520	512	618	687	1,039	1,171	1,047	1,057	1,288	1,560	1,811
Discrete	$M	1,138	1,192	995	1,011	866	963	954	1,153	1,384	1,516	1,594	1,915
	SIWA (M)	1,157	1,192	1,231	1,429	1,365	1,715	1,762	1,682	1,737	1,841	2,075	2,179
	ECU (M)	785	906	915	1,031	970	1,223	1,250	1,176	1,204	1,273	1,466	1,513
Optoelectronic	$M	133	161	154	168	181	208	210	291	278	306	367	400
	SIWA (M)	135	161	190	237	285	370	388	425	349	372	478	455
	ECU (M)	92	122	142	171	203	264	275	297	242	257	338	316
	SIWA/$	101.66	100	123.69	141.3	157.59	178.06	184.7	145.89	125.52	121.46	130.2	113.78
	ECU/$	0.69	0.76	0.92	1.02	1.12	1.27	1.31	1.02	0.87	0.84	0.92	0.79

Source: Dataquest (March 1991)

Table 2
Estimated European Semiconductor Consumption Growth Rates
(US Dollars and Local Currency)

		AGR 1980/1979	AGR 1981/1980	AGR 1982/1981	AGR 1983/1982	AGR 1984/1983	AGR 1985/1984	AGR 1986/1985	AGR 1987/1986	AGR 1988/1987	AGR 1989/1988	AGR 1990/1989
Total Semiconductor	$M	22.13%	-17.50%	4.14%	6.41%	42.58%	-1.77%	17.20%	14.88%	33.61%	14.89%	9.62%
	SIWA (M)	20.14%	2.05%	18.97%	18.68%	61.10%	1.89%	-7.42%	-1.16%	29.29%	23.15%	-4.21%
	ECU (M)	34.52%	-0.13%	15.46%	16.84%	61.68%	1.32%	-8.74%	-2.02%	29.00%	25.83%	-5.87%
Total IC	$M	33.54%	-18.90%	5.07%	16.85%	56.44%	-2.15%	14.96%	14.80%	42.11%	16.87%	7.49%
	SIWA (M)	31.36%	0.31%	20.03%	30.32%	76.76%	1.50%	-9.20%	-1.23%	37.51%	25.28%	-6.06%
	ECU (M)	47.09%	-1.83%	16.50%	28.31%	77.39%	0.94%	-10.49%	-2.08%	37.21%	28.00%	-7.70%
Bipolar Digital	$M	30.77%	-10.98%	-4.41%	11.29%	49.90%	-2.07%	10.30%	-7.29%	6.48%	-17.10%	-12.19%
	SIWA (M)	28.63%	10.11%	9.20%	24.12%	69.37%	1.58%	-12.88%	-20.23%	3.04%	-11.13%	-23.26%
	ECU (M)	44.04%	7.76%	5.99%	22.20%	69.97%	1.01%	-14.12%	-20.92%	2.81%	-9.20%	-24.60%
MOS Digital	$M	45.84%	-22.56%	7.48%	29.43%	70.50%	-6.64%	16.74%	20.75%	58.52%	25.07%	1.21%
	SIWA (M)	43.46%	-4.22%	22.79%	44.35%	92.64%	-3.16%	-7.79%	3.89%	53.39%	34.07%	-11.55%
	ECU (M)	60.63%	-6.26%	19.17%	42.12%	93.33%	-3.70%	-9.10%	2.99%	53.05%	36.98%	-13.09%
MOS Memory	$M	47.96%	-21.55%	10.09%	23.88%	71.26%	-24.62%	9.60%	1.95%	114.44%	41.79%	-10.40%
	SIWA (M)	45.54%	-2.96%	25.77%	38.16%	93.50%	-21.81%	-13.43%	-12.29%	107.50%	51.99%	-21.70%
	ECU (M)	62.97%	-5.03%	22.06%	36.03%	94.19%	-22.25%	-14.66%	-13.05%	107.04%	55.30%	-23.06%
MOS Micro	$M	51.20%	-21.16%	12.75%	42.26%	94.56%	4.30%	19.18%	37.37%	52.64%	21.20%	26.21%
	SIWA (M)	48.73%	-2.49%	28.80%	58.66%	119.83%	8.19%	-5.87%	18.19%	47.71%	29.93%	10.29%
	ECU (M)	66.54%	-4.57%	25.01%	56.21%	120.62%	7.59%	-7.21%	17.17%	47.38%	32.75%	8.37%
MOS Logic	$M	40.83%	-24.57%	1.30%	30.87%	55.28%	13.61%	22.56%	27.39%	20.87%	6.35%	-3.75%
	SIWA (M)	38.53%	-6.70%	15.73%	45.96%	75.45%	17.84%	-3.19%	9.60%	16.96%	14.00%	-15.89%
	ECU (M)	55.12%	-8.69%	12.31%	43.70%	76.08%	17.19%	-4.57%	8.65%	16.71%	16.48%	-17.35%

(Continued)

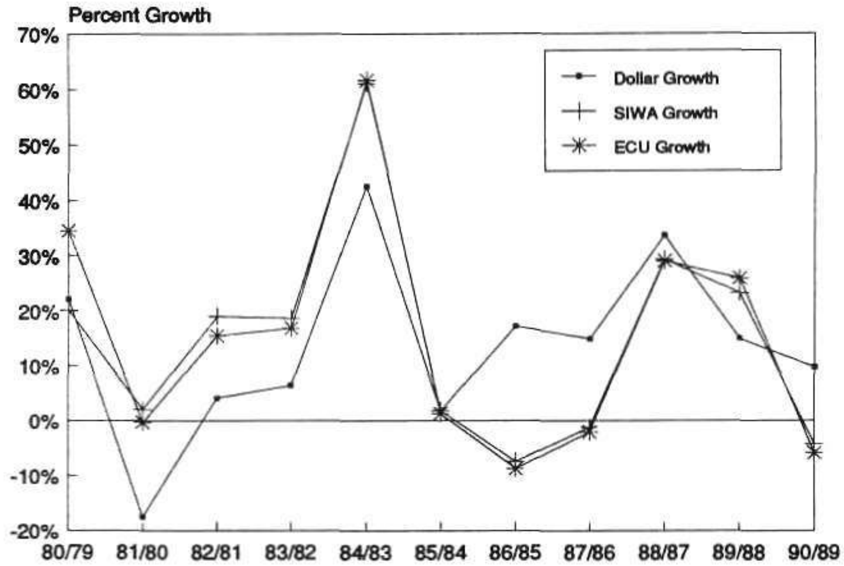
TABLE 2 (Continued)
Estimated European Semiconductor Consumption Growth Rates
(US Dollars and Local Currency)

		AGR 1980/1979	AGR 1981/1980	AGR 1982/1981	AGR 1983/1982	AGR 1984/1983	AGR 1985/1984	AGR 1986/1985	AGR 1987/1986	AGR 1988/1987	AGR 1989/1988	AGR 1990/1989
Analog	$M	18.75%	-18.71%	8.99%	1.16%	33.44%	9.29%	14.77%	18.42%	26.17%	10.63%	35.14%
	SIWA (M)	16.81%	0.54%	24.51%	12.82%	50.78%	13.37%	-9.35%	1.89%	22.09%	18.59%	18.10%
	ECU (M)	30.80%	-1.60%	20.84%	11.07%	51.31%	12.73%	-10.64%	1.01%	21.82%	21.17%	16.05%
Discrete	$M	4.75%	-16.53%	1.61%	-14.34%	11.20%	-0.93%	20.86%	20.03%	9.54%	5.15%	20.14%
	SIWA (M)	3.03%	3.25%	16.07%	-4.47%	25.65%	2.76%	-4.54%	3.27%	5.99%	12.71%	4.99%
	ECU (M)	15.37%	1.05%	12.65%	-5.94%	26.09%	2.19%	-5.90%	2.38%	5.76%	15.16%	3.16%
Optoelectronic	$M	21.05%	-4.35%	9.09%	7.74%	14.92%	0.96%	38.57%	-4.47%	10.07%	19.93%	8.99%
	SIWA (M)	19.08%	18.31%	24.62%	20.16%	29.84%	4.73%	9.45%	-17.81%	6.51%	28.56%	-4.75%
	ECU (M)	33.33%	15.79%	20.95%	18.30%	30.31%	4.14%	7.90%	-18.52%	6.28%	31.36%	-6.41%

AGR = Annual growth rate
Source: Dataquest (March 1991)

FIGURE 1

European Historical Growth Comparisons (Millions of Dollars and Local Currency)



Source: Dataquest (March 1991)

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Research *Newsletter*

EC EPROM REFERENCE PRICE AGREEMENT

INTRODUCTION

The European Commission (EC) has introduced a definitive antidumping duty of 94 percent on all Japanese-manufactured EPROM products. Concurrently, the EC has accepted that seven Japanese EPROM manufacturers will undertake to abide by reference prices (RPs), which provides for a conditional suspension of this duty. The regulation and undertakings were published in the "Official Journal of the European Communities" on March 12, 1991, and came into effect the following day. This newsletter examines the agreement and comments on the likely effects on the market.

SUMMARY

The introduction of the EPROM reference price agreement is in response to a complaint received by the EC in December 1986 from the European Electronic Components Manufacturers Association (EECA). It was made on behalf of SGS Microelettronica and Thomson Semiconducteurs and concerned Japanese-manufactured EPROMs that had been dumped in the market.

In April 1987, the EC opened an investigation and the following companies were named: Fujitsu, Hitachi, Mitsubishi, NEC, and Texas Instruments Japan. In addition to these are Sharp and Toshiba which came forward voluntarily at a later stage in the proceedings. These seven manufacturers comprise the participants of the new agreement; all have been provided with reference prices which apply to orders confirmed from March 13, 1991. Any EPROM products sourced from Japan, but not manufactured by one of the above companies, will be subject to a mandatory 94 percent import duty.

EC EPROM PRODUCT DEFINITION

The agreement covers all densities of EPROM-based memory products. These are ultraviolet (UV) EPROM, one-time-programmable (OTP) EPROM and flash memory based on an EPROM cell structure. A separate reference price is calculated for each of these three products by density, and is issued quarterly by the European Commission.

The inclusion of flash memory in the EPROM definition is interesting. Dataquest expects that flash memory will be the only EPROM-based product developed beyond the 16M density. The value of the flash memory market is forecast to be 60 percent of the size of the standard (UV and OTP) EPROM market in Europe by 1995. This is because flash memory offers all the functions of EPROM with the bonus of electrical erasure, and all for a similar price to EPROM in the long term. Although none of the participants in the EPROM RP agreement have any significant share of the flash memory market today, they are all at the sampling stage. With the exception of Texas Instruments, all these companies plan flash memory products based on an EPROM cell.

MAIN FEATURES

The EPROM RP agreement follows the same ground rules as for DRAM. For more information on the workings of the DRAM RP agreement, see ESIS newsletters 1990-17 "European Commission DRAM Reference Prices Behind The Scenes," and 1990-04 "European Commission DRAM Reference Price Agreement." However, there are areas in which the EPROM RP agreement differs. These reflect the difference between the EPROM market

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and the DRAM market, as well as the fact that the EC has learned some lessons from the operation of the DRAM RP agreement over the last year. These differences are discussed below.

Weighted Average Costs

The cost of manufacture, a key element in the calculation of the RP, is averaged across all types of Japanese EPROM at a given density. For the DRAM RP, only the cheapest version of the product is considered in the cost calculation. The cheapest type of DRAM is always the leader in terms of unit shipments, and is referred to by the European Commission as the "0" type. But EPROM products consumed in Europe cover a broad range of packages and speeds, so there is no clear leading type. The net effect is that the calculated cost of manufacture will be above that of "0"-type EPROMs alone, which consequently raises the EPROM RP threshold.

Actual Cost of Production

EPROM RPs will be based on *actual* cost of production, unlike DRAM RPs which are based on *projected* cost of production. As an illustration, EPROM RPs for the first quarter of 1991 are based on actual costs from the third quarter of 1990, whereas DRAM RPs for the first quarter of 1991 are based upon projected costs from the fourth quarter of 1990, calculated in the third quarter. The reason for the different approach is that projected costs always contain an element of error. For the DRAM RP, this error is measured as soon as actual costs become available, and is then used as corrective feedback in the next cost projection. One of the net effects of using actual costs in the EPROM RP agreement is a reduction of administrative overhead for the EC and its RP participants. More importantly, an element of RP control is taken away from the participants, which should make EPROM RPs more predictable than DRAM RPs.

Profit Margin

The EPROM RP assumes a 12.5 percent profit on cost of sales, while the DRAM RP assumes a 9.5 percent profit. The choice of a higher profit margin in the EPROM RP agreement is made to prevent all possible injurious dumping, rather than just to provide a rock-bottom price safety net as in the case of DRAM. This also raises the EPROM RP threshold.

Free Samples

Each user is allowed 20 free samples from each EPROM RP participant for qualification purposes. For DRAM, the user may receive 1,000 pieces. The reason for this difference is that OEM volume shipments in EPROM are typically smaller than those for DRAM. An exception is made when an OEM trade association wishes to qualify an EPROM on behalf of its members; in this case, the free sample size is increased to 350 pieces.

New Generations

The introduction of a new EPROM density poses a special problem: the cost of manufacturing is very high. Traditionally, a new density is first sold below cost until unit demand brings the cost down and the product becomes profitable. Without this approach, it would never attract any business, and the production line would not ramp up to profitability. To enable a new generation of EPROM to enter the market, the RP agreement allows this practice to continue. For a new generation of EPROM, the RP applicable is 6 times that of its predecessor. However, as soon as the cost of manufacture is reduced enough so that the normally calculated RP drops below this level, then the usual RP applies. In the case of DRAM, the reference price for the new generation is 10 times that of its predecessor. The reason for this difference is plain. Each successive generation of EPROM is twice the density of its predecessor, while for DRAM the increase is fourfold. In the case of a manufacturer skipping an intermediate EPROM density, the predecessor factor would be the same as for DRAM.

DATAQUEST ANALYSIS

Vendor Perspective

Many vendors believe the EC EPROM RP agreement is unwarranted, as in 1990 sales of Japanese-manufactured EPROMs accounted for no more than 15 percent of the total European market. This proportion has steadily declined from 1985, when Japanese market share is estimated to have been in excess of 35 percent. The decline in market share is widely believed to be the result of guidelines set by the Japanese Ministry of International Trade and Industry (MITI) on foreign market values (FMVs). This followed the US-Japan trade agreement of 1986. As a consequence, Japanese EPROM prices currently range between 10 and 40 percent higher than European market average prices.

Japanese EPROM manufacturers choosing not to participate in the EPROM RP agreement include Oki, Ricoh, and Seiko-Epson. In addition, NMBS, which is not a manufacturer of EPROMs, is developing an EPROM-based flash memory. These companies will face a 94 percent duty if they choose to ship EPROM-based products into Europe; but none of these manufacturers currently feature in the European EPROM market. Each of these companies will have the option of entering into the RP undertaking at a later stage if necessary.

The top five suppliers to the European EPROM market in 1990 were three North American and two European suppliers. Collectively, they control an estimated 85 percent of the total market. Fierce competition exists between these five suppliers, and in the past year there have been several open accusations of dumping between them. However, no formal complaints have been filed with the European Commission or the US Department of Commerce. This is not really surprising because these five vendors have significant business in both Europe and North America. Any complaint against a foreign EPROM vendor is likely to be followed by a counter-complaint in that vendor's home market. The result is a stalemate. Of course, Japanese vendors do not currently benefit from such protection.

The top five suppliers to the European flash memory market in 1990 were four North American and one Japanese supplier. One of these suppliers, Intel, controls an estimated 90 percent of the market in terms of sales, but Japanese companies have made little impact to date. This is a traditionally Japanese approach—waiting until a product market has been established before entering it. Japanese flash memory products will benefit from Japan's strength in high-density EPROM technology. Dataquest believes that manufacturing costs associated with flash memory will not be so great as to generate prohibitively high reference prices. However, if RPs do appear to prevent market entry, it is believed there may be an opportunity for Japanese companies to negotiate with the European Commission to prevent market entry being obstructed by exceptionally high RPs. A solution of the nature already discussed in the section entitled "New Generations" would probably suffice.

User Perspective

Memory users in Europe have recently made strong complaints to the European Commission about the use of reference prices. These have come via trade associations such as Standard Computer Komponenten GmbH (Stack GmbH) and Eurobit, as well as via the governments of the United Kingdom and Ireland where there is a strong base of memory users. The main issue is that European users believe they are being forced to pay higher prices for their memory than they would in a free trade environment. They are not impressed by arguments that RP agreements protect local suppliers of memory, to prevent European users being dependent on memory from Japanese vertically integrated (and therefore competitive) suppliers. They claim that European memory suppliers are also vertically (or at least virtually) integrated, and so pose the same threat.

The sample size required by a medium-size user for the qualification of an EPROM is believed to be in the region of 200 pieces. The EC has set a limit of 20 on the number of free samples available for this purpose before reference prices come into play. We understand that many users disagree with this low sample size, believing it to be unrealistic.

Another criticism is that RPs should not start to increase as a product approaches maturity. It is intuitive that the cost of manufacture of a memory product should continue to decline with age until falling demand and fixed overheads force an inflection. For example, Dataquest forecasts that 1991 will be the demand peak year for the 1M DRAM, and yet the 1M DRAM RP increased by an estimated 15 percent between the fourth quarter of 1990 and the first quarter of 1991. This reverse trend has angered many DRAM users who declare that the RP agreement does not match industry trends.

Dataquest notes that DRAM RPs of the first quarter of 1991 are based on cost estimates made in the third quarter of 1990, at which time there was a slowdown in DRAM demand. The increase in RPs for the first quarter of 1991 reflects a slowdown in DRAM production in response to the demand slump of the third quarter of 1990. There is thus a six-month dislocation between production fluctuations and reference prices.

The final analysis shows that users want the lowest total cost of ownership, regardless of origin.

Dataquest Perspective

On the face of it, it would appear that the European Commission is too late in responding to the original complaint of December 1986. This is because Japanese companies do not feature strongly in the European market and they are not competitive on pricing.

Although this criticism is valid to some extent, looking beyond Europe, a different story emerges. Japanese companies' share of the Japanese and North American EPROM markets are estimated at 85 and 30 percent, respectively. This positions Japanese companies with approximately a 50 percent share of the worldwide EPROM market. Furthermore, Japanese companies dominate the markets for high-density EPROM (1M and above) while North American and European companies dominate the lower densities.

For example, based on estimated 1989 worldwide unit shipments, Japanese companies supplied 65.2 percent of the 1M EPROM, 96.2 percent of the 2M, and 79.8 percent of the 4M. In contrast, North American companies are estimated to have supplied 67.0 percent of the 128K EPROM, 55.4 percent of the 256K, and 57.1 percent of the 512K. European vendors' share of these markets are 11.4 percent, 16.4 percent, and 14.5 percent, respectively.

This proves that Japanese companies are not just world leaders in DRAM, but also lead in high-density EPROM technology and have a strong commitment to product development. The concept of the EPROM RP agreement is therefore supported from the point of view that Japanese companies continue to represent a major competitive force in the worldwide EPROM market.

Of course, competition today in the European market is being fought between European and North American suppliers, and this will continue regardless of the existence of the EPROM RP agreement. If EPROM RPs from the European Commission are lower than the equivalent FMVs from MITI, then it is conceivable that Japanese companies will find themselves in a position to lower their prices. This will then increase their competitiveness and possibly their market share.

In the case of the DRAM RP agreement, there has been widespread leakage of the RPs to the trade press and users. This has been seen to modulate market prices, as buyers use an RP as the target price to pay when it offers them an advantage. In the second half of 1990, Dataquest believes this was a contributing factor to Europe becoming one of the cheapest markets for 1M DRAMs in the world. However, as the 1M DRAM RP increased in the first quarter of 1991, so 1M DRAM prices in Europe immediately rose by an estimated 10 percent. The slowdown in 1M DRAM production by Japanese manufacturers would have led to increased market prices anyway, but the quarterly transitions between RPs are though to be producing sudden market price changes. These are all the more noticeable when market prices and RPs follow each other closely. In the case of EPROM, it is not yet known how closely market prices and RPs will track each other, and therefore whether market price modulation is an issue.

While the European flash memory market is in its infancy, it does hold great promise for sales in the long term. This has not been lost on the EPROM RP participants, all of which are understood to have accelerated their flash memory development programs. But if the EPROM RP agreement fixes a high price on Japanese flash memory, then North American vendors may continue to be the competitive leaders in the European market.

In conclusion, Dataquest believes that the EPROM RP agreement will not be as controversial as the DRAM agreement, if only because the market is smaller and less volatile. However, the strategic nature of flash memory will make the inclusion of this product in the agreement the subject of much debate.

Byron Harding

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Research *Newsletter*

A GLIMPSE AT FUTURE 64M DRAM TECHNOLOGIES

SUMMARY

The IEEE International Solid State Circuits Conference (ISSCC) held every February is a good barometer of future trends in device technology and applications. The 1991 conference featured several experimental versions of 64M DRAM devices. Although these devices are at least five years away from volume production, they provide a glimpse of future high-volume process technologies. In this newsletter, Dataquest analyses key implications of these prototype 64M DRAM technologies for the semiconductor equipment, manufacturing, and materials industries in the years ahead.

64M DRAM TRENDS

Table 1 illustrates the key features of experimental 64M DRAMs unveiled by Fujitsu, Matsushita, Mitsubishi, and Toshiba at ISSCC 1991. Dataquest believes that DRAM companies will continue to push optical lithography to 0.4-µm geometries for the 64M DRAM. All of the 64M DRAM devices were characterized by multiple levels of poly/polycide and double-level interconnect technology. Gate and capacitor dielectric thickness values are expected to be in the 50- to 100-angstrom range. All four companies used variations of a stacked-capacitor cell scheme.

US-based DRAM manufacturers have traditionally favored a trench capacitor–based memory cell. In contrast, Japan-based DRAM companies favor the simple stacked capacitor scheme over the more complex trench capacitor scheme with its attendant problems of trench etch damage and trench sidewall leakage currents. Toshiba appears to have the most aggressive 64M DRAM design. Toshiba's use of excimer laser lithography, together with the asymmetric stacked trench capacitor design, yields the smallest cell size ($0.9 \times 1.7\ \mu m^2$) and the fastest speed (33ns).

LITHOGRAPHY TRENDS

All of these 64M DRAMs were fabricated with 0.4-µm design rules using optical lithography tools. Fujitsu and Mitsubishi opted for i-line steppers and Matsushita and Toshiba chose excimer laser steppers. The astonishing progress of optical lithography in combination with technology such as phase-shift masks pushes X-ray lithography even further out into the future. Semiconductor manufacturers have a huge installed base of investment and experience in optical lithography that they are reluctant to throw away. Japan-based DRAM companies are racing to convert development results in phase-shift masks into commercially useful technologies to extend the lifetime of optical lithography tools through the 64M DRAM generation and potentially to the 256M DRAM generation.

Issues such as global and local planarization, depth of focus, wafer flatness, and intrafield focus on large fields may yet force semiconductor manufacturers to eventually migrate to X-ray lithography, which has far higher depth-of-focus latitude. However, X-ray lithography has to contend with the challenges of 1X mask technology. The prohibitive costs associated with synchrotron orbital rings (SORs) for X-ray lithography, together with the technical challenges of 1X mask materials, mask fabrication, inspection, and repair, have prompted 64M DRAM manufacturers to stay with the evolutionary, incremental advantages of optical lithography.

Dataquest believes that the extension of optical lithography using i-line and excimer laser steppers in combination with phase-shift mask technology may enable the 64M DRAM device to follow the traditional decrease in the cost-per-bit curve. Given the extension of optical lithography to the 64M DRAM generation, lithography equipment companies need to focus on high-throughput, wide-field steppers that can offer better productivity in

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TABLE 1
Key Features of 64M CMOS DRAMs at ISSCC 1991

Company	Minimum Feature size (μm)	Lithography	Poly/ Polycide Levels	Metal Levels	Gate Oxide Thickness (Angstroms)	Capacitor Type	Cell Size (μm x μm)	Chip Size (mm × mm)	Access Time (ns)
Fujitsu	0.4	I-line Phase-shift	4	2	NA	Double-fin stacked	1.0 × 1.8	11.27 × 19.94	40
Matsushita	0.4	KrF excimer laser	3	2	120	Tunnel stacked	1.0 × 2.0	10.85 × 21.60	50
Mitsubishi	0.4	I-line	3	2	120	Dual-cellplate stacked	1.0 × 1.7	12.5 × 18.7	45
Toshiba	0.4	KrF excimer laser	4	2	· 50	Asymmetric stack trench	0.9 × 1.7	9.22 × 19.13	33

NA = Not available
Source: ISSCC, Dataquest (April 1991)

spite of higher average selling prices (ASPs). Significant opportunities exist for companies to target new business areas such as i-line and excimer laser photoresists, ancillary lithography chemicals, phase-shift masks, mask coatings, mask etch, and mask inspection/repair equipment.

ETCH/CLEAN TRENDS

Dataquest estimates that the number of mask/etch levels will almost double between the 1M DRAM (16 levels) and the 64M DRAM (about 30 levels). In fact, the number of wet clean/dry etch processes will exceed the number of masking processes because of the addition of more elaborate wet/dry vapor cleans as well as blanket (maskless) etchback steps such as trench refill etchback, LDD spacer etchback, and contact/via plug etchback, intermetal planarization etchback. The unique requirements of the 3-D stacked or trench 64M DRAM capacitor offer extraordinary challenges to the ability of wet chemical/vapor phase cleans to truly "clean" the wafer without adding additional particles and contamination.

Dry etch equipment has to offer extremely high selectivities, uniformity, critical dimension (CD) control across 8-inch wafers, and low ionization damage in order to etch 0.4-µm gate features. A variety of plasma sources are being considered in order to handle the stringent processing requirements of 64M DRAM dry etch processes. New gas chemistries such as bromine, NF_3, and other nonfluorocarbon processes offer significant processing challenges to gas suppliers and dry etch equipment companies.

DEPOSITION TRENDS

DRAM manufacturers have already switched from single-level metal to double-level metal for the 16M DRAM generation. The challenges associated with metal step coverage dramatically increase as contact and via dimensions approach the 0.4-µm level. CVD titanium nitride, CVD tungsten, and CVD polysilicon are being examined as viable candidates for contact plug processes. Meanwhile, the efforts to improve the step coverage of sputtered aluminum and refractory barrier metals such as titanium nitride continue vigorously. Many opportunities exist for materials companies to develop new sputtering materials and CVD source materials for interconnect applications in the 64M DRAM generation.

The polysilicon CVD equipment market is expected to grow dramatically over the next five years in order to cater to mushrooming applications for high-quality polysilicon films at multiple levels in the 64M DRAM process. For example, Toshiba is reportedly planning to use four levels of poly/polycide films in its 64M DRAM process. Stacked capacitors and trench capacitors will use multiple poly depositions to achieve the desired cell capacitor area. Many new types of poly CVD equipment such as improved vertical LPCVD poly tubes and integrated cluster tools incorporating rapid thermal oxidation/nitridation (RTO/RTN), low-pressure poly CVD, and low-pressure tungsten silicide CVD may emerge in response to these applications.

Interlayer dielectrics between poly and first-level metal and intermetal dielectrics between metal levels need to be highly planarized because of metal step coverage, bridging, depth of focus, resist uniformity, and over-etch considerations in 64M DRAM wafers. In addition to the familiar spin-on-glass planarization schemes, Dataquest believes that 64M DRAM companies will examine other global planarization techniques such as biased electron cyclotron resonance (ECR) CVD techniques, chemical-mechanical polishing, TEOS-based plasma-enhanced CVD oxide fill/etchback, and in situ deposition/low-temperature reflow oxides. Tungsten, poly, aluminum, and copper CVD plugs are being explored for contact and via fills. The choice of the optimum planarization and back-end interconnect process will have profound effects on 64M DRAM speeds, yield, and reliability.

DIFFUSION/IMPLANT TRENDS

Vertical diffusion and LPCVD tubes will probably be used for all diffusion and oxidation processes on 8-inch 64M DRAM wafers. Vertical furnaces offer high-quality thin oxides, thermal nitride, and polysilicon. Vertical tubes are also more compatible with the automation and film uniformity requirements of 8-inch fabs. Load-locked vertical diffusion furnaces may be used to implement tube-to-tube transfer between oxidation, nitridation, and LPCVD poly/nitride processes.

The number of implant steps continues to rise significantly in order to precisely control the electrical behavior of 0.4-µm geometry transistors. In addition to the traditional requirements for dose uniformity and low particulates across 8-inch wafers, continuously variable tilt angles and parallel beam scanning are expected to become the norm for implanting 3-D 64M DRAM device structures.

PROCESS CONTROL TRENDS

CD and wafer-inspection equipment companies will enjoy major business opportunities at the 64M DRAM generation. The process of analysing variations in critical dimensions at the 0.4-µm level across 8-inch wafers is a major challenge. The move toward integrated processes will lead to the loss of critical intermediate CD and wafer-condition information. Some equipment companies are evaluating the incorporation of in situ metrology tools such as CD SEM measurement chambers and particle-detection/wafer-inspection chambers onto cluster tool platforms.

Thin films and resistivity measurement systems will face similar challenges in measuring thin oxides and shallow doped junctions. Electrical measurement techniques may be used to augment physical thin-film thickness and resistivity measurements.

DATAQUEST CONCLUSIONS

Dataquest believes that DRAM process technology will continue its evolutionary progress between generations. The extension of optical lithography and the stacked capacitor cell structure to the 64M DRAM devices are aimed at keeping the DRAM cost per bit on its historical decline. Dramatic increases in the complexity of lithography, interconnect, planarization, dry etch, and process-control processes may push the price tag of an 8-inch high-volume 64M DRAM fab to well over $600 million. At the 0.4-µm 64M DRAM level, interconnect process complexity and performance will be the limiting factors that control the device speed and cost per bit.

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Dataquest
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Research Newsletter

EUROPEAN DRAM MARKET UPDATE—WELCOME TO THE 4M

INTRODUCTION

Dataquest published its long-term outlook for the European DRAM market in the European MOS Memory Market Consumption Forecast booklet in March this year. This newsletter focuses on the short-term issues which will affect the market up to the end of 1992. Our forecast is quarterly, and where appropriate, updates are made to our March analysis. Special attention is given to the 4M DRAM as this product is approaching volume production and DRAM buyers are now considering their options.

SUMMARY

The European DRAM market is in a state of transformation. Our quarterly forecast shows that the European DRAM market will grow in value by 10.9 percent in 1991, assuming a unit growth of 6.6 percent and an average selling price (ASP) growth of 4.0 percent. This is a promising recovery from 1990, which saw a 26.1 percent market decline caused by an ASP decline of 33.8 percent and a unit growth of 11.6 percent.

Three key changes have occurred in the market since we prepared our long-range European MOS Memory Consumption Forecast booklet. These are as follows:

- Total DRAM sales to the European market for 1990 have been finalized at $1,216 million. This is $76 million greater than the preliminary market size given in the booklet, and is believed to include direct shipments of 1M from Japan.
- Poor first quarter results by major end users of DRAM have led us to revise the expected unit demand for the 1M in 1991.
- Market prices for the 1M increased substantially at the beginning of the second quarter of 1991. This is believed to be related to the DRAM reference price agreement between Japanese companies and the European Commission, and is discussed in detail later.

In summary, key assumptions for 1991 are:

- The 64K is experiencing a sharp decline in demand.
- The 256K shows general slowdown in production leading to higher prices.
- The 1M shows slowdown in Japanese production leading to higher prices.
- The 4M is ramping up in Japanese production leading to price erosion.
- The 4M has reached price-per-bit parity with the 1M.
- European PC market is growing at around 10.0 percent.
- No shortages are expected in 1M or 4M DRAMs.
- DRAM market growth is at 10.9 percent.
- DRAM market growth in 1992 will be at 34.9 percent.

PRODUCT ANALYSIS

Price Trends

Japanese companies continue to be a major influence in the European market. This is despite the fact that only two out of the top five suppliers to the European DRAM market in 1990 were Japanese, those two being Toshiba and NEC, ranked second and fifth, respectively. In fact, the market share results belie the fact that in 1990 Japanese

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companies collectively served an estimated 47.1 percent of the European DRAM market. At the 4M density, this dominance is greatest, and currently stands at around 85.0 percent. Obviously then, any forces affecting the DRAM activities of Japanese companies will affect the marketplace.

In January 1990, the European Commission entered into an agreement with Japanese DRAM manufacturers; it set minimum European price guidelines for Japanese DRAM products based on cost of manufacture. Dataquest believes that 1M and 4M DRAM reference prices (RPs) applied to Japanese-sourced DRAMs increased in the first quarter of 1991, followed by further growth in the second quarter. The cause was rising manufacturing costs, which are used to determine RPs. Japanese companies have been reducing production of 1M DRAMs, which has augmented unit costs, and hence the 1M RP.

The 4M DRAM RP increases are less easy to understand, but are believed to be caused by the late inclusion of some previously overlooked manufacturing costs by Japanese companies. The RP agreement allows for the correction of previously underestimated costs by adding the shortfall to current cost estimates. The scale of the rise in RP varies depending on the currency used, but the fact remains that these increases have been followed closely by growth in market prices.

Dataquest believes that Japanese companies do not always lose their business to non-Japanese competitors as a result of increases in reference prices. Some Japanese suppliers are believed to offer package deals which maintain conformance to DRAM reference price levels, but include other products at discount. In this way, competitiveness can be maintained against suppliers not bound by DRAM reference prices. The net effect is that Japanese companies hold on to their DRAM customers, and the market ASPs reflect RP levels.

We have found it necessary to integrate RP trend assumptions into our forecast. These are linked to how Japanese DRAM production capacity is utilized and affects the 1M and 4M:

- 1M RPs are expected to continue to rise throughout the forecast period.
- 1M market ASPs will follow a similar trend, but will be below 1M RPs. RPs will have progressively less effect on market ASPs as Japanese suppliers withdraw from this density.
- 4M RPs are expected to decline from the third quarter of 1991 to the end of the forecast period.
- 4M market ASPs will closely follow 4M RP trends as Japanese suppliers are expected to maintain leadership in this market throughout the forecast period.
- RP trends will show short-term deviations as a result of exchange rate fluctuations, DRAM production changes, and errors and corrections in cost projection.

For further information on the RP agreement and its methodology, refer to ESIS newsletters 1990-4 "European Commission DRAM Reference Price Agreement," and 1990-17 "European Commission DRAM Reference Prices—Behind the Scenes."

Product Diversification

The DRAM market of the past was driven by technology, and users needed to design their systems around the product. The DRAM market of today is driven by application. The number of user options available for DRAM has increased with each generation, and currently exceeds 400 at the 4M density from some vendors. These options cover speed, configuration, package type, refresh mode, write mode, read mode, power consumption, and special modes. This excludes permutations possible from DRAM module configurations. It is now vitally important to understand what the customer wants in order to ensure that the correct balance of options are made available to the market.

Trends by Product

Dataquest has surveyed major European users of DRAM in order to produce a demand-driven quarterly forecast which has been balanced against production estimates from suppliers. Table 1 shows our expectations for DRAM to the end of 1992; Figure 1 plots unit shipments; Figure 2 plots ASPs; and Figure 3 plots revenues. (These have been placed at the end of the newsletter for space reasons.) We can see the following trends by product.

64K DRAM

From the beginning of the year, this part has experienced a sharp decline in demand. Users have finally chosen to move up to the 256K part, which is only 10 percent more expensive. The 64K and 256K DRAM ASPs are expected to converge and follow a similar upward trend through to the end of 1992 (see Figure 2). Dataquest believes that the timing of this move was inevitable. The number of suppliers of the 64K are dwindling, and as each one of them withdraws, the volume of supply will be reduced significantly. Most vendors can effectively support three generations of DRAM, and so the imminent take-off of the 4M market puts the 64K on borrowed time. Typical applications for the 64K include TV teletext buffers, satellite receiver memory, and small system memory upgrades. Even if some of these applications do not require the capacity of a 256K, the lower cost-per-bit and benefit of a more secure supply will prevail. The short-term outlook for the 64K market is therefore rapid decline.

256K DRAM

Demand for the 256K part has been in steady decline since mid-1989 when the price-per-bit of the 1M reached parity with it. Current supply of this part in Europe is mainly from non-Japanese vendors such as Samsung, Texas Instruments and Siemens, and many of these plan to phase out the product by the close of 1991. Major European users of the 256K include telecommunications and computer manufacturers, with key applications being digital exchanges and PCs, respectively. These end users are finding that shortages of the part have lead to higher prices.

Leading package options, in order of preference, are DIP, PLCC, and ZIP (see footnote). The 1M, in 64K×16 and 256K×4 configurations, is a convenient replacement for the 256K in 64K×4 and 256K×1 configurations. The outlook for the 256K market is for continued decline in units coupled with increasing prices, detailed in Table 1. The extent of the decline of the 256K market since its peak in mid-1989 can be seen in Figure 3. Notices of withdrawal from the 256K market are expected to be announced by vendors throughout the year.

1M DRAM

This product has now reached maturity and is expected to peak in unit shipments in the third quarter of this year. Unit demand is expected to decline in the second half of 1991 (see Figure 1), this coupled with price erosion (shown in Figure 2) will lead to a sharp drop in revenue and after the second quarter of 1992, 1M revenue will fall below that of the 4M (see Figure 3). Key European applications of the 1M include most PCs, workstations, memory expansion modules, laser printers, and telecommunications equipment. Leading package options, in order of preference, are SOJ, DIP, ZIP, and TSOP type 2. Configuration options, also in order of preference, are 1M×1, 256K×4, and 64K×16. Access speeds vary from 120ns to 53ns, with most demand in the region of 80ns, though the trend is towards 70ns.

Japanese suppliers began cutting back on 1M production in the third quarter of 1990 as there was a slump in worldwide demand. This led to increases in 1M reference prices from the first quarter of 1991, which took the 1M user base by surprise (see ESIS newsletter 1991-3 "European DRAM Price Hike"); Figure 2 shows this sudden reverse trend. Many non-Japanese vendors have ramped up production in order to take up the excess business. This has led to Samsung becoming the world's largest producer of 1M DRAMs. However, this concerted effort has not prevented the 1M from becoming booked out or prices from rising in Europe.

The result of the 1M price rise meant that the 4M part achieved price-per-bit parity with the 1M. It is expected that non-Japanese suppliers will want to reduce 1M prices again to delay users migrating to the 4M. However, there are complications to this effort, as the European Commission is investigating a number of South Korean DRAM suppliers accused of dumping DRAMs in Europe. Dataquest is of the opinion that 1M DRAM market prices in Europe will begin to diverge from reference price trends in the medium term.

Welcome to the 4M

This part is now at parity on price-per-bit with the 1M DRAM. Second-generation devices are becoming available, with package outlines and speeds that are attractive as replacements for the 1M. This newsletter pays special attention to the future development of this market.

The growth of the 4M market to the end of 1990 has been dogged by continued price erosion of the 1M DRAM. This kept the price-per-bit of the 4M above that of the 1M for longer than would normally be expected (see Table 1). Added to this,

Packaging Terms
DIP—dual in-line package
PLCC—plastic leaded chip carrier
ZIP—zigzag in-line package
SOJ—small outline J-leaded
TSOP—thin small outline package
SIMM—single in-line memory module
TAB—tape-automated bonding
SIP—single in-line package

4M suppliers shot themselves in the foot by promising that the 4M would eventually have the same outline as the 1M. This would be achieved by releasing a second-generation 4M using 0.8-μm design rules to replace the initial first-generation 1.0-μm offering. This is believed to have given users cause for concern: the first-generation 4M in 350-mil SOJ might not last long before being made obsolete by its 300-mil SOJ successor. A wait-and-see attitude thus developed.

The growth of the 4M market is now finally under way. Dataquest has analysed the options available for this product, and has produced a detailed forecast shown in Table 2 at the end of this newsletter. Our key 4M market assumptions are given below in configuration options:

- 4M×1—bit-wide organized versions of the 4M are required in large systems such as mainframe, mini-computers, and large dedicated systems. These users were some of the early adopters of the 4M. This organization currently accounts for 50 percent of the European market. It will represent a smaller share in the future, as strong growth in other applications are expected to demand wider organized 4M.
- 1M×4—nibble-wide organized versions of the 4M are in demand for 80386/80486- and 68030/68040-based systems for main and expanded memory. This organization has remained popular from the earliest days of the 4M, although it lost some ground to the 4M×1 over the last two years. The outlook is for increased share of the 4M market, as OEMs of the above systems collectively move to the 4M from the 1M. Memory modules are also an important application for the 1M×4. As an example, a 1M×9-configured SIMM can have its power consumption reduced by 67 percent and its height reduced by 18 percent when using two 4M (1M×4) DRAMs and one 1M (1M×1) DRAM instead of nine 1M (1M×1) DRAMs on the board.
- 512K×8—byte-wide organized versions of the 4M are required in a number of portable systems such as notebook computers and in high-resolution output devices such as laser printers. Memory modules are also an important application for the 512K×8. As an example, the 512K×36-configured SIMM can have its power consumption reduced by 50 percent by using four 4M (512K×8) DRAMs and eight 256K (256K×1) DRAMs instead of sixteen 1M (256K×4) DRAMs and eight 256K (256K×1) DRAMs.

  Samples of this part are now becoming available from leading suppliers, with other vendors following by the end of this year. Versions of the 512K×9 configuration will be released simultaneously for users requiring a parity check facility on chip. The outlook for this configuration is expected to be a relatively minor share in the medium term.
- 256K×16—word-organized versions of the 4M are already in demand from users currently employing the 1M in a 256K×4 configuration. This covers a wide range of equipment, including systems based on 80386 and 68030 microprocessors. High-resolution displays also require this configuration. Samples of this part will become available from major vendors this quarter, and from other vendors over the next 12 months. Some vendors have brought forward their release dates in response to strong interest from users. 256K×18 versions will be released simultaneously for parity checking. The outlook for this part is for a significant share in the medium term.

Packaging options for the 4M are given below. All dimensions in the following list are based on 4M×1 and 1M×4 configurations. For 512K×8/9 and 256K×16/18 configurations, add 50 mil and 100 mil respectively to give a rough guide.

- SOJ—this surface mount package is available in 350 mil from most 4M vendors. Second-generation 300-mil versions are now becoming available from leading vendors. This part is suitable for use on motherboards and modules in most systems. The SOJ is estimated to account for 85 percent of all European shipments today. This share is forecast to decline as other packages increase in popularity.
- ZIP—this through-hole package is available in 400 mil from most vendors. Second-generation 300-mil versions are now being test-marketed in through-hole and surface-mount versions. This part is suitable for motherboard mounting in large systems where small footprint and heat dissipation are major issues.
- TSOP type 1—this surface-mount package is now available in 315 mil from leading vendors.

Second-generation versions featuring smaller outlines will be available in the second quarter of this year. This part is suitable for high-density mounting on motherboards, modules and most importantly, memory cards. The availablity of reverse-pinout versions allows for maximum mounting density when required. However, the fine pin pitch (0.5 mm) of this device makes it difficult to mount, and is expected to be used only in applications where minimum board space is a critical consideration. The future for this package is mainly dependent on the market for memory cards, which is expected to take off strongly in the medium term. Development of memory cards is particularly advanced in Japan.

- TSOP type 2—this surface-mount package is available in 450 mil from most vendors. Second-generation 300-mil versions are now also becoming available from leading vendors. The main benefit of this part is that it has the same height as TSOP type 1 and the same footprint as the second-generation SOJ. However, it is easier to mount than TSOP type 1 because the pin pitch (1.27 mm) is greater. Applications will be a cross between those for SOJ and TSOP type 1. The outlook for this part is for significant market share in the medium term.
- Other—this category includes DIP and TAB. DIP is a through-hole part, and is believed to be available from only one manufacturer to date. It is suitable for small-volume custom equipment where small outline is not a concern and assembly facilities are primitive. The outlook for this part is as a niche option. TAB is a low-profile surface-mount part, and is expected to be used in portable applications such as memory cards and notebook computers. The outlook for this part is mainly dependent on the market for memory cards, which is expected to take off in the medium term, as discussed earlier.
- Modules—this category includes padded SIMMs and pinned SIPs. Modules currently account for a high proportion of 4M DRAM shipments, and in the first quarter of 1991, stood at an estimated 70 percent of all 4M shipments. Modules are suitable for memory expansion and dense motherboard assemblies. They are expected to continue to account for a major part of the market, although TSOP and second-generation ZIP will steal some of this business.

16M DRAM

Samples of this product are available now from leading suppliers. It is available in 400-mil SOJ, ZIP, and TSOP type 2. Access speeds range from 60ns to 100ns, with the most popular at 70ns, and a trend is expected towards 60ns. Current configurations are 16M×1 and 4M×4, with plans for 2M×8 and 1M×16 by the end of 1992. Internal voltages range between manufacturers, but are understood to be 3.3V or 4.0V, as opposed to 5.0V standard for preceding generations. External voltages are 5.0V in all versions, but users may find the internal voltage better to work with, especially if the 16M is for use in portable equipment. The outlook for the 16M market is for general prototyping demand beginning in the first half of 1992.

DATAQUEST PERSPECTIVE

The European DRAM market is now in recovery following weak unit growth and rapid price erosion in 1990. The end of the Gulf war has released a wave of pending orders, reflected in the very high DRAM book-to-bill ratios of leading suppliers in recent months. Some of these orders are likely to have been prompted by the news that DRAM reference prices were to increase again in the second quarter of this year. Orders of this nature tend to be soft. Dataquest believes that these are a minority, and the majority of recent orders are firm. However, the second half of 1991 is expected to be weak in terms of new orders, leading to a mild growth of 10.9 percent in total revenue. The year 1992 should see a stronger market, with 34.9 percent growth in revenue.

The availability and pricing of the 4M now makes it an attractive proposition in Europe. Users are looking hard at their options, and are generally believed to be ready to take up the successor to the 1M. The 4M supplier needs to be ready to supply the options its customer wants. This is a task to be undertaken with forethought, especially for those suppliers with the responsibility of investing in European fabrication facilities. The 4M market has no clear leader yet, though Hitachi and Toshiba are clearly ahead of the rest of the competition. Ultimately, the successful players of the 4M market will be determined by the customer base which will place orders with those suppliers offering the right product mix. Diversification will be the name of the game.

Byron Harding

TABLE 1
European DRAM Quarterly Shipments Forecast

	1Q90	2Q90	3Q90	4Q90	1Q91	2Q91	3Q91	4Q91	1Q92	2Q92	3Q92	4Q92
Units (Millions)												
64K	1.9	2.0	2.2	1.8	1.3	1.0	0.8	0.4	0.3	0.2	0.1	0.1
256K	27.0	25.0	21.0	17.0	16.3	16.0	14.0	11.0	9.0	8.8	7.5	7.0
1M	29.0	37.0	38.0	42.0	45.5	48.0	49.0	42.0	44.5	46.0	43.0	40.0
4M	0.2	0.4	0.6	1.1	1.7	3.0	5.0	7.5	10.0	14.0	19.0	24.0
16M							0.01	0.01	0.03	0.08	0.12	0.25
Total	58.1	64.4	61.8	61.9	64.8	68.0	68.8	60.9	63.8	69.1	69.7	71.4
ASP (US Dollars)												
64K	$1.45	$1.40	$1.30	$1.30	$1.35	$1.40	$1.45	$1.50	$1.55	$1.60	$1.65	$1.70
256K	$2.60	$2.20	$1.80	$1.65	$1.50	$1.55	$1.60	$1.65	$1.70	$1.75	$1.80	$1.85
1M	$8.00	$6.95	$6.30	$4.95	$4.65	$5.15	$5.00	$4.85	$4.70	$4.60	$4.45	$4.30
4M	$60.00	$52.50	$30.33	$23.64	$18.00	$22.03	$20.82	$19.03	$17.22	$15.51	$13.49	$12.02
16M							$250.00	$150.00	$130.00	$110.00	$90.00	$80.00
Average	$5.46	$5.22	$4.83	$4.27	$4.14	$4.99	$5.44	$6.02	$6.27	$6.56	$6.77	$6.92
Revenues (Millions of Dollars)												
64K	2.8	2.8	2.9	2.3	1.8	1.4	1.2	0.6	0.5	0.3	0.2	0.2
256K	70.2	55.0	37.8	28.1	24.5	24.8	22.4	18.2	15.3	15.4	13.5	13.0
1M	232.0	257.2	239.4	207.9	211.6	247.2	245.0	203.7	209.2	211.6	191.4	172.0
4M	12.0	21.0	18.2	26.0	30.6	66.1	104.1	142.7	172.2	217.1	256.3	288.5
16M							1.3	1.5	3.3	8.8	10.8	20.0
Total	$317.0	$336.0	$298.3	$264.3	$268.5	$339.5	$374.0	$366.7	$400.5	$453.2	$472.2	$493.7

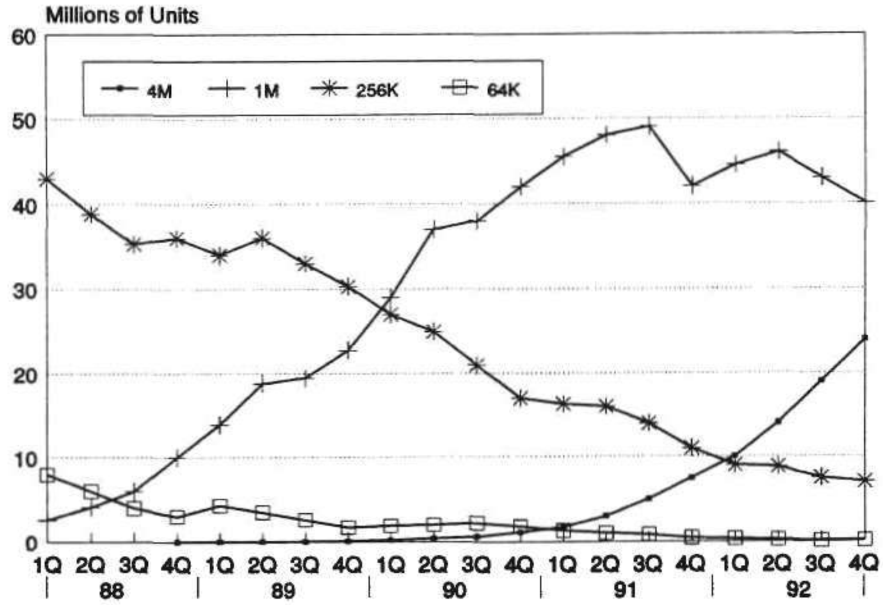
(Continued)

Table 1
European DRAM Quarterly Shipments Forecast (Continued)

	1Q90	2Q90	3Q90	4Q90	1Q91	2Q91	3Q91	4Q91	1Q92	2Q92	3Q92	4Q92
Capacity (Terabits)												
64K	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
256K	6.9	6.4	5.4	4.4	4.2	4.1	3.6	2.8	2.3	2.3	1.9	1.8
1M	29.0	37.0	38.0	42.0	45.5	48.0	49.0	42.0	44.5	46.0	43.0	40.0
4M	0.8	1.6	2.4	4.4	6.8	12.0	20.0	30.0	40.0	56.0	76.0	96.0
16M							0.1	0.2	0.4	1.3	1.9	4.0
Total	36.8	45.1	45.9	50.9	56.6	64.2	72.8	75.0	87.2	105.6	122.8	141.8
ASP Ratios												
256K/64K	1.8	1.6	1.4	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
1M/256K	3.1	3.2	3.5	3.0	3.1	3.3	3.1	2.9	2.8	2.6	2.5	2.3
4M/1M	7.5	7.6	4.8	4.8	3.9	4.3	4.2	3.9	3.7	3.4	3.0	2.8
16M/4M							12.0	7.9	7.5	7.1	6.7	6.7

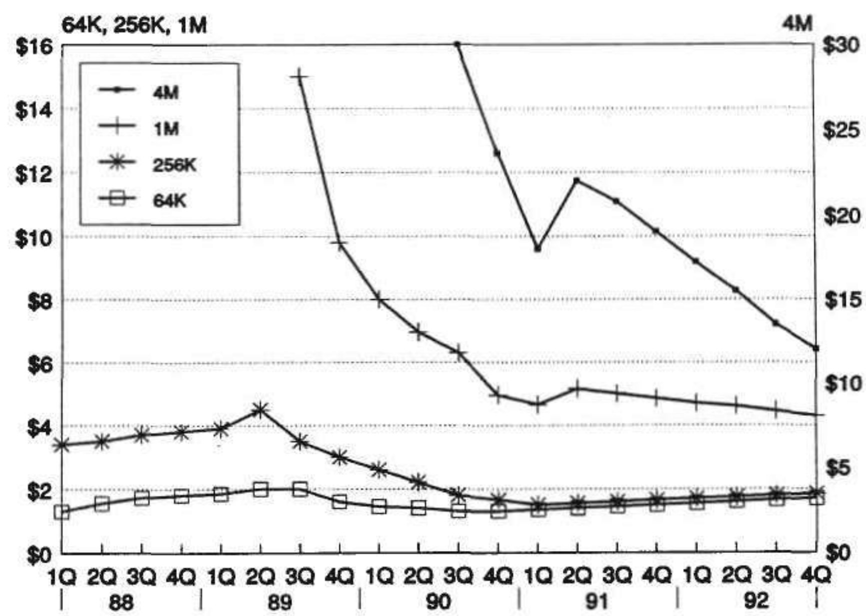
Source: Dataquest (May 1991)

FIGURE 1
Estimated European DRAM Unit Shipments



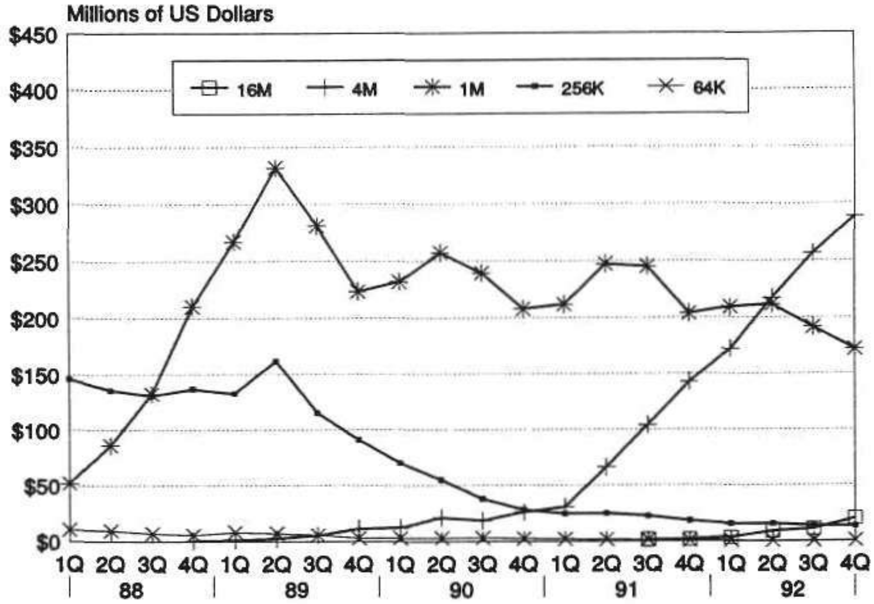
Source: Dataquest (May 1991)

FIGURE 2
Estimated European DRAM Prices
(Billing ASPs in US Dollars)



Source: Dataquest (May 1991)

FIGURE 3
Estimated European DRAM Revenues



Source: Dataquest (May 1991)

TABLE 2
European 4M DRAM Quarterly Shipments Forecast by Organization and Package Type

Organization	1Q90	2Q90	3Q90	4Q90	1Q91	2Q91	3Q91	4Q91	1Q92	2Q92	3Q92	4Q92
Units (Millions)												
4M×1	0.11	0.22	0.33	0.55	0.85	1.35	2.15	3.08	4.00	5.32	7.03	8.40
1M×4	0.09	0.18	0.27	0.55	0.85	1.62	2.80	4.28	5.50	7.70	9.88	12.00
512K×8-9						0.03	0.05	0.15	0.40	0.84	1.52	2.40
256K×16-18									0.10	0.14	0.38	0.96
Other											0.19	0.24
Total Units	0.20	0.40	0.60	1.10	1.70	3.00	5.00	7.51	10.00	14.00	19.00	24.00
Units (Percent)												
4M×1	55.0	55.0	55.0	50.0	50.0	45.0	43.0	41.0	40.0	38.0	37.0	35.0
1M×4	45.0	45.0	45.0	50.0	50.0	54.0	56.0	57.0	55.0	55.0	52.0	50.0
512K×8-9						1.0	1.0	2.0	4.0	6.0	8.0	10.0
256K×16-18									1.0	1.0	2.0	4.0
Other											1.0	1.0
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
ASP (US Dollars)												
4M×1	$59.00	$52.00	$30.00	$23.50	$18.00	$22.00	$20.80	$19.00	$17.15	$15.45	$13.40	$11.95
1M×4	$61.36	$53.56	$30.60	$23.74	$18.00	$22.00	$20.80	$19.00	$17.15	$15.45	$13.40	$11.95
512K×8-9					$21.60	$26.40	$23.92	$20.90	$18.01	$16.07	$13.80	$12.19
256K×16-18								$22.80	$20.58	$17.77	$14.74	$12.55
Other										$18.54	$16.08	$13.74
Average	$60.00	$52.50	$30.33	$23.64	$18.00	$22.03	$20.82	$19.03	$17.22	$15.51	$13.49	$12.02

(Continued)

TABLE 2
European 4M DRAM Quarterly Shipments Forecast
by Organization and Package Type (Continued)

Organization	1Q90	2Q90	3Q90	4Q90	1Q91	2Q91	3Q91	4Q91	1Q92	2Q92	3Q92	4Q92
Revenues (Millions of Dollars)												
4M×1	6.5	11.4	9.9	12.9	15.3	29.7	44.7	58.5	68.6	82.2	94.2	100.4
1M×4	5.5	9.6	8.3	13.1	15.3	35.6	58.2	81.3	94.3	119.0	132.4	143.4
512K×8-9						0.8	1.2	3.1	7.2	13.5	21.0	29.3
256K×16-18								2.1	2.5	5.6	12.0	
Other											3.1	3.3
Total	$12.0	$21.0	$18.2	$26.0	$30.6	$66.1	$104.1	$142.9	$172.2	$217.2	$256.3	$288.4
Package Type	1Q90	2Q90	3Q90	4Q90	1Q91	2Q91	3Q91	4Q91	1Q92	2Q92	3Q92	4Q92
Units (Millions)												
SOJ	0.17	0.34	0.51	0.94	1.45	2.51	4.03	5.85	7.50	10.08	13.21	16.20
ZIP	0.03	0.06	0.08	0.14	0.21	0.38	0.63	0.98	1.35	1.96	2.66	3.48
TSOP 1			0.00	0.01	0.03	0.06	0.15	0.30	0.50	0.84	1.33	1.92
TSOP 2				0.01	0.02	0.06	0.20	0.38	0.65	1.12	1.81	2.40
Module	0.14	0.29	0.44	0.79	1.19	2.01	3.20	4.65	6.10	8.40	11.21	13.92
Total	0.20	0.40	0.60	1.10	1.70	3.00	5.00	7.50	10.00	14.00	19.00	24.00
Units (Percent)												
SOJ	85.0	86.0	85.5	85.5	85.0	83.5	80.5	78.0	75.0	72.0	69.5	67.5
ZIP	15.0	14.0	14.0	13.0	12.5	12.5	12.5	13.0	13.5	14.0	14.0	14.5
TSOP 1			0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0
TSOP 2				0.5	1.0	2.0	4.0	5.0	6.5	8.0	9.5	10.0
Module	70.0	72.0	73.0	72.0	70.0	67.0	64.0	62.0	61.0	60.0	59.0	58.0
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (May 1991)

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Research Newsletter

EUROPEAN SEMICONDUCTOR MARKET REGIONAL ANALYSIS

SUMMARY

Dataquest's final market share estimate reveals that, in 1990, the European semiconductor market grew by 9.3 percent compared with 1989, reaching $10,661 million. When exchange rate variations are taken into account, true local currency growth in Europe was actually minus 6.1 percent with the market expressed in European Currency Units (ECU).

This newsletter presents Dataquest's European regional semiconductor market forecast for 1991. It also provides an analysis of European regional growth in 1990. Currency variations often obscure real growth trends when analysing the European market. In order to clarify the true market trends in Europe this newsletter includes three tables that show the regional markets in their own local currencies—francs, pounds, lira, etc. (Table 1), in ECU (Table 2), and also in dollars (Table 3).

The growth patterns of the individual European regions depended on their markets' relative dependence on the major applications segments of electronic data processing (EDP), communications, industrial, consumer, military and transportation. The European EDP application segment declined considerably last year due to falling memory prices and reduced PC manufacture. The communications segment was very strong; manufacture of central exchange switch equipment for export markets lead to high semiconductor demand. The industrial segment declined slightly due to weakening economic conditions and falling prices. Demand for TVs and VCRs provided for healthy growth in the consumer segment. The military segment declined as nations continued to adjust to the changing world order. Finally, the transportation segment grew further from a relatively small base as the electronic content of cars continued to increase.

Analysis of the seven regional markets that Dataquest tracks in Western Europe reveals that all the regional markets declined last year in local currencies. The least affected of the European markets was Germany which declined by only 1.2 percent in deutsche marks. The German market benefited from strong demand from its substantial consumer and telecoms manufacturing base. This meant that Germany remains Europe's biggest market. The German semiconductor market is estimated to be worth DM 4,984 million or $3,077 million, making it 12.7 percent bigger than its nearest rival, UK/Eire, which is estimated to be worth $2,730 million (or £1,529 million). The UK/Eire market is heavily dependent on computer manufacturers and was impacted by a steep decline in memory prices. This was coupled with a weak economy in the United Kingdom.

The weakest region was Scandinavia which declined by 7.0 percent in Swedish krona. Scandinavia was impacted by weak economic conditions. Factors such as the high level of taxation in Sweden continue to force OEMs to move manufacturing outside the region.

The outlook for 1991 is more positive. Dataquest expects some degree of recovery in all the regional markets. The strongest of the major markets will be Germany, which will grow by 11.3 percent in deutsche marks, 2.8 percent above the European market average growth of 9.8 percent when the market is expressed in ECU (see Table 2), continued strong demand from telecoms equipment manufacturers being the key factor. Scandinavia will again show the lowest growth at 4.7 percent in Swedish krona because of continued economic difficulties.

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TABLE 1
European Semiconductor Market Regional Growth Analysis (European Local Currencies)

Country	Currency	1989	1990	1991	1990/89	1991/90
Benelux	F M	1,075	1,018	1,070	-5.3%	5.1%
France	FF M	8,857	8,330	8,771	-5.9%	5.3%
Italy	L M	1,486,235	1,411,100	1,521,166	-5.1%	7.8%
Scandinavia	SKr M	4,399	4,091	4,283	-7.0%	4.7%
UK/Eire	£M	1,595	1,529	1,657	-4.1%	8.4%
West Germany	DM M	5,044	4,984	5,547	-1.2%	11.3%
Rest of Europe	Pta M	94,959	91,161	103,924	-4.0%	14.0%
Total Europe	ECU M	8,926	8,383	9,206	-6.1%	9.8%

Source: Dataquest (May 1991)

TABLE 2
European Semiconductor Market Regional Growth Analysis (Millions of ECU)

Country	1989	1990	1991	1990/89	1991/90
Benelux	464	440	466	-5.2%	6.0%
France	1,268	1,204	1,266	-5.1%	5.1%
Italy	990	927	997	-6.4%	7.6%
Scandinavia	624	543	565	-12.9%	4.0%
UK/Eire	2,392	2,147	2,372	-10.2%	10.5%
West Germany	2,455	2,419	2,725	-1.5%	12.6%
Rest of Europe	733	703	815	-4.1%	15.9%
Total Europe (ECU)	8,926	8,383	9,206	-6.1%	9.8%

Source: Dataquest (May 1991)

TABLE 3
European Semiconductor Market Regional Growth Analysis (Millions of US Dollars)

Country	1989	1990	1991	1990/89	1991/90
Benelux	507	559	621	10.3%	11.1%
France	1,386	1,531	1,688	10.5%	10.2%
Italy	1,082	1,179	1,330	8.9%	12.8%
Scandinavia	682	691	753	1.3%	9.0%
UK/Eire	2,614	2,730	3,163	4.5%	15.8%
West Germany	2,683	3,077	3,633	14.7%	18.1%
Rest of Europe	801	893	1,086	11.5%	21.6%
Total Europe ($)	9,755	10,661	12,274	9.3%	15.1%

Source: Dataquest (May 1991)

CURRENCY FLUCTUATIONS AND REGIONAL GROWTHS

In 1990 the European semiconductor market appeared to grow by 9.3 percent when the market size is expressed in dollars. However, during 1990 the value of the dollar dropped dramatically versus all the European national currencies, from Swedish krona to Italian lira. Thus the US dollar is not the best currency to measure the European market. The ideal solution is to choose a common European currency that the 19 countries in Western Europe could refer to as a fixed reference. The nearest Europe comes to this is the European Currency Unit or ECU. However, in choosing the ECU we must remember that during 1990 all the 19 European currencies, independent of each other, changed in value with respect to the ECU. This even includes European Community countries whose currencies participate in the European Exchange Rate Mechanism (ERM) itself.

In order to highlight these currency fluctuations Table 4 shows the difference in percentage market growth between a market expressed in, say, francs, and the same market in dollars and ECU. So, for example, Table 1 shows that the French semiconductor market declined by 5.9 percent in 1990 when expressed in francs. Using Table 4, however, we see that we must add 16.4 percent to this in order to find the dollar growth of the French market, and only 0.8 percent to find the ECU growth rate. Thus, in conclusion we use the ECU to express average market growth rates in each of the seven regional markets.

REGIONAL ANALYSIS

Benelux

The Benelux semiconductor market was estimated to be F 1,018 million in 1990. This represented a decline of 5.3 percent over 1989. The three countries which make up the region have relatively little manufacturing base of data processing equipment. This has tended to mean the region has grown below the European average for the past 10 years. The most important OEMs with regard to semiconductor purchasing are involved in telecoms and consumer equipment manufacture. However, while these companies have strong purchasing power centered in Belgium and the Netherlands, the semiconductors their companies buy tend to be consumed in factories outside the region.

Dataquest's outlook for Benelux in 1991 is again for below-average growth. Table 1 shows a 5.1 percent growth rate for the region. Table 2 shows that this is 3.8 percent below the European market average growth rate of 9.8 percent in ECU. Critical factors behind achieving this growth are the continued success of Alcatel Bell's System 12 digital telephone exchange, and Philips' successful business restructuring.

France

Table 1 shows that the French semiconductor market declined by 5.9 percent in 1990. A decline in the European EDP total available market (TAM) has been singled out as a primary negative factor in the European semiconductor market in 1990. However, Table 5 reveals that the French semiconductor market has a relatively low dependence on EDP

TABLE 4
European Market Growth Rate Variances versus the Dollar and the ECU

	Dollar		ECU	
Country	**1990**	**1991**	**1990**	**1991**
Benelux	15.6%	6.0%	0.1%	0.9%
France	16.4%	4.9%	0.8%	-0.2%
Italy	14.0%	5.0%	-1.3%	-0.2%
Scandinavia	8.3%	4.3%	-5.9%	-0.7%
UK/Eire	8.6%	7.4%	-6.1%	2.1%
West Germany	15.9%	6.8%	-0.3%	1.3%
Rest of Europe	15.5%	7.6%	-0.1%	1.9%
Total Europe	15.4%	5.3%		

Source: Dataquest (May 1991)

Table 5
Preliminary 1990 French Semiconductor Market Split by Application
(Millions of Francs)

	EDP	Com.	Ind.	Con.	Mil.	Trn	Total
Value (FF M)	1,832	1,916	1,666	1,166	1,083	667	8,330
Percent (%)	22%	23%	20%	14%	13%	8%	100%

Source: Dataquest (May 1991)

manufacturers in comparison to UK/Eire and Italy for example. The table shows that communications and industrial are of almost equal importance in driving the French TAM. Now, communications has been singled out as one of the key growth segments in 1990, so one might conclude that the French market should have been stronger than it was. As already noted, switches were the key application driving semiconductor demand in communications last year. Alcatel, the main telecoms manufacturer in France, makes most of its switches in Europe in Germany (Alcatel-SEL) and Belgium (Alcatel-BTMC). So, while the French communications market grew last year, it grew below the European average.

The French company, Thomson, is one of the leading consumer companies in Europe. However, it manufactures the majority of its TVs, VCRs and other consumer equipment outside Europe, in the United States and the Far East. Indeed, Thomson is continuing to follow the policy of moving manufacture to regions of lower labor cost, particularly Singapore. This factor, combined with the fact that Thomson is undergoing a process of rationalizing its production, has had a negative impact on the French consumer TAM.

The outlook for France in 1991 is for below-average market growth of 5.3 percent in francs. Table 2 shows that, in ECU France will grow 4.9 percent below the European average. There are signs of economic slowdown creeping into the French economy; we see this leading to little growth in the French industrial segment. On the positive side, Bull is increasing capacity at its Villeneuve d'Asque plant in order to make Zenith PCs; this will be at the expense of production at Bull's Eire factory. We also expect Hewlett-Packard to increase its spending on semiconductors this year.

France has the biggest military semiconductor market in Europe. While the aftermath of the Gulf war may lead to some spares and repairs requirements, we still expect military segment sales to decline in line with a relaxation of East–West tension.

While the slowdown in new car sales in Europe is affecting Renault and Peugeot Citroën, the rapid increase in usage of electronic systems in cars should drive an increased TAM in the transportation segment. France has the second-largest transportation semiconductor market in Europe after Germany.

Italy

The Italian TAM is dominated by the EDP segment, as shown in Table 6. Olivetti is the main reason for this, though US multinationals, most notably IBM, have increased their manufacturing presence in Italy considerably in recent years. So, with the steep fall in memory prices last year and difficulties at Olivetti, the overall semiconductor market declined by 5.1 percent in lira.

The application segments that declined least in Italy last year were communications and transportation. Italtel and Telettra benefited from local PTT demand, though most of their orders fell in the first half of the year, and high inventories became a

Table 6
Preliminary 1990 Italian Semiconductor Market Split by Application
(Billions of Lira)

	EDP	Com.	Ind.	Con.	Mil.	Trn	Total
Value (L B)	523	282	268	169	56	113	1,411
Percent (%)	37%	20%	19%	12%	4%	8%	100%

Source: Dataquest (May 1991)

problem in the second half of the year. In transportation, unit demand was down though component value increased. The net result was a flat TAM.

The Italian market growth last year represented an extreme example of the European quarterly billing pattern that has characterized the overall European market in recent years. All the growth occurred in the first two quarters. Sales in the second half of 1990 declined on the first half. This was due to a tight inventory management policy exercised by some Italian companies, whereby they aim to finish the year with very little inventory.

The outlook for 1991 is for Italy to grow by 7.8 percent in lira. Table 2 shows that this is 2.2 percent below the European average in ECU. IBM, which makes AS/400 mainframes and PC motherboards will be adding production of its workstations during 1991. Also, Hewlett-Packard will be starting to produce laser printers this year. However, a slowing in the overall growth of the European PC market, combined with the general business difficulties that Olivetti is in, should lead to lower semiconductor orders from Olivetti.

We expect the communications segment to show reasonable growth this year. Demand for exchanges from the Italian PTT should continue, and the inventory problems that affected the second half of 1990 have eased. However, the slump in new car sales will affect semiconductor demand in the transportation segment.

Italy's consumer segment is composed mainly of white goods manufacturers. As most European economies appear to be slowing in 1991, this will mean reduced demand for their products. Thus we expect little growth in this segment.

Scandinavia

The Scandinavian semiconductor market was the weakest of the European regions last year, declining by 7.0 percent in Swedish krona. Sweden is about 60 percent of the Scandinavian market and Ericsson represents 60 percent of the Swedish TAM. So, the region's TAM is dominated by Sweden and Ericsson.

While Ericsson's business in doing very well both in exchanges and mobile communications, the company is moving more and more production away from Sweden. The socialist government has imposed high taxes in order to support the high social benefits it provides, resulting in a very high cost of manufacturing in Sweden. Thus, Ericsson and other Swedish manufacturers are tending to move their production out of the country.

The next-largest OEM in Scandinavia is Nokia of Finland. In the region Nokia makes PCs (both in Finland and Sweden), communications equipment such as modems and PBXs (in Finland), and consumer TVs (through Solora in Finland and Luxor in Sweden). (Nokia also makes TVs under the ITT-Nokia label in Germany.)

Semiconductor spend in PCs was down due to memory price erosion. Sales to the communications segment were flat. But semiconductor consumption in TVs increased. As noted in the summary, demand from TV and VCR manufacturers was strong last year, with Nokia being one of the main beneficiaries.

The other center of expertise in Scandinavia is in industrial control and power management. Asea Brown Boveri uses specialized high-power discretes in motor control and power management systems. However, this represents quite a small amount of semiconductors in value terms.

The outlook for 1991 is for below-average growth of 4.7 percent in krona. Table 2 shows that Sweden will grow 5.8 percent below the European average in ECU. The Swedish economy is in a particularly weak state. While Ericsson's business is still healthy, we expect the trend to move manufacturing outside of the region will continue.

UK/Eire

As Table 7 shows, the UK/Eire semiconductor market is dominated by the EDP segment. Much of this comprises US multinational computer companies such as IBM, Digital Equipment, Apple and Western Digital. With this in mind, it is surprising that the UK/Eire market declined by only 4.1 percent in 1990 when expressed in pounds sterling.

Preventing a deeper recession were the following key factors:

- Increased demand from Far Eastern office equipment, automotive and consumer manufacturers. This has come about through an influx of these companies in the past three years. However, Dataquest notes that these companies' semiconductor purchases were not visible to all suppliers; it was Japanese semiconductor companies which benefited most from this.
- Strong demand from satellite equipment manufacturers.

TABLE 7
Preliminary 1990 UK/Eire Semiconductor Market Split by Application
(Millions of Pounds)

	EDP	Com.	Ind.	Con.	Mil.	Trn	Total
Value (£M)	551	291	306	229	76	76	1,547
Percent (%)	36%	19%	20%	15%	5%	5%	100%

Source: Dataquest (May 1991)

In addition to the decline in memory prices, there were other negative factors:

- A weak communications segment impacted by inventory problems at GEC Plessey Telecommunications (GPT).
- A UK economy that was in recession by the end of 1990. This impacted the industrial/distribution segment, with many small companies going out of business.
- Poor demand from mobile communications equipment manufacturers, with inventory problems among the cellular equipment manufacturers.
- Demand from PC manufacturers was lower than in previous years.

The transportation segment grew above the European average last year. A combination of the revitalized Rover Group and the presence of Nissan enabled the segment to grow despite a big slump in new car sales in the United Kingdom. However, the UK/Eire automotive market is still the smallest of the four leading countries, in Europe (Germany, France, Italy and UK/Eire).

The outlook for 1991 is for the region to grow by 8.4 percent in pounds sterling, 0.7 percent above the European average in ECU. While memory prices have firmed and may even increase slightly over 1991, the PC market in Europe is slowing. This will mean semiconductor demand from the EDP segment will recover, but show modest growth.

The UK economy has begun the year in recession. It will take till the end of 1991 before we see significant improvement, which will impact government and consumer spending.

The communications segment should show reasonable growth this year due to the resolution of inventory problems that have troubled it for 18 months.

Germany

The first important point to note about the reunified Germany is that the semiconductor TAM of east Germany was small before reunification—Dataquest estimates $189 million. After reunification it has greatly reduced, because most electronics manufacturing in east Germany has ceased.

The west German semiconductor market did benefit from reunification in 1990. This was visible in the strong demand for semiconductors from the communications and consumer segments. East Germans were quick to spend their new deutsche marks on electronic consumer goods from west Germany. Also, German telecom manufacturers were well-positioned to win lucrative contracts to rebuild the east German communications infrastructure.

Table 8 indicates the relative size and importance of the communications and consumer segments in Germany. Together they represent 44 percent of the German semiconductor market. This served to reduce the impact of a decline in the EDP segment. Growth in the transportation segment was slower in 1990 than in previous years—the German

TABLE 8
Preliminary 1990 German Semiconductor Market Split by Application
(Millions of Deutsche Marks)

	EDP	Com.	Ind.	Con.	Mil.	Trn	Total
Value (DMM)	1,296	1,097	947	1,096	50	498	4,984
Percent (%)	26%	22%	19%	22%	1%	10%	100%

Source: Dataquest (May 1991)

transportation semiconductor TAM is the biggest in Europe. The German transportation industry is a strong exporter; a combination of the weakness in the US economy, and to some extent the UK economy, combined with a weak dollar led to lower German car production.

We expect the German semiconductor market to grow by 11.3 percent in deutsche marks in 1991, 3.0 percent above the European average in ECU. This will make it the strongest of the major semiconductor markets in Europe again this year. Government investment in east Germany and Germany's favorable position with respect to other Eastern European countries will continue to create healthy markets for German industry in 1991. However, by the end of 1991 we expect to see some signs of serious overheating in the German economy, as a result of the large sums of German government money that have been poured into reunification in the past 10 months.

Early signs in 1991 indicate that demand from telecoms manufacturers remains strong. The first quarter of 1991 grew by some 14 percent in deutsche marks over the same quarter in 1990.

Rest of Europe

Dataquest includes the following countries in Rest of Europe: Spain, Portugal, Austria, Switzerland, Turkey, Greece and Malta.

While there is growing equipment and subassembly manufacture in these countries, there tends to be little purchasing power associated with it. This is particularly true in Spain and Portugal where companies such as Olivetti, Philips, IBM, Siemens, Samsung, Sony, and Fujitsu make a variety of telecoms, EDP and consumer goods. However, the purchasing decisions are taken elsewhere in Europe. As a whole the region declined by some 4 percent when measured in Spanish pesetas in 1990. Healthy demand from consumer factories in the various countries that make up the region failed to offset the negative impact of the decline in the EDP TAM.

In 1991 we see Spain, Portugal and Austria leading the region out of recession. Austria benefits from its neutral position with respect to Eastern European countries, and represents a useful trading post to do business with countries such as Hungary and Poland. Spain and Portugal continue to attract foreign investment in manufacturing plants. With a recovery in the EDP sector we expect to see positive growth.

DATAQUEST CONCLUSION

In 1991 the European semiconductor market will recover from the 1990 slump, showing a 9.8 percent growth in ECU. However, Europe will still be dogged by slow economic conditions. The economic recession that affected the United Kingdom and some Scandinavian countries during 1990 will tend to be reflected through the rest of Europe to a lesser extent in 1991. As semiconductor memory prices firm, the EDP segment will recover. Thus regions whose markets are heavily dependent on EDP manufacturers will strengthen—most notably Italy and UK/Eire. However, two of Europe's own EDP companies, Olivetti and Bull, will still be engaged in restructuring, which will affect the semiconductor market in Italy and France.

The consumer segment is expected to be flat in 1991, because demand for TVs and VCRs will be less than in 1990. However, there is every indication that the healthy demand from telephone exchange manufacturers is set to continue in 1991. Siemens Telecom, Ericsson and Alcatel are key manufacturers; their success in export markets has led to strong semiconductor demand. The transportation segment will reflect the slower economic conditions; we expect new car sales to be weak, and this will affect the growth of semiconductor consumption. Military will remain depressed through 1991, though the Gulf war will force many countries to reconsider their military budget cuts. The industrial segment will reflect the various national economies; overall, we expect semiconductor consumption from the industrial segment to grow by only a few percentage points.

With these applications factors in mind, Germany will continue to grow above the European average at 11.3 percent in deutsche marks or 12.6 percent in ECU. While Bull will increase production in France, we expect France will grow below the European average at 5.3 percent in francs or 5.1 percent in ECU. UK/Eire will show an 8.4 percent growth in pounds sterling, and growth above the European average in ECU at 10.5 percent. Improvement in memory prices will help the region, but a slowing European PC market will impact the spend of some of its leading semiconductor procurers. These factors also apply to Italy, which will grow at 7.8 percent in lira, or 7.6 percent in ECU, held back by a troubled Olivetti. Scandinavia will remain the weakest regional market in Europe, despite the continued success of Ericsson.

Jim Eastlake

Research *Newsletter*

PROFIT THROUGH THE SILICON CYCLE TENTH EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE

SUMMARY

Dataquest's tenth annual European Semiconductor Industry Conference was held in Marbella, Spain from May 29 to 31. The theme of the conference, "Profit Through the Silicon Cycle: the Next Ten Years," focused on the increasingly global nature of semiconductor companies, and the growth of Far Eastern vendors in the European market, mainly at the expense of North American vendors. Future success may depend on exploiting hidden assets, such as intellectual property rights (IPR), training, organization and technology investments.

Speakers at the conference discussed the current situation in the European semiconductor scene and forecasts for the future, as well as the importance of customer–vendor relationships in the 1990s. One of the two concurrent panel sessions particularly covered the issue of managing the hidden assets for profit.

SPEAKER HIGHLIGHTS

This newsletter gives brief synopses of presentations by invited speakers in the following extracts.

Successful Supplier Relationships and Enterprise Selling

Raiyo Schroff
Senior Consultant, Esprit Ltd.

Companies commonly lack two important perceptions: that the people who design products need to get involved in selling them; and that the people who interface with the customer are the ones who put the company's vision into practice. Where company perceptions are deficient, training is a means of changing the way people think about their job. But training is useless if people return to their company after training only to find that they cannot put into practice what they have been taught because their manager has not himself been on the course. Changes can only come about if companies explain what they want and why; if they set achievable goals and provide the procedures and tools to achieve them; if they collect feedback and maintain enthusiasm for the change.

Spain's Premier Technology Park: Andalucía

Felipe Romera
Managing Director, Andalucía Technology Park

Foreign companies investing in Andalucía, southern Spain benefit in two ways: a big local market and significant financial inducements. Spain has a gross national profit (GNP) of ECU 345 billion (8 percent of the European Community); Andalucía has a GNP of ECU 44.6 billion (13 percent of Spain); Málaga Province has a GNP of ECU 8.3 bilion. Investment in inward electronics manufacturing is represented by Alcatel, Fujitsu and Siemens/Matsushita. Established in the Andalucía Technology Park are Hughes Microelectronics, Telefónica, RWTUV and Esamat. Regional subsidies are available up to 30 percent of the investment, and companies in the Park are additionally entitled to subsidies of 30 percent of the investment; maximum subsidies allowed are 50 percent. There are agreements with local banks to provide low interest rate loans. Joint-venture arrangements with local firms are available.

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The Electronics Industry in Spain

Manuel Lazaro
General Sub-Director of Information and Communication Technologies
Ministry of Industry, Spanish Government

Boosting Spain's electronics industry is a priority of the Spanish government. Last year the government approved a plan for the electronics industry, the "Plan Electrónica e Informático Nacional." For three to four years the Spanish electronics industry has been growing faster than the European industry. The problems it faces are a large trade deficit (a $15 billion market with local $8 billion production) and a shortage of qualified people. The National Plan is designed to improve that, concentrating particularly on wideband communications, HDTV and microelectronics. In the microelectronics area grants, subsidies and low-rate loans are available for work in ASIC design, smart power ICs, IC sensors, gallium arsenide ICs, hybrids and discretes (mainly diodes and transistors), and to promote involvement in European projects such as displays. The government has allocated a Pta 6 billion budget for the program. Subsidies are typically 20 percent of a project's cost plus 35 percent in soft loans. But in some cases, like ASICs, the loans could amount to 50 percent of the project's cost.

Grasping ASSPs and Making Money

Doug Dunn
Managing Director, GEC Plessey Semiconductors (GPS)

The semiconductor industry walks a tightrope between taking all the business on the table and taking acceptable profit margins. If more companies walked away from unprofitable business—as GPS does—then overall profit margins in the industry would improve. It is to be hoped that a more responsible attitude to pricing will be taken. GPS has been profitable for 11 successive years (averaging 11 percent before interest and tax). That has not been achieved by spending unlimited amounts of capital but by "using intellect and creativity to take to customers unique products which they require." The basis for GPS' future profitable growth is to continue making application-specific standard products (ASSPs) based increasingly on the use of multichip modules, particularly involving mixed technologies. Personal and satellite communications were key areas for GPS. The changes the industry was going to see in the 1990s would make the 1980s seem like a peaceful decade indeed.

Smart Cards

Marc Lassus
President and CEO, Gemplus Card International

Last year over 100 million smart cards were used worldwide, and in 1995 a billion will be used, worth close to $2 billion. Every card uses either a secured memory chip or a microcomputer chip and so, added to the number of chips used in card readers, it represents a significant chip market and is an application in which Europe is leading the world. New uses are emerging in banking ($1 billion a year lost in the United States from cash-machine fraud), ID, secure access (people and computers), encrypted TV ($500 million a year lost in the United States and Europe through nonauthorized viewing of subscription services), vending, health, mobile phones (to convert a nondedicated phone line to the user's line), car parks, medical (expected to be the largest user), and company cards. Moreover, according to the Electrical Industry Association of Japan, $1 of smart card sales generates $14 of associated sales hardware, software and services.

Multimedia: Virtually a Reality Today

Dr. Andy Hopper
Director, Olivetti Research Ltd.

One of the "killer applications" for multimedia could be video mail—the audio/video recording of a personal message on a PC and transmission to another PC for playback. Olivetti Research Labs are working on 100-Mbit/s LANs for this and other applications for multimedia systems. A multimedia workstation system could include a camera-on-a-chip ("the whole screen of a workstation could be lined with them if they are cheap enough"), a TV tuner, a CD-ROM player, a DAT bank, a bespoke compressor, a supercompressor, ISDN bridge, and audio/video file server. Networking could be via broadband ISDN. Applications could include being able to call up on your PC an audio/visual clip of anyone in your company so you get a personal feel for them.

Multichip Modules: a Vehicle for Industry Integration

Dr. Michael F. Ehman
Director, Alcoa Electronic Packaging Inc.

Multichip modules answer three of the industry's current problems:

- The problem of air-cooling chips dissipating up to 80W/cm²
- The "tremendous" and "unending" increase in I/Os
- The pitch on bond pads which could reach the limit for wiring at 110 µm

For the systems designer the module is a boon giving him a ruggedized single component. However, there are considerable problems for the assembler in design where "a whole new set of CAD tools are required which take into account the partitioning of the system" and which provide electrical and thermal simulation. Furthermore, "testability is a critical issue especially where the dies come from different vendors." Mixed technology testing—linear/digital, GaAs/Si, multiple power levels—needs improving as well as diagnostic and fault testing. Typical reasons for failure are where IC specifications do not match IC performance. Reworks cause customer dissatisfaction. The rewards in space reduction, speed increases and cost reduction will make the technology development worth it.

Zetex—Making the World of Difference

Bob Conway
Managing Director, Zetex plc
Paper delivered by Terry Roeves, Quality and Marketing Director, Zetex

Too much of the European electronics industry is tied up in large companies. Without a new breed of technological and industrial adventurers, European inertia and anti-entrepreneurial bureaucracy will stifle the "rich ingenuity" of Europe's scientists and technologists. Europe has got to show itself capable of fostering all kinds of electronics companies—start-ups, medium-size MBOs, as well as large multinationals and the large should "encourage, support and partner," while the small should feed the large with "concepts, applications and enlightened human material."

Semiconductor Start-Up Company Strategy for Profitability in the 1990s

David L. Angel
President, Information Storage Devices, Inc. (ISD)

Success is no longer assured in Silicon Valley. Well-financed, technology-rich start-ups fail. Now the term "distinctive competence" is used to describe the requirement to survive. It means distinctive innovation rather than incremental improvement offering significant value added to the customer and a sustainable competitive advantage to a start-up company. ISD has, for the first time, made a silicon device that can store analog signals without conversion. Moreover, it is non-volatile storage. That was its distinctive innovation and its sustainable competitive advantage derived from it keeping quiet about what it was doing until it had developed its product to the point of shipping it to the market. In this way it achieved a lead on any potential competitors of at least two years. Furthermore, it has made 164 patent claims to protect its technology and has made the products very hard to copy. The chips have analog, digital, high-voltage, EEPROM, CMOS and bipolar technologies all on one chip; few companies have competence in all those technologies. Test is critically important and is all done in-house. All these things make it difficult for potential competitors. Two other rules for start-ups are: spend as little as possible—ISD got its products developed and shipping to the market for $2.2 million; Intel didn't start out as a microprocessor comany, but took business opportunities as they arose.

Action Against Unfair Trade in Semiconductors

Dr. Raimund Raith
Administrator, Commission of the European Communities

The task of the EC has been twofold:

- To safeguard the legitimate interests of the DRAM-making industry
- Not to unduly harm the user industry

It was clear that an ad valorem duty would not be satisfactory and the Japanese offered price undertakings. Eurobit, representing the user industries, was opposed to antidumping measures because they wanted access to DRAMs as cheaply as possible. The EC had to get Eurobit to change its mind and the argument used was that in world terms both the makers and the users were relatively weak and only by cooperating together could they survive. Eurobit was persuaded and measures were taken to fix a minimum price every quarter based on the weighted average cost of production of the cheapest device type in each density plus a modest margin of profit. "This was one of the, unfortunately rare, cases where a Community industry was able to recover in a very positive way as a result of antidumping policies." Now, one EC company has 25 percent of the Community's 1M DRAM market and another has 4 to 5 percent. Before the antidumping measures were taken, EC companies had zero market share, so EC users were not hurt.

Procurement Trends in the '90s

Ewan Davidson
Manager Purchasing, Production Materials
Alcatel NV

Procurement performance will become a key element in the success of a company. Alcatel's policy is where possible to use standard components and where possible to use standard design tools. It expected suppliers to get involved early in a product's design cycles, to be able to adjust quantities at short notice, to give early notice of bottlenecks, supply problems and lead times; to be so reliable that incoming inspection could be eliminated; to hold wafer stocks if needs be to support a product through its lifetime; to reduce internal order and manufacturing cycle time; to ensure IPRs are protected; to make new technologies available when forecast; to provide a worldwide order management system; and to standardize on packing, bar-coding, lot-size and marking.

PANEL SESSION 1: Managing the Hidden Assets for Profit

Dave Manners
Editor, *Electronics Weekly*

The means of IPR protection are: patent, copyright and trademark. The reasons for the multiplicity of recent lawsuits over IPR are: GATT-enforced recognition of IPRs in trading partners, more sophisticated laws and law enforcement, negative cashflow in the US chip industry. The motives of litigants are: to help them to win in the market (Intel), to make money (Texas Instruments), to extend IPR libraries (industry norm).

Ray Reusser
Manager, Intellectual Property, AT&T

To achieve registration a patent has to be new and useful, to be original to the inventor, not to be abandoned, and not obvious to one skilled in the art. AT&T has 18,000 patents, 9,000 in foreign countries. Licensing patents is a cheap way to access R&D.

Hideharu Egawa
Senior Vice President, Director of the Board
Toshiba Corporation

Toshiba recognizes intellectual property and uses patents and copyrights to protect its business, but it will not use them as a tool to earn money. The semiconductor industry is a combination of thousands of technologies. If everyone chased patent rights and charged royalties at two or three times the production costs then it would cause confusion in the semiconductor industry and damage to its customers.

Keith Chapple
Managing Director, Intel UK

The capital spending by the top 10 companies amounts to $6 billion a year. The risks are huge and the industry has to out-innovate the competition and derive top value from its products and protect that capability using all the legal means available to it. Intel concluded that the semconductor industry had to get more aggressive in exploiting its intellectual property or die.

Jerry Sanders III
Chairman and CEO, Advanced Micro Devices (AMD)

Between 1979 and 1990, the only company to gain market share was Intel and the only reason was the 386. Intel succeeded by limiting the competition. The more competition the lower the margin. Intel has not challenged AMD on patent grounds but on copyright grounds. It is preposterous for Intel to say you are entitled to use the copyrights but not entitled to sell the products based on them. We condemn aggressive tactics which are meant to be exclusionary and contrary to public policy.

In subsequent discussion it was agreed that new entrants to the business could be a threat to the industry's profitability—Dr. Egawa mentioned steel and chemical companies in Japan getting into the semiconductor business. Mr. Sanders agreed asking "Why should a ball-bearing factory in Japan want to get into this business?" These companies had nothing to offer the industry. In many cases the use of intellectual property by new companies was "nothing more than theft," said Mr. Sanders who had negotiated a dozen patent licenses to start in business when he founded AMD. He looked forward to the day when only by owning both process capability and patent capability could someone be able to operate in the semiconductor business. Nonetheless he thought that it would be wrong if the manufacturers of tools charged high levels of royalties. He would like to see widespread licensing of tools but aggressive protection of IC IPRs. AMD had 500 patents and protected its own IPR by suing Samsung and Cypress in respect of patent infringement on the 22V10 PLD. It had licensed Atmel to make the chip.

"Glocalization"

Pat Weber
Executive Vice President, President Semiconductor Group, Texas Instruments
Paper delivered by Roberto Schisano, Assistant Manager Worldwide MOS Memory Division, Texas Instruments

Texas Instruments (TI) is establishing a worldwide network of submicron CMOS processing which will bring manufacturing close to its customers in all the main electronics producing areas of the world: in Europe, it is adding a plant at Avezzano, Italy to its existing factory in Freising, Germany; in Asia it is building a joint-venture factory at Taipei, Taiwan with Acer; in Japan it will add a joint-venture plant being set up with Kobe Steel to its existing factory at Miho. In the United States it has submicron plants at Lubbock and Dallas. The Acer and Kobe joint ventures have had substantial contributions to their cost of construction from the joint-venture partners, and in the case of Avezzano substantial subsidy from the Italian government. Customers have agreed to pay in advance for products from those factories to ensure deliveries and prices. So customers can source locally with confidence in the flexibility that a global network provides. Processes around the world are standardized and TI has one of the largest communications networks with 100 percent of the workforce having PCs allowing global exchange of information. TI has pioneered a new era of cooperation with governments (e.g. Avezzano), with customers (e.g. advance payment for contracted supplies) and with competitors (e.g. technology exchange with Hitachi on the 16M DRAM.

After the Monopoly: a New Era of Innovation

Jerry Sanders III
Chairman and CEO, Advanced Micro Devices

Between 1979 and 1990 National Semiconductor lost nearly 70 percent market share, TI lost 60 percent, AMD lost 20 percent, and Motorola lost 18 percent. The only company to grow its market share was Intel because of the 386. The monopoly was of great benefit to Intel but not to the world. "Learning-curve pricing was a thing of the past with the 386 monopoly." Intel manipulated the PC market for five years first by indicating there would be second sourcing and then by going solo and keeping the price up. Moreover "Intel didn't use submicron technology, it didn't improve the 386." With the end of the monopoly and the stimulus of competition from AMD there was going to be more innovation from Intel. The PC market was soon going to be revolutionized. "DRAM pricing curves will be applied to PCs." Fifty percent margins of DRAMs were a thing of the past. The 386 would be a $12 to $20 part inside five years: "the microprocessor for the masses."

Changes in the Characteristics of the Japanese Semiconductor Market and User Needs

Tatsuo Tanaka
Senior Executive Vice President, INSEC

Japan has been increasing its purchase of foreign chips but has suffered problems. A survey of the users of foreign chips in Japan found that 64 percent of respondents reported that their production lines had been disrupted by delays in deliveries of foreign chips. Half those surveyed said that such delays had occurred more than three times in the period covered by the survey. According to a case study submitted to Insec by Japanese users, foreign suppliers have lower technical-support capability than Japanese firms and take twice as long to perform failure analysis. Foreign suppliers failed to specify standards and reliability and quality evaluation rules at the time of contract but "bring them out only after any trouble or dispute arises." The quality of foreign chips is seen as lower than Japanese-made chips with a higher frequency of defects in foreign chips. Although 97 percent of Japanese chip users would like foreign firms to have design centers in Japan, only 40 percent of them do. There were signs that better relationships between Japanese users and foreign suppliers were possible in the future.

New Products for Home and Office

Dr. Peter Draheim
Director, Product Division Semiconductors
Philips International BV

Two trends are driving the evolution of electronic markets: the merger of applications, and portability. The merger of applications has been driven by DSP—digital audio-signal processing, digital videosignal processing, digital data processing and digital information and data exchange are the driving forces towards putting new functions on TVs, telephones, PCs and cars. Portability requires long up-time for personal products; lower voltages and lower power leading to smaller and fewer batteries are the routes to that. Voltages will decline from the industry standard 5V. Operating voltages for ICs below 2V are essential. Components manufacturers must look to supporting applications involving the mix of video, audio, speech and telephony with data/video/disc/audio processors and peripherals. Philips has a Taipei development center for multimedia products. Multimedia hardware is being used 32 percent for industrial presentations, 28 percent for desktop publishing, 19 percent for education and training, 11 percent for CAD, 7 percent for medical imaging, and 3 percent for remote inspection and quality control.

Consistency, Predictability and Commitment

Jack Gifford
Chairman, President and CEO
Maxim Integrated Products, Inc.

The causes of profitability are consistency, predictability and commitment. Consistency involves: establishing a brand identity which does not vary (Maxim now has 208 proprietary chips out of 420); pricing fairly; delivering accurately; maintaining high quality; keeping key employees (Maxim has lost only seven professionals in eight years); sticking to a market area; maintaining high productivity ($170,000 sales per employee at Maxim); avoiding expense ("Everyone has to confront me to buy something"). Predictability involves: continual new product development; meeting specs ("a religion at Maxim"); maintaining yields; managing uncertainty; following the corporate plan; and maintaining a clear vision. It is important to look for the technologies required and take action to get them. Commitment involves: believing in Maxim's 13 Principles ("There's no room for nonbelievers"). The result of maintaining these standards is 23 percent return on equity, 50 percent gross margins, 21 percent operating profits and 90 percent per year growth in the share price since the IPO in February 1988.

Semiconductor Manufacturing Strategy and Capital Investment in the 1990s

Kazuo Kimbara
Executive Managing Director, Hitachi, Ltd.

Maintaining the technological pace is becoming increasingly demanding. Test is becoming increasingly difficult and pin counts have increased 2.5 times in 10 years: "By the year 2000 we will probably see 1,000 pin devices." Production technology is becoming increasingly complex with both process steps and the number of masks increasing. One result of this is the increasing time-lag between announcement of products and their mass production. For instance between announcing the 1M DRAM and reaching 1 million pieces a month production levels, there was a lag of 2.5 years; for the 4M there was a lag of 3 years; for the 16M it will be 4 years; for the 64M, 5 years. The investment efficiency ratio calculated by dividing one year's increased shipments by the previous year's investment volume shows a decline of one-third from 1980 to 1990. "If this continues chip makers cannot survive." The best way out of this problem is cooperation between companies. That would also help solve the problems of the imminent shortage of engineers and trade friction. Joint ventures are suitable for production factories and global cooperation for R&D.

Profits Are Possible

Steve Poole
European General Manager, Intel Corporation

Not many companies achieve consistent profitability but Intel has made profits of $248 million, $453 million and $605 million (1990) in the last three years. "Either we're lucky or a malignant monopoly, or we cheated our customers—or all three." Intel followed a policy of responsible sole sourcing. Multisourcing does not guarantee low prices or security of supply—look at the DRAM market—and many will remember nine-month lead times on low-power Schottky. "We ramped 386 production as fast as money would let us" and the 386 learning curve matched, proportionately, the DRAM learning curve with a price reduction every quarter for five years. The 386 has been developed going from 16 to 33 MHz, with the SX introduced at the bottom end and the 486 at the top end. With a capital spend of $1.6 billion this year, Intel needed a guarantee of steady revenue and sole sourcing is essential for that. "Sole sourcing is a trend for our maturing industry."

Costs and Risks in the Next Ten Years

Jürgen Knorr
Senior Vice President and President of Semiconductor Group, Siemens Corporation

The semiconductor industry is becoming polarized towards on the one side broad-based companies and on the other specialist niche market companies. The former will be responsible for technology development, the latter will be driven by intellectual creativity. If it is true that you have to spend $1 of investment to return $1 in sales, then in order to keep pace with the growth in the market, each of the broad-based companies will need to spend $10 billion over the next 10 years to stay in the business. The number of masks for memories and the number of metal layers for logic is increasing, so pushing up costs. Siemens would like to generate enough cash to make a return on its investment to create a market for future generations. Learning curve pricing is not a good thing. In 1970 both the steel and car industries peremptorily increased prices substantially. "That has to happen in ICs."

Semiconductor Strategic Alliances and Investment Trends in the '90s

Hideharu Egawa
Senior Vice President and Director of the Board, Toshiba Corporation

Although engineers are always optimistic about future technology development, it is becoming increasingly difficult to keep up with it in the semiconductor industry. Process steps increase by 1.3 times each generation and die sizes by 1.5 times; the cost per bit of DRAM reduces by 0.5 times per generation and the investment required per unit area of silicon is increasing. A big problem is the increase in the investment required when set against the decrease in the efficiency of the equipment. Japan has a further problem which is a decrease in the number of engineering students from 1991 onwards. Intercompany alliances are the best way to solve these problems, and the most successful alliances are in R&D, such as SGS-Thomson/Toshiba in CMOS logic, Hitachi/TI for 16M DRAM, IBM/Siemens for 64M DRAM, and VTI/Hitachi for standard cell. Intercompany alliances work better than R&D consortia such as Sematech, JESSI and the VLSI Project in Japan. Although the latter was generally regarded as successful, in reality it was not successful except in that it made company presidents aware that the semiconductor business is very important. "That is no longer necessary." In fact the Japanese companies in the VLSI Project developed their technology separately and didn't share it. By contrast, intercompany collaborations work: in manufacturing—LSI Logic/Kawasaki Steel, TI/Kobe Steel, Hitachi/Goldstar, NMB/Intel, and Toshiba/Chips and Technologies; in technology/product collaboration—Sun/Fujitsu, NEC/MIPS, and Motorola/Toshiba. These collaborations are good for systems companies offering reliable chip supplies without a big investment.

The '90s: Progressing into the Marketing Phase of Microelectronics

Pasquale Pistorio
President, SGS-Thomson Microelectronics

After the technology phase and the manufacturing phase of the semiconductor industry's evolution comes the marketing phase, in which as well as having world-class technology and a world-class manufacturing machine you also have Six Sigma quality "as the norm" and close working partnerships with customers. "Zero-defect products and zero-defect services." Niche companies can avoid these requirements but for everyone else "it's the price you pay to play." Even if we set up joint ventures with the Japanese, would the product flow be two-way? "Without reciprocity in the markets it's just creeping technological colonization." Europe has to have at least one indigenous semiconductor company capable of being a top 10 world player. No one in Europe has the scale although they have the technology and the organization.

Mike Williams

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Research Newsletter

EUROPEAN 1990 MEMORY MARKET SHARE RANKINGS—THE DOWNHILL RUN

SUMMARY

The value of the European market for MOS memory declined by 15.5 percent in US dollars between the years 1989 and 1990. However, in real terms this decline was much worse. When measured in European Currency Units (ECUs), which represent a weighted average of all major European currencies, the market decline is measured at 27.4 percent. Not surprisingly, the sales figures of most suppliers to this market suffered badly in 1990. This analysis provides final 1990 European MOS memory market share rankings. The key issues are:

- Rapid price erosion in all memory product families:
  - DRAM average selling prices (ASPs) declined by 43.2 percent in ECUs.
  - SRAM ASPs declined by 22.0 percent in ECUs.
  - Nonvolatile memory ASPs declined by 29.8 percent in ECUs.
- Reference prices were agreed for Japanese-manufactured DRAM, affecting the 1M generation in particular. We believe that this put an artificial downward pressure on market prices of 1M DRAM in Europe. Sales of Japanese DRAM accounted for 47.6 percent of the total market.
- Bit growth of European MOS memory is estimated at 61.3 percent, which is a slowdown from 1989 when it reached an estimated 73.8 percent. This was mainly a result of the decline in European PC demand. An estimated 60 percent of all PCs purchased in Europe are manufactured locally, so a market slowdown directly affects semiconductor procurement in the PC sector.
- A worldwide surplus exists in MOS memory, caused by increased capacity from existing suppliers as well as from new entrants in the memory market.

RANKINGS

MOS Memory

The leading position in the European MOS memory market in 1990 was held jointly by Siemens and Toshiba. This tie occurred after Toshiba's displacement of Texas Instruments from second position in 1989, following an above-average performance in the markets for DRAM and nonvolatile memory. Siemens is heavily dependent on DRAM for its MOS memory business and grew below average in 1990. Europe represents around 76 percent of Siemens' worldwide MOS memory business for the same year, while Toshiba's sales in this market represented only 15 percent of its worldwide business.

Table 1 provides rankings of suppliers to the European MOS memory market in 1990, measured in ECUs. This reflects the real sales growth of each supplier to the European market. Table 2 provides the same rankings measured in US dollars.

Companies that performed above average in the European MOS memory market in 1990 include Toshiba, Samsung, SGS-Thomson, and Motorola. Those companies that performed below average include Siemens, Texas Instruments, NEC, and Mitsubishi.

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DRAM

Siemens remains the top supplier in the European DRAM market with a 50 percent lead over its nearest competitor, Toshiba. However, this gap has shrunk from the 80 percent lead Siemens held in 1989. Not far behind Toshiba is Samsung, which has displaced Texas Instruments for third rank. The top five suppliers in this market come from Europe, Japan, North America, and South Korea. However, this belies the fact that Japanese manufacturers were supplying half the market in 1990. Table 3 provides rankings of suppliers to the market.

The European DRAM market suffered the worst decline of all the European memory markets in 1990. Measured in dollars, the decline of this market was 27.4 percent. However, in ECUs, the decline was much more serious at 37.1 percent. Manufacturers with more than 50 percent of their revenue derived from DRAM sales urgently need to find stability by penetrating non-DRAM markets.

Average revenue per supplier in the European DRAM market was $71.5 million. This is a comparatively high value as a result of the relatively small supplier base. However, the investments are also high so profit margins are not impressive.

Additional manufacturers of DRAM that did not feature in our European rankings in 1990 include Sanyo, Sony, and Vitelic. These suppliers are expected to make inroads to the European market in 1991.

SRAM

NEC held on to its top position in 1990 in the European SRAM market, although its lead over Hitachi and Toshiba has dropped substantially. Mitsubishi and Samsung have seen meteoric growth, moving up six and three positions in the rankings respectively. Table 4 provides rankings of suppliers to the market.

A number of companies announced their withdrawal from the SRAM market due to excessive competition and diminishing profits. These companies include AMD, National Semiconductor, VLSI Technology, and Philips. They appear in the rankings, although possibly for the last time, because they continued to ship stock in 1990. Further withdrawals are expected in 1991 as well as a number of partial withdrawals, particularly from the slow SRAM market where profit margins are slim.

The European SRAM market grew by 7.6 percent measured in US dollars, but in ECUs this translates into a 7.6 percent decline. This reinforces the importance of using local currency to measure real performance.

Average revenue per supplier in the European SRAM market in 1990 was $14.1 million. This is relatively low in comparison with DRAM, where a greater number of suppliers serve a market which is three times smaller.

Other manufacturers of SRAM that did not feature in our European rankings in 1990 include AT&T, Atmel, Honeywell, Inova, Intel, NCR, Texas Instruments, Matsushita, Rohm, Seiko Epson, Hualon Microelectronics, Silicon Integrated Systems, UMC, and Winbond. Many of these suppliers are expected to begin penetrating the European market in 1991.

Nonvolatile Memory

The leading supplier to the European nonvolatile memory market in 1990 was SGS-Thomson, which overtook Intel for the number one position. Interestingly, SGS-Thomson's sales grew by nearly 30 percent in US dollars, while Intel's declined by 20 percent. The strong competitiveness of SGS-Thomson in EPROM is believed to have eroded some of Intel's business. Texas Instruments maintained its third position despite a similar decline in its sales. Table 5 provides rankings of suppliers to the market.

The major proportion of nonvolatile memory business is held by EPROM. This product was estimated to account for 70 percent of the European nonvolatile memory market in 1990. The average selling price for EPROMs suffered a great deal throughout 1990 as a result of competition for market share. Public statements were issued by some suppliers indicating that dumping was occurring. However, no official complaints were ever lodged with the European Commission, and low prices remain a concern.

The European nonvolatile memory market declined by 0.8 percent when measured in US dollars. In ECUs, it represents a 14.8 percent decline. Average sales per supplier in 1990 to the European nonvolatile memory market were $19.1 million. This is similar to the SRAM market, and indicates that it is overpopulated.

Other suppliers of nonvolatile memory not featured in our 1990 European rankings include AT&T, Goldstar, Harris, Hualon Microelectronics, Hyundai, IMP, Matsushita, MOSel, Ricoh, Rohm, Sanyo, Seiko Epson, Silicon Integrated Systems, Sony, UMC, and Winbond. Some of these suppliers are actively pursuing European sales.

Specialty Memory

Table 6 provides rankings of suppliers to the European specialty memory market. This category includes products which do not fit into the former three standard product families, and includes sales of products such as cache tag memory, cache RAM, dual and multiport RAM, FIFOs, LIFOs, and RAMDACs. IDT and SGS-Thomson lead in this small but high-growth market, jointly accounting for three-quarters of all sales.

CONCLUSION

The revenue roller-coaster ride of the European MOS memory market continues to thrill its participants. While 1989 saw market growth of 41.8 percent in terms of US dollars (55.3 percent growth in ECUs), 1990 saw market decline of 15.5 percent (27.4 percent decline in ECUs). In order to endure these cycles, it is becoming increasingly clear that risks must be minimized.

Suppliers with a high proportion of their business in MOS memory are at the mercy of the memory market and are therefore at most risk when it is in decline phase. Many are urgently seeking to diversify their product lines, using the technology gained in their memory development to address the more stable markets of MOS logic and precision analog. Success will certainly come more slowly than in commodity memory and will require gradual penetration of strategic accounts.

In parallel to the exploitation of existing technology, risk of investment in new leading-edge technology must also be minimized. The problem here is that costs are increasing faster than forecast market sizes, making participation progressively less profitable. The strategic solution is joint ventures and alliances. This allows costs and expertise to be shared, but it is important to ensure each partner is both capable and committed to achieving a mutual goal. The downhill run in MOS memory sales in 1990 have served to underline these issues.

Byron Harding

TABLE 1
European 1990 Market Share Rankings
All MOS Memory in Millions of ECUs

1989 Rank	1990 Rank	Change in Rank	Company	1989 Sales (ECU M)	1990 Sales (ECU M)	1989/90 AGR (%)	1990 Cum. Sum (ECU M)	1990 Market Share (%)	1990 Cum. Share (%)
1	1	0	Siemens*	311	192	-38.3	192	11.3	11.3
3	1	2	Toshiba*	227	192	-15.4	384	11.3	22.6
5	2	3	Samsung	171	145	-15.2	529	8.5	31.1
2	3	-1	Texas Instruments	230	143	-37.8	672	8.4	39.5
4	4	0	NEC	213	140	-34.3	812	8.2	47.7
6	5	1	Hitachi*	158	122	-22.8	934	7.2	54.9
7	5	2	SGS-Thomson*	119	122	2.5	1,056	7.2	62.0
8	6	2	Fujitsu	110	78	-29.1	1,134	4.6	66.6
10	7	3	Intel	94	66	-29.8	1,200	3.9	70.5
13	8	5	Motorola	55	60	9.1	1,260	3.5	74.0
9	9	0	Mitsubishi	96	58	-39.6	1,318	3.4	77.4
11	10	1	AMD	65	48	-26.2	1,366	2.8	80.3
12	11	1	Matsushita	62	41	-33.9	1,407	2.4	82.7
13	12	1	Micron Technology	55	36	-34.5	1,443	2.1	84.8
15	13	2	Oki	44	27	-38.6	1,470	1.6	86.4
17	14	3	National Semiconductor	28	26	-7.1	1,496	1.5	87.9
18	15	3	Matra-MHS	26	25	-3.8	1,521	1.5	89.4
23	16	7	Philips	18	23	27.8	1,544	1.4	90.7
22	17	5	Cypress	19	22	15.8	1,566	1.3	92.0
19	18	1	Sony	24	21	-12.5	1,587	1.2	93.2
21	19	2	Sharp	20	19	-5.0	1,606	1.1	94.4
20	20	0	IDT*	22	14	-36.4	1,620	0.8	95.2
21	20	1	Xicor*	20	14	-30.0	1,634	0.8	96.0
25	21	4	Atmel*	9	9	0.0	1,643	0.5	96.5
24	21	2	Hyundai*	17	9	-47.1	1,652	0.5	97.1
14	21	-8	NMB Semiconductor*	47	9	-80.9	1,661	0.5	97.6
27	22	4	Catalyst*	6	6	0.0	1,667	0.4	97.9
29	22	6	Goldstar*	4	6	50.0	1,673	0.4	98.3
27	23	3	SEEQ Technology	6	5	-16.7	1,678	0.3	98.6
28	24	3	GEC Plesssey	5	4	-20.0	1,682	0.2	98.8
27	25	1	Microchip Technology*	6	3	-50.0	1,685	0.2	99.0
32	25	6	Performance*	1	3	200.0	1,688	0.2	99.2
32	26	5	Harris*	1	2	100.0	1,690	0.1	99.3
32	26	5	VLSI Technology*	1	2	100.0	1,692	0.1	99.4
31	26	3	MOSel*	2	2	0.0	1,694	0.1	99.5

(Continued)

TABLE 1 (Continued)
European 1990 Market Share Rankings
All MOS Memory in Millions of ECUs

1989 Rank	1990 Rank	Change in Rank	Company	1989 Sales (ECU M)	1990 Sales (ECU M)	1989/90 AGR (%)	1990 Cum. Sum (ECU M)	1990 Market Share (%)	1990 Cum. Share (%)
31	26	3	WSI*	2	2	0.0	1,696	0.1	99.6
32	27	3	Dallas Semiconductor*	1	1	0.0	1,697	0.1	99.7
32	27	3	Gould AMI*	1	1	0.0	1,698	0.1	99.8
-	27	NA	ICT*	-	1	NA	1,699	0.1	99.8
32	27	3	Macronix*	1	1	0.0	1,700	0.1	99.9
32	27	3	Sanyo*	1	1	0.0	1,701	0.1	99.9
30	27	1	Vitelic*	3	1	-66.7	1,702	0.1	100.0
26	-	NA	ITT	8	-	NA	NA	NA	NA
NA	NA	NA	Other Japanese	35	-	NA	NA	NA	NA
32	-	NA	Ricoh	1	-	NA	NA	NA	NA
			Total	2,345	1,702	-27.4		100.0	
			North American	635	469	-26.1		27.6	
			European	478	366	-23.4		21.5	
			Japanese	1,039	706	-32.1		41.5	
			Asia/Pacific	192	160	-16.7		9.4	

Exchange rate = ECU/$ 1989:0.92 1990:0.79
*Indicates joint ranking
NA = Not Applicable
Source: Dataquest (July 1991)

TABLE 2
European 1990 Market Share Rankings
All MOS Memory in Millions of Dollars

1989 Rank	1990 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989/90 AGR (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Share (%)
1	1	0	Siemens*	338	243	-28.1	243	11.3	11.3
3	1	2	Toshiba*	247	243	-1.6	486	11.3	22.6
5	2	3	Samsung	186	184	-1.1	670	8.5	31.1
2	3	-1	Texas Instruments	250	181	-27.6	851	8.4	39.5
4	4	0	NEC	232	177	-23.7	1,028	8.2	47.7
6	5	1	Hitachi*	172	154	-10.5	1,182	7.1	54.9
7	5	2	SGS-Thomson*	129	154	19.4	1,336	7.1	62.0
8	6	2	Fujitsu	120	99	-17.5	1,435	4.6	66.6
10	7	3	Intel	102	84	-17.6	1,519	3.9	70.5
13	8	5	Motorola	60	76	26.7	1,595	3.5	74.0
9	9	0	Mitsubishi	104	73	-29.8	1,668	3.4	77.4
11	10	1	AMD	71	61	-14.1	1,729	2.8	80.3
12	11	1	Matsushita	67	52	-22.4	1,781	2.4	82.7
13	12	1	Micron Technology	60	46	-23.3	1,827	2.1	84.8
15	13	2	Oki	48	34	-29.2	1,861	1.6	86.4
17	14	3	National Semiconductor	30	33	10.0	1,894	1.5	87.9
18	15	3	Matra-MHS	28	32	14.3	1,926	1.5	89.4
23	16	7	Philips	20	29	45.0	1,955	1.3	90.8
22	17	5	Cypress	21	28	33.3	1,983	1.3	92.1
19	18	1	Sony	26	26	0.0	2,009	1.2	93.3
21	19	2	Sharp	22	24	9.1	2,033	1.1	94.4
20	20	0	IDT*	24	18	-25.0	2,051	0.8	95.2
21	20	1	Xicor*	22	18	-18.2	2,069	0.8	96.1
25	21	4	Atmel	10	12	20.0	2,081	0.6	96.6
24	22	2	Hyundai*	19	11	-42.1	2,092	0.5	97.1
14	22	-8	NMB Semiconductor*	51	11	-78.4	2,103	0.5	97.6
27	23	4	Catalyst*	6	8	33.3	2,111	0.4	98.0
29	23	6	Goldstar*	4	8	100.0	2,119	0.4	98.4
27	24	3	SEEQ Technology	6	6	0.0	2,125	0.3	98.7
28	25	3	GEC Plesssey	5	5	0.0	2,130	0.2	98.9
27	26	1	Microchip Technology*	6	4	-33.3	2,134	0.2	99.1
32	26	6	Performance*	1	4	300.0	2,138	0.2	99.3
32	27	5	Harris*	1	3	200.0	2,141	0.1	99.4
32	27	5	VLSI Technology*	1	3	200.0	2,144	0.1	99.5
31	28	3	MOSel*	2	2	0.0	2,146	0.1	99.6

(Continued)

TABLE 2 (Continued)
European 1990 Market Share Rankings All MOS Memory

1989 Rank	1990 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989/90 AGR (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Share (%)
31	28	3	WSI*	2	2	0.0	2,148	0.1	99.7
32	29	3	Dallas Semiconductor*	1	1	0.0	2,149	0.0	99.8
32	29	3	Gould AMI*	1	1	0.0	2,150	0.0	99.8
-	29	NA	ICT*	-	1	NA	2,151	0.0	99.9
32	29	3	Macronix*	1	1	0.0	2,152	0.0	99.9
32	29	3	Sanyo*	1	1	0.0	2,153	0.0	100.0
30	29	1	Vitelic*	3	1	-66.7	2,154	0.0	100.0
26	-	NA	ITT	9	-	NA	NA	NA	NA
NA	NA	NA	Other Japanese	38	-	NA	NA	NA	NA
32	-	NA	Ricoh	1	-	NA	NA	NA	NA
			Total	2,548	2,154	-15.5		100.0	
			North American	690	594	-13.9		27.6	
			European	520	463	-11.0		21.5	
			Japanese	1,129	894	-20.8		41.5	
			Asia/Pacific	209	203	-2.9		9.4	

*Indicates joint ranking
NA = Not Applicable
Source: Dataquest (July 1991)

TABLE 3
European 1990 Market Share Rankings, DRAM

1989 Rank	1990 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989/90 AGR (%)	1990 Cum. Sum ($M)	1990 Market Share ($M)	1990 Cum. Share ($M)
1	1	0	Siemens	338	243	-28.1	243	20.0	20.0
2	2	0	Toshiba	186	163	-12.4	406	13.4	33.4
4	3	1	Samsung	170	157	-7.6	563	12.9	46.3
3	4	-1	Texas Instruments	175	122	-30.3	685	10.0	56.3
5	5	0	NEC	165	119	-27.9	804	9.8	66.1
6	6	0	Hitachi	121	97	-19.8	901	8.0	74.1
8	7	1	Fujitsu	80	63	-21.3	964	5.2	79.3
12	8	4	Motorola	47	61	29.8	1,025	5.0	84.3
9	9	0	Matsushita	67	52	-22.4	1,077	4.3	88.6
7	10	-3	Mitsubishi	91	42	-53.8	1,119	3.5	92.0
10	11	-1	Micron Technology	55	36	-34.5	1,155	3.0	95.0
13	12	1	Oki	39	28	-28.2	1,183	2.3	97.3
11	13	-2	NMB Semiconductor	51	11	-78.4	1,194	0.9	98.2
17	14	3	Goldstar	4	7	75.0	1,201	0.6	98.8
15	15	0	Hyundai	9	6	-33.3	1,207	0.5	99.3
18	16	2	Intel	3	5	66.7	1,212	0.4	99.7
16	17	-1	Sharp	5	4	-20.0	1,216	0.3	100.0
NA	NA	NA	Other Japanese	38	0	NA	NA	NA	NA
19	-	NA	Vitelic	2	0	NA	NA	NA	NA
			Total	1,646	1,216	-26.1		100.0	
			North American	282	224	-20.6		18.4	
			European	338	243	-28.1		20.0	
			Japanese	843	579	-31.3		47.6	
			Asia/Pacific	183	170	-7.1		14.0	

NA = Not Applicable
Source: Dataquest (July 1991)

TABLE 4
European 1990 Market Share Rankings, SRAM

1989 Rank	1990 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989/90 AGR (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Share (%)
1	1	0	NEC	55	47	-14.5	47	11.9	11.9
3	2	1	Hitachi*	39	45	15.4	92	11.4	23.2
3	2	1	Toshiba*	39	45	15.4	137	11.4	34.6
2	3	-1	SGS-Thomson	49	41	-16.3	178	10.4	44.9
4	4	0	Matra-MHS	28	32	14.3	210	8.1	53.0
11	5	6	Mitsubishi	9	28	211.1	238	7.1	60.1
5	6	-1	Sony	26	26	0.0	264	6.6	66.7
10	7	3	Samsung	10	23	130.0	287	5.8	72.5
6	8	-2	Fujitsu	20	18	-10.0	305	4.5	77.0
9	9	0	Cypress*	12	14	16.7	319	3.5	80.6
9	9	0	Motorola*	12	14	16.7	333	3.5	84.1
7	10	-3	AMD*	18	10	-44.4	343	2.5	86.6
12	10	2	Micron Technology*	5	10	100.0	353	2.5	89.1
8	11	-3	IDT	14	8	-42.9	361	2.0	91.2
13	12	1	Sharp	4	6	50.0	367	1.5	92.7
10	13	-3	Hyundai	10	5	-50.0	372	1.3	93.9
15	14	1	Performance*	1	4	300.0	376	1.0	94.9
14	14	0	Philips*	3	4	33.3	380	1.0	96.0
15	15	0	Harris*	1	3	200.0	383	0.8	96.7
13	15	-2	Oki*	4	3	-25.0	386	0.8	97.5
14	16	-2	GEC Plessey*	3	2	-33.3	388	0.5	98.0
15	16	-1	VLSI Technology*	1	2	100.0	390	0.5	98.5
15	17	-2	Catalyst*	1	1	0.0	391	0.3	98.7
-	17	NA	Goldstar*	0	1	NA	392	0.3	99.0
15	17	-2	MOSel*	1	1	0.0	393	0.3	99.2
15	17	-2	National Semiconductor*	1	1	0.0	394	0.3	99.5
15	17	-2	Sanyo*	1	1	0.0	395	0.3	99.7
21	17	4	Vitelic*	1	1	0.0	396	0.3	100.0
			Total	368	396	7.6		100.0	
			North American	68	69	1.5		17.4	
			European	83	79	-4.8		19.9	
			Japanese	197	219	11.2		55.3	
			Asia/Pacific	20	29	45.0		7.3	

*Indicates joint ranking
NA = Not Applicable
Source: Dataquest (July 1991)

Table 5
European 1990 Market Share Rankings, Nonvolatile Memory

1989 Rank	1990 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989/90 AGR (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Share (%)
2	1	1	SGS-Thomson	80	103	28.8	103	20.0	20.0
1	2	-1	Intel	99	79	-20.2	182	15.3	35.3
3	3	0	Texas Instruments	75	59	-21.3	241	11.5	46.8
4	4	0	AMD	52	50	-3.8	291	9.7	56.5
6	5	1	Toshiba	22	35	59.1	326	6.8	63.3
5	6	-1	National Semiconductor	29	32	10.3	358	6.2	69.5
8	7	1	Philips	17	25	47.1	383	4.9	74.4
7	8	-1	Fujitsu*	20	18	-10.0	401	3.5	77.9
6	8	-2	Xicor*	22	18	-18.2	419	3.5	81.4
9	9	0	Sharp	13	14	7.7	433	2.7	84.1
11	10	1	Atmel*	10	12	20.0	445	2.3	86.4
10	10	0	Hitachi*	12	12	0.0	457	2.3	88.7
10	11	-1	NEC*	12	11	-8.3	468	2.1	90.9
13	12	1	Cypress	7	10	42.9	478	1.9	92.8
15	13	2	Catalyst	5	7	40.0	485	1.4	94.2
14	14	0	SEEQ	6	6	0.0	491	1.2	95.3
14	15	-1	Microchip*	6	4	-33.3	495	0.8	96.1
14	15	-1	Samsung*	6	4	-33.3	499	0.8	96.9
17	16	1	GPS*	2	3	50.0	502	0.6	97.5
16	16	0	Mitsubishi*	4	3	-25.0	505	0.6	98.1
15	17	-2	Oki	5	3	-40.0	508	0.6	98.6
17	18	-1	WSI	2	2	0.0	510	0.4	99.0
18	19	-1	Gould AMI*	1	1	0.0	511	0.2	99.2
-	19	NA	ICT*	0	1	NA	512	0.2	99.4
18	19	-1	Macronix*	1	1	0.0	513	0.2	99.6
18	19	-1	Motorola*	1	1	0.0	514	0.2	99.8
-	19	NA	VLSI Technology*	0	1	NA	515	0.2	100.0
12	-	NA	ITT	9	0	NA	NA	NA	NA
18	-	NA	Ricoh	1	0	NA	NA	NA	NA
			Total	519	515	-0.8		100.0	
			North American	325	284	-12.6		55.1	
			European	99	131	32.3		25.4	
			Japanese	89	96	7.9		18.6	
			Asia/Pacific	6	4	-33.3		0.8	

*Indicates joint ranking
NA = Not Applicable
Source: Dataquest (July 1991)

Table 6
European 1990 Market Share Rankings, Specialty Memory

1989 Rank	1990 Rank	Change in Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1989/90 AGR (%)	1990 Cum. Sum ($M)	1990 Market Share (%)	1990 Cum. Share (%)
1	1	0	IDT*	10	10	0.0	10	37.0	37.0
-	1	NA	SGS-Thomson*	0	10	NA	20	37.0	74.1
2	2	0	Cypress	2	4	100.0	24	14.8	88.9
3	3	0	AMD*	1	1	0.0	25	3.7	92.6
3	3	0	Dallas Semiconductor*	1	1	0.0	26	3.7	96.3
3	3	0	MOSel*	1	1	0.0	27	3.7	100.0
			Total	15	27	80.0		100.0	
			North American	15	17	13.3		63.0	
			European	0	10	NA		37.0	

*Indicates joint ranking
NA = Not Applicable
Source: Dataquest (July 1991)

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Research Newsletter

MIXED SIGNAL ASIC

SUMMARY

Mixed signal in Europe represents one of the highest growth areas in the ASIC market. Cell-based ICs (CBICs) represented 80 percent of the mixed signal ASIC market in Europe in 1990. Of the total cell-based IC market, 30 percent was made up of mixed signal CBICs. Although this market segment is enjoying very high growth, certain factors are limiting it:

- The low number of designers capable of designing mixed signal devices
- The shortage of mixed signal design tools
- The high cost of mixed signal tests

This newsletter examines this high-growth market and analyses its limiting factors. It also suggests what is needed to overcome the limitations and the possible consequences of any changes.

DEFINITIONS

Dataquest's definition of a mixed signal ASIC is an ASIC device with both digital and analog signal input or output (excluding line driver outputs and single comparator and Schmitt trigger inputs). Mixed signal ASICs fall into two broad categories. Simple, mixed signal ASICs use precharacterized cells which can be tested using a digital tester, whereas more complex, high-performance mixed signal ASICs require a mixed signal tester. The definition is intended to cover both categories.

COMPANIES AND MARKETS

The European mixed signal ASIC market grew to $171 million in 1990, a growth of 68 percent over 1989. This is compared with a growth of 16 percent for the total ASIC market in Europe. Over 80 percent of this mixed signal revenue was for MOS cell-based ICs. Figures 1 and 2 (overleaf) show that mixed signal CBIC revenue now represents 30 percent of the total CBIC revenue in Europe, up from 27 percent in 1989. CBIC revenue has also increased its share of the total ASIC market in Europe from 27 percent in 1989 to 33 percent in 1990.

The top 10 mixed signal ASIC suppliers to the European market are shown in Table 1. The leading supplier, Mietec, grew its revenue because of its

TABLE 1

Top 10 Suppliers, 1990 Estimated MOS Mixed Signal ASIC Revenue

1990 Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1990-89 Growth (%)
1	Mietec	27	63	133%
2	AMS	14	27	93%
3	IMP Europe[1]	11	16	45%
4	GEC Plessey	0	15	NA
5	Sierra Semiconductors	4	10	250%
6	Texas Instruments	6	8	33%
7	National Semiconductor	6	6	0%
8	Harris Semiconductor	0	4	NA
9	LSI Logic	2	2	0%
10	Allegro[2]	0	2	NA

NA = Not Applicable
1 Now known as Dialog Semiconductor
2 Previously known as Sprague
Source: Dataquest (August 1991)

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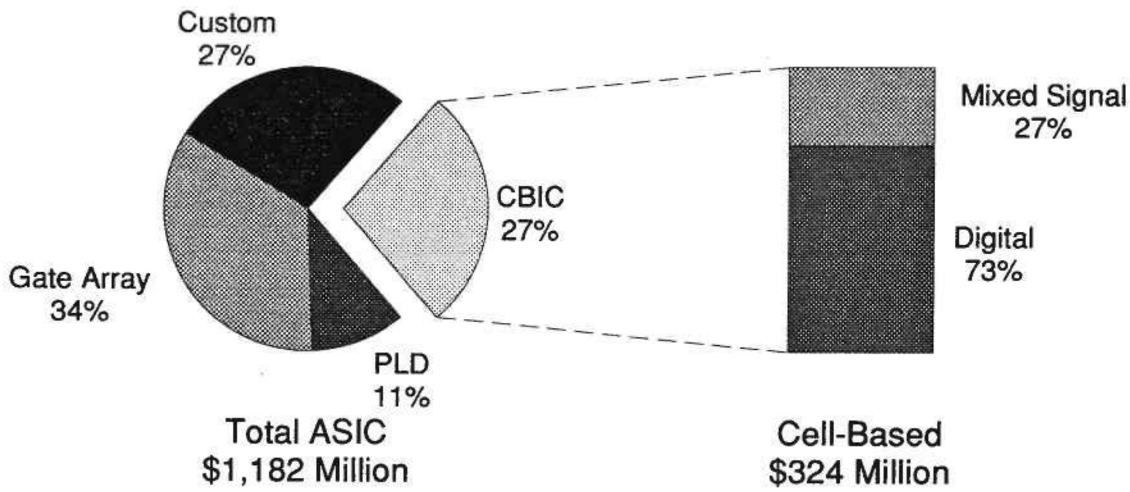
FIGURE 1

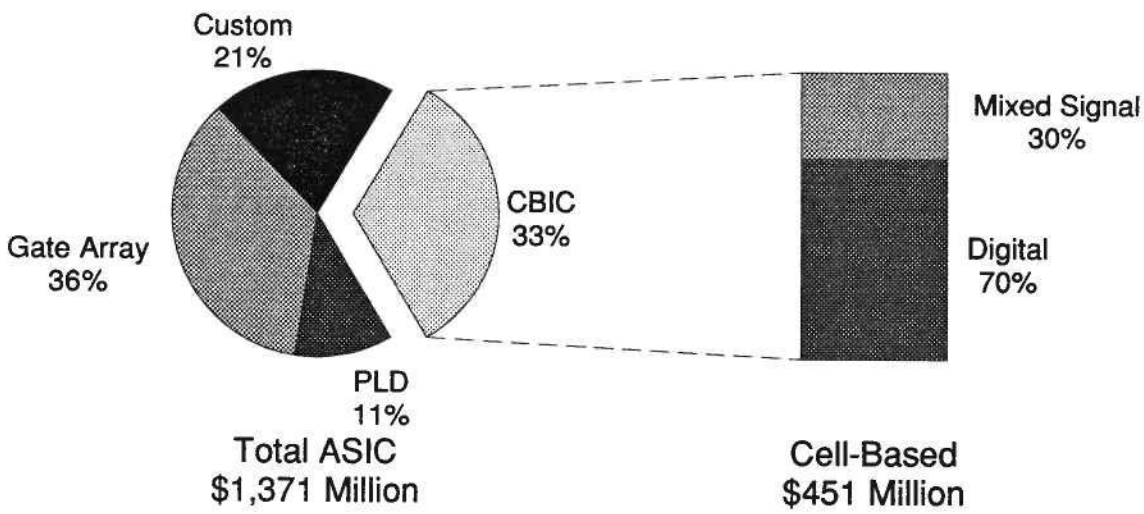
ASIC Product Split 1989



Source: Dataquest (August 1991)

FIGURE 2

ASIC Product Split 1990



Source: Dataquest (August 1991)

presence in the telecoms market, and specifically because of its involvement with Alcatel's System 12 exchanges. This is a high-growth market where European telecoms suppliers are world leaders. Mietec's parent company, Alcatel, was the world's second-largest supplier of telecoms hardware in 1989 and so provides a good strategic direction for Mietec. Mietec also sells automotive and industrial products—again, good mixed signal applications areas.

Austria Mikro Systeme (AMS), ranked second, also has strong telecoms links, and also supports its telecoms activity with automotive and industrial applications. Both Mietec and AMS have enjoyed high growth in this market and both companies' success reflects the importance of the telecoms, automotive and industrial market segments in mixed signal ASICs. Figure 3 shows the applications share for both companies' revenues in 1990.

IMP Europe is ranked third in the mixed signal market, and this company has recently undergone a buyout from the parent company. The company will be known in future as Dialog Semiconductor. IMP Europe narrowly beat GEC Plessey Semiconductors (GPS) to third position. GPS has a greater concentration in data processing applications such as disk drives, and in consumer applications.

TECHNICAL ISSUES

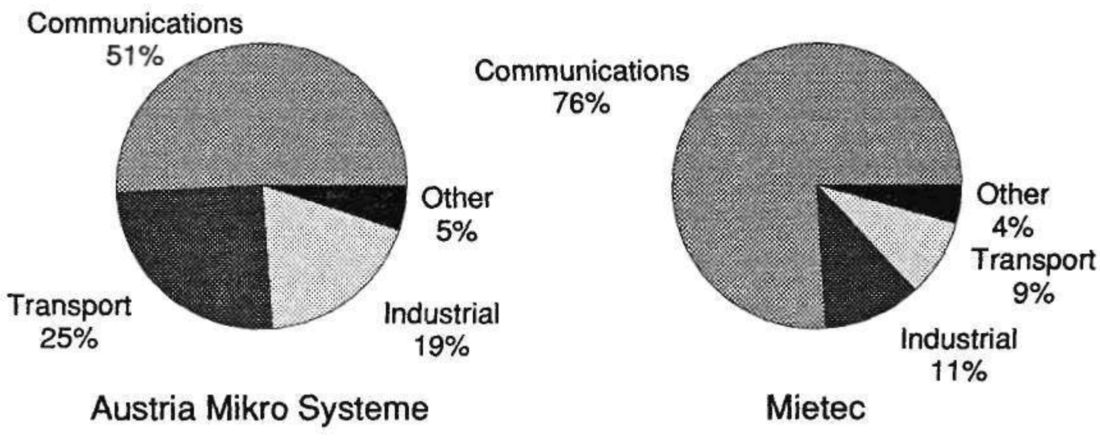
Software

The software used for ASIC design has to date concentrated on digital ASICs. Only three parameters can be varied for digital cells: power, speed and size; whereas over 40 parameters can be varied for analog cells such as op-amps. This makes the design of these cells much more complex, and the software's task much harder. This partly explains why the software tools for analog and mixed signal ASIC design lag behind those of digital design.

The greatest shortfall for software in analog and mixed signal ASIC design is in the modelling of the circuit. Software tools provide modelling capability, but the models for the cells have not yet been written and matched to the silicon. The development of the models can be very time-consuming, and so far has been the responsibility of the ASIC manufacturer. Simple cell models may only require a few lines of model code description, but to model accurately an analog cell requires several pages of description. This description needs to be repeated for all the cells in a cell library, and the descriptions also need to be matched to the silicon performance of the cells. At present, there is no method for extracting the data for the models automatically from test chips, so all this work

FIGURE 3

ASIC Applications Share 1990



Source: Dataquest (August 1991)

requires considerable engineering effort from the ASIC manufacturer.

Traditionally, the design of mixed signal ASICs has been separated into digital and analog components. These two parts are designed separately, and then joined together. The software tools also follow this division. The problems that arise from the design come from this interface and most of the reiterations of prototypes are because of this. The digital and analog circuitry interact on the silicon, but because the software tools treat the two parts separately this interaction is not simulated. In addition, the techniques used for digital and analog simulation are different, so this also presents interface problems when the two parts are joined.

Software companies are working on solutions to these problems, and there are tools which can provide some analysis of the circuit as a whole, rather than as two separate parts. However, the tools are not at a stage comparable to digital design, where automatic generation of large areas of the design is possible. Dataquest estimates it will be between two and five years before the software is at a level where circuit generation, rather than circuit analysis, will be possible.

The greatest benefit that can be provided by software tools is time. Design time can be reduced significantly through faster and more accurate simulation. Improved accuracy of simulation can reduce the number of iterations required to produce products within the required specification. If only one iteration is saved by using better software, then three to six months can be saved in product development. This saving comes from the reduction in redesign, reprototyping and retesting. With product lifetimes reducing, a saving of six months can be vital to the profitability of a product. However, the time saving offered by improved software performance can also be gained by using faster computers to improve simulation and layout times.

Test

Testing of mixed signal ASICs is very expensive, with mixed signal testers costing between $1 million and $4 million. This high cost is one of the reasons why companies have tried to compromise in their mixed signal offering, by providing analog cells that can be tested with a digital tester. However, for high-performance analog cells, this is not possible.

Mixed signal testing encompasses much more than just generation and application of test vectors. The yield of a mixed signal ASIC can be improved considerably through careful design of the analog cells in the circuit. At the prototype stage, the device needs to be sufficiently tested to measure yield improvements when required, so careful test design is necessary. This also applies to digital circuits, but not to the same degree. The compromises made in digital cell design allow more margin for performance degradation, so the efforts required for yield enhancement are not normally worth the benefits attained. (This lower sensitivity to process parameters is one of the reasons for the rise in use of digital circuitry.)

A test for a mixed signal device can take 40 seconds or more because of settling times needed for some of the analog cells. This compares with less than 1 second for most digital ASICs. This long test uses expensive resources and may result in the need for additional testers. The complexity of the test program, together with the length of some mixed signal tests, means that the amount of engineer involvement in test program development is very high, and this can limit a company's design throughput.

Strategies such as scan- or self-testing give much help in testing digital circuits, but there are no test strategies available yet for mixed signal ASICs. Therefore, no easy solution is in sight to resolve these issues. Most digital strategies test functionality rather than performance. Analog components need a performance test, so the digital strategies will not work.

Design

The design of mixed signal ASICs is still very labor-intensive. The software tools provide some support, but not to the same degree as for pure digital ASICs. Because of this, mixed signal ASIC design is much closer to custom design than to cell-based or gate array. The extensive influence of mixed signal ASIC design on production and test means much closer cooperation is needed between the customer, the designer and the test engineer.

The close involvement of the customer as part of the design process can yield great dividends later. The development of the specification can identify design and test constraints. The intelligent setting of design limits can, for example, mean only a digital tester is used rather than a mixed signal tester. The involvement of the engineer can also prevent a design becoming untestable.

The greatest benefit to a company will come from the intelligent use of the design resource, and most of the profit for a mixed signal design will come from leveraging this design resource. This leverage comes in part from the development of a targeted cell library. The most efficient use of a design engineer's time is to develop components that can command high margins or be used many times. A major competitive advantage can be gained by pre-empting the requirements of a particular application segment by developing a cell library in time to make maximum use of future needs. Suitable applications for mixed signal design in Europe include, for example, cellular radio and in particular Groupe Spéciale Mobile (GSM). To take the greatest advantage from these applications requires systems knowledge rather than IC design knowledge, and hence ASIC suppliers need systems designers, rather than more IC designers.

CONCLUSIONS

The mixed signal ASIC market is growing at a rate well above the average for the ASIC market as a whole. One of the limiting factors to growth is still design capacity, but this cannot be solved simply through the recruitment of more design engineers. Test is also a major limit to the growth of the market. Software tools are improving but they are still not at the same level as for digital design tools. The mixed signal ASIC market is closer to custom design than cell-based design, so the need is for design expertise from designers. However, the improvements in design techniques, manufacturing processes and software mean the advantage gained by having an in-house design team will gradually be diminished.

As software tools improve, so the ASICs they design will improve. Fewer compromises will be made in performance, so the additional expertise provided by designers will only be needed for smaller niches such as very high-performance ASICs. When this happens the healthy margins enjoyed by the few mixed signal ASIC manufacturers will be quickly eroded by those companies taking a commodity approach to mixed signal ASICs. Very high-performance mixed signal ASICs will always be in demand, but few companies will be prepared to pay the high price demanded for them.

Digital cell-based designs required considerable design expertise when the digital CBIC market was emerging. This was also closer to custom ASIC than gate array. Constraints were placed on the design process in the form of the layout of the cells and the tests which were performed; then cell-based design became easier. The software tools also improved and overcame some of the constraints which were previously imposed on design. Mixed signal ASIC works within few constraints at the moment, which is why the software tools have such a difficult job. The intelligent setting of limits will ease the design task and allow the tools to develop. This will ease the design task for the ASIC user and open up the mixed signal ASIC market. When this happens a large number of ASIC suppliers will jump into what was previously a high-margin market. This will force prices and margins down, and mixed signal ASIC will join digital ASIC in the battle for profits and market share.

Mike Glennon

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Research *Newsletter*

EUROPEAN ASIC MARKET AND MARKET SHARE RANKINGS 1990

SUMMARY

Dataquest research shows the European ASIC market grew by 17 percent in 1990, to $1,380 million. This compares with a growth of 9 percent for the total semiconductor market in Europe. The ASIC product that showed the highest growth was mixed signal ASIC, growing by 72 percent.

This newsletter examines the European ASIC market in 1990, and presents Dataquest's rankings for the top 10 ASIC companies in Europe in 1990.

MARKETS

The European ASIC market grew by 17 percent in 1990, to $1,380 million. This compares with a growth for the total semiconductor market for 1990 of 9 percent. Figure 1 shows the European ASIC market revenues over the past four years (see the end of the newsletter). Figure 2 shows the growth of the four product categories: gate array, PLD, CBIC, and custom. From this it is clear that the greatest growth comes from CBIC, with 44 percent growth over the previous year. This is more than twice the growth of gate array revenue for the same period; CBIC revenue is approaching gate array revenue and should overtake it in 1991. The growth in gate array revenue should not be undervalued, however, as at 20 percent it is also more than twice that for the total semiconductor market.

The high growth in the CBIC revenue is attributable to the increase in the use of linear and mixed signal cell-based design. Previously mixed signal and linear ASIC required custom ASIC design techniques, but the continuing development of CBIC design tools has allowed cell-based techniques to be applied to many mixed signal and linear ASICs. Figure 3 shows the relative size of the linear array and mixed signal ASIC revenues, indicating a considerable contribution to the ASIC market by linear and mixed signal ASICs. Figure 4 shows how the linear and mixed signal revenue is spread across the four product categories, and it is clear from this that CBIC has the largest share of this revenue.

COMPANIES

GEC Plessey Semiconductor

Table 1 shows the top 10 ASIC suppliers to Europe in 1990, while Tables 2 and 3 show the MOS and bipolar top 10 suppliers. GEC Plessey Semiconductors was created by the merger of Marconi Electronic Devices and Plessey Semiconductors at the end of 1990, and moves directly to the top of the ASIC rankings with a revenue of $124 million. GEC Plessey has a well-balanced range of ASIC products, covering MOS and bipolar technologies, and all of the gate array, PLD, CBIC and custom products. The combined Plessey Semiconductors and Marconi Electronic Devices revenue in 1989 was $122 million, so the effective growth of GEC Plessey was only 1.6 percent. This low growth is due to the overlap of operations and products, which was resolved during 1990.

Siemens

GEC Plessey's low effective growth has allowed Siemens to challenge GEC Plessey for the top position. Siemens major strength is with custom ASIC, and the company was able to grow its custom ASIC revenue when the market declined by 15 percent. The custom ASIC market is in decline, however, so Siemens will need to expand its CBIC and gate array offering if it is to pose a real threat to GEC Plessey's leading position.

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Table 1
European Estimated Total ASIC Revenue
Top 10 Suppliers, 1990

1990 Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1990-89 Growth (%)
1	GEC Plessey		124	NA
2	Siemens	92	106	15%
3	Texas Instruments	79	98	24%
4	Mietec	50	84	68%
5	LSI Logic	69	84	20%
6	SGS-Thomson	50	65	30%
7	Toshiba	52	65	25%
8	Austria Mikro Systeme	44	58	32%
9	AMD	52	51	-2%
10	NEC	31	48	55%
	Total ASIC	1,182	1,380	17%

Source: Dataquest (September 1991)

Table 2
European Estimated Total MOS ASIC Revenue
Top 10 Suppliers, 1990

1990 Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1990-89 Growth (%)
1	GEC Plessey		86	NA
2	Mietec	50	84	68%
3	LSI Logic	69	83	20%
4	Texas Instruments	59	76	29%
5	Siemens	55	64	16%
6	Toshiba	50	63	26%
7	Austria Mikro Systeme	44	58	32%
8	SGS-Thomson	48	52	8%
9	VLSI Technology	37	43	16%
10	National Semiconductor	36	37	3%
	Total MOS ASIC	951	1,145	20%

Source: Dataquest (September 1991)

TABLE 3
European Estimated Total Bipolar ASIC Revenue
Top 10 Suppliers, 1990

1990 Rank	Company	1989 Sales ($M)	1990 Sales ($M)	1990-89 Growth (%)
1	Siemens	37	42	14%
2	AMD	49	39	-20%
3	GEC Plessey		38	NA
4	Texas Instruments	20	22	10%
5	NEC	5	19	280%
6	SGS-Thomson	2	13	550%
7	Philips	14	11	-21%
8	National Semiconductor	11	10	-9%
9	Fujitsu	5	7	40%
10	Telefunken	7	7	0%
	Total Bipolar ASIC	231	235	2%

Source: Dataquest (September 1991)

Texas Instruments

Texas Instruments has grown well above average to reach third position in the ASIC rankings. This growth has been evenly spread through all of the product categories, and Texas Instruments is well positioned to rise further in the rankings. Its new BiCMOS gate arrays have high integration and performance capabilities, and are well positioned to take a significant percentage of future gate array business. The company has a broad portfolio of products, but most of its PLD revenue is from bipolar PLD. This market is forecast to decline over the next five years, and be replaced by MOS PLDs. Texas Instruments' agreements with both Actel and Altera for the supply of MOS field-programmable gate arrays (FPGA) should ensure its continuing presence in the PLD market.

Mietec

Mietec, at fourth place in the ASIC rankings, has exhibited a massive 68 percent growth over the previous year. Surprisingly, though, the company still has only the seventh-highest growth in the ASIC market, but the other six companies with higher growth—Motorola, Lattice Semiconductor, Sierra Semiconductor, Xilinx, Cypress and Honeywell Atmel—have high growth from a much lower base. Mietec's high growth is because of its strong mixed signal products, and its links with its parent telecommmunications company, Alcatel. Most of Mietec's revenue is in mixed signal CBIC applications, and its focus on the high growth areas of telecoms and automotive applications should help it maintain its progress.

LSI Logic

LSI Logic has also enjoyed above-average growth with its focus on gate array and cell-based ASICs. Over 80 percent of LSI Logic's revenue is from MOS gate array—its traditional strength. Looking in more detail at this growth, however, shows the company's gate array revenue increased by 19.0 percent, slightly lower than the gate array market average performance of 19.7 percent; and its CBIC revenue grew at 27.3 percent, lower than the total CBIC market growth of 44.3 percent. The apparent above-average performance from LSI Logic thus comes from its avoidance of low-growth markets such as custom and bipolar PLD.

SGS-Thomson

SGS Thomson, at sixth place in the ASIC rankings, also grew above the average for the total ASIC market. Most of this high growth is because of its inclusion of analog arrays in the ASIC category; previously these arrays were included in the analog category. SGS-Thomson is one of the largest suppliers of linear and mixed signal gate arrays into the European market. The company has also grown its CBIC revenue significantly.

Toshiba

Toshiba has retained its seventh position in the ASIC rankings, although growing above average. Toshiba has gate array, CBIC and custom revenue for 1990, and its growth is evenly spread across these markets. Even the company's custom ASIC revenue grew in 1990, while the custom ASIC market actually declined by 15 percent, but this was from a low base. Toshiba also announced an FPGA product in 1991, allowing it to enter this high-growth market. The company's future progress should therefore match its previous good performance.

Austria Mikro Systeme

Austria Mikro Systeme is strong in the mixed signal segment of the ASIC market, and has show above-average growth. Previously much of the company's revenue has been for custom ASIC, reflecting the difficult nature of analog and mixed signal design. The improvements of CBIC design methods has allowed Austria Mikro Systeme to grow its mixed signal CBIC revenue well above the average rate, and it has risen from eleventh position in 1989 to eighth in 1990. The focus on telecoms and automotive applications has best utilized its mixed signal strength.

Advanced Micro Devices (AMD)

Advanced Micro Devices' revenue declined in 1990 by 2 percent, causing the company to fall from sixth to ninth position; as a direct result of its bipolar PLD revenue decline by 20 percent. AMD has moved its focus away from bipolar PLD to MOS PLD, and was able to quadruple its MOS PLC revenue. In spite of the 20 percent decline in bipolar PLD revenue, AMD still retains the top position in PLD sales into Europe, with more than twice the PLD revenue of its closest competitor, Texas Instruments.

NEC

NEC showed the greatest climb in position in 1990, rising from fifteenth to tenth position. Most of this high growth has come from the inclusion of NEC's ECL gate array revenue, which previously had not been counted. This revenue was misreported in the standard product category. NEC also grew its MOS gate array revenue, but below average.

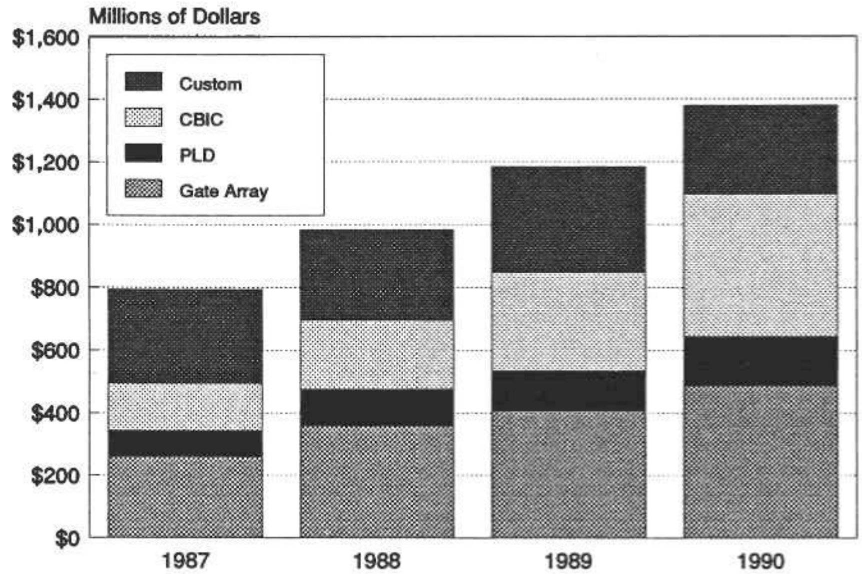
Conclusions

The ASIC market grew above the average for the total semiconductor market in 1990, and is set to continue this level of growth. The mixed signal and linear array markets have made notable contributions. The above-average growth of the telecoms and automotive markets, and Europe's strength in these markets, has aided the high growth of linear and mixed signal ASIC. Of the top 10 ASIC suppliers, 5 are European, and 4 of the top 5 have mixed signal or linear ASIC revenue.

MOS ASIC is showing a higher percentage of the total ASIC market, and this is to be expected. As ASIC complexity increases, the low power and high integration provided by MOS make it the preferred choice. The high speeds offered by ECL devices are now being approached by BiCMOS products, and BiCMOS poses the biggest threat to ECL gate arrays. BiCMOS has the added advantage of high-performance mixed signal and linear design being possible. Most of the mixed signal and linear ASIC suppliers have or are developing BiCMOS processes. The highest growth areas are MOS PLD and mixed signal CBIC. The introduction of high gate count FPGAs has stimulated this PLD market, and MOS PLD has overtaken bipolar PLD for the first time. Mixed signal and linear CBIC have also allowed cell-based revenue to approach gate array revenue. The growth in linear array will provide some defense to the CBIC onslaught, but CBIC revenue should overtake gate array revenue in Europe in 1991.

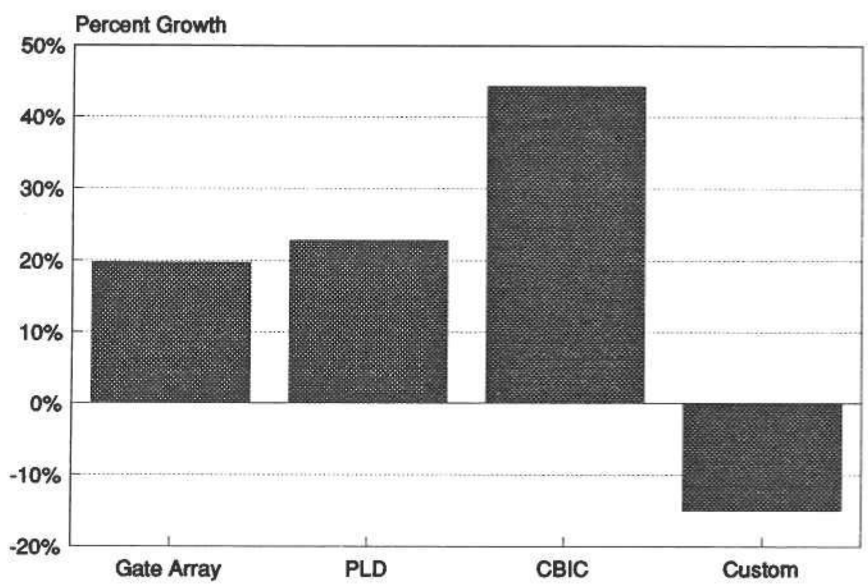
Mike Glennon

FIGURE 1
European ASIC Market Revenue by Product, 1987-1990 (includes Linear and Mixed Signal)



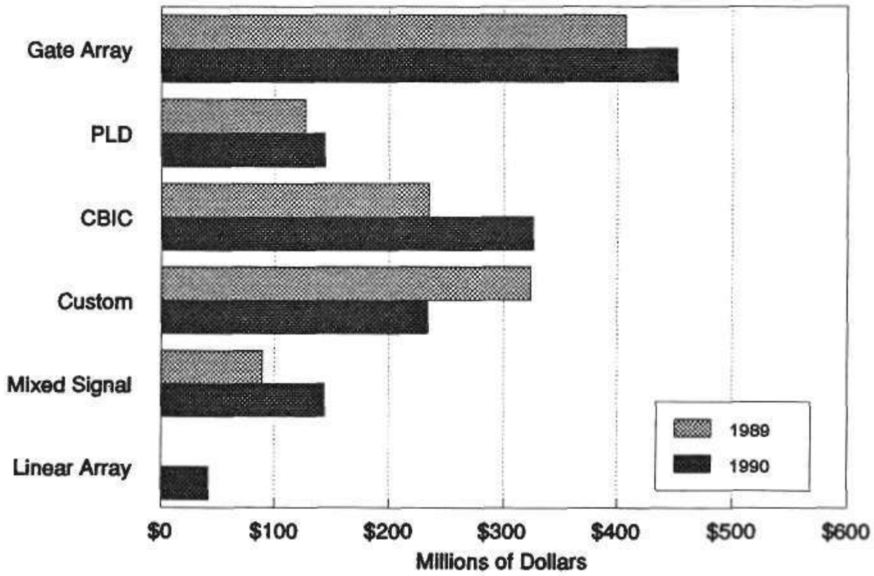
Source: Dataquest (September 1991)

FIGURE 2
European 1990 ASIC Product Growth (includes Linear and Mixed Signal)



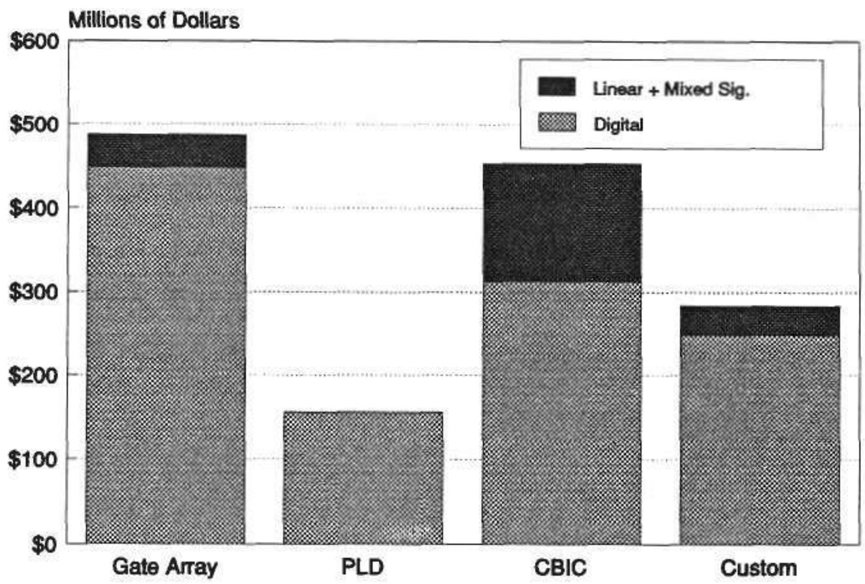
Source: Dataquest (September 1991)

FIGURE 3
European ASIC Market Revenue, Product Split 1990 and 1989



Source: Dataquest (September 1991)

FIGURE 4
European 1990 ASIC Market Revenue
Linear and Mixed Signal Share of ASIC Products



Source: Dataquest (September 1991)

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Research Newsletter

MOS EPROM: FLAGSHIP OF THE NONVOLATILE PRODUCTS

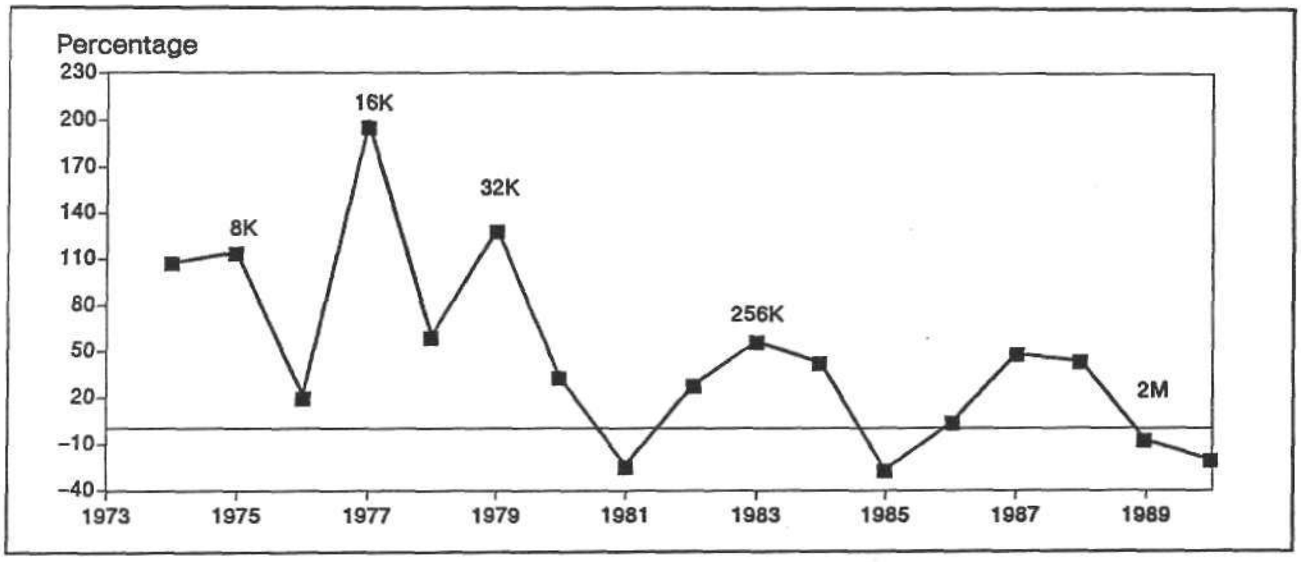
SUMMARY ANALYSIS

The EPROM product was introduced in 1971 by Intel Corporation. It shares a 20-year anniversary with the introduction of the microprocessor and was initially developed as a prototype device for ROMs. The pinnacle of EPROM development was reached in 1977, as shown in Figure 1, with the introduction of the 16K EPROM. The 16K density became the industry standard for EPROMs and also was compatible with microprocessors. In essence, the marriage of the EPROM and the microprocessor accelerated the development of both products and the advance of the microcomputer industry. In 1991, both Intel and Signetics announced their intent to stop manufacturing EPROMs during the 1990s. Although the EPROM product became a profitable growth market for Intel, Signetics, and others, it has not achieved, nor has it sustained, comparable yearly revenue growth rate patterns since the 16K density. As a revenue generator, the product is besieged by too many suppliers. As a performance indicator, the product is being eroded by other nonvolatile trade-offs. From all indications, the commodity EPROM is a sunset technology.

MARKET ANALYSIS

Since Dataquest began coverage of EPROM technology, worldwide EPROM suppliers have generated over $12.5 billion in revenue from 1976 through 1990. Viewed as the largest EPROM supplier to the worldwide market, Intel has generated over $2.5 billion in EPROM revenue during this same time frame. The 1990 forecast predicted that EPROM revenue would decline 5 percent to $1,690 million with a 3 percent unit growth to 405 million devices produced during 1989. Actual product

FIGURE 1
MOS EPROM Revenue—Yearly Growth Rates



Source: Dataquest (September 1991)

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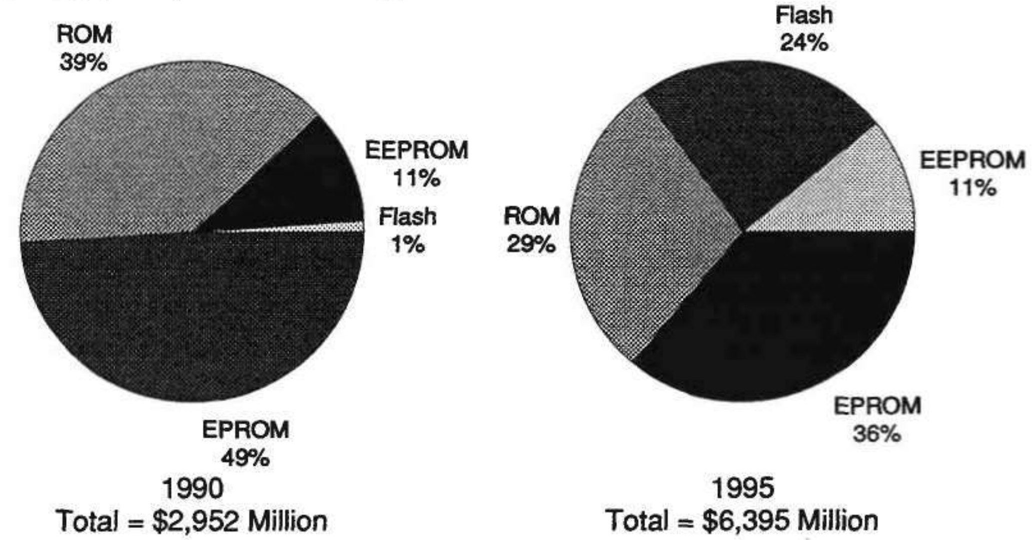
revenue for 1990 declined 20 percent to $1,446 million with a 5 percent unit growth to 424 million devices over 1989 actuals. Long viewed as the lackluster product area of MOS memory products, EPROMs continue to claim the lion's share of the nonvolatile market, as shown in Figure 2.

During the 1988-through-1990 time frame, the nonvolatile market became a jungle fraught with predatory supplier tactics and low profit margins. Although total MOS memory revenue is expected to have a compound annual growth rate (CAGR) of 17.9 percent from 1990 through 1995, EPROM is expected to have a modest CAGR of 9.4 percent during the same time frame. The forecast revenue of $2.2 billion by 1995, as shown in Figure 3, will occur as an end result of submicron high density, 4M, 8M, and 16M EPROM products.

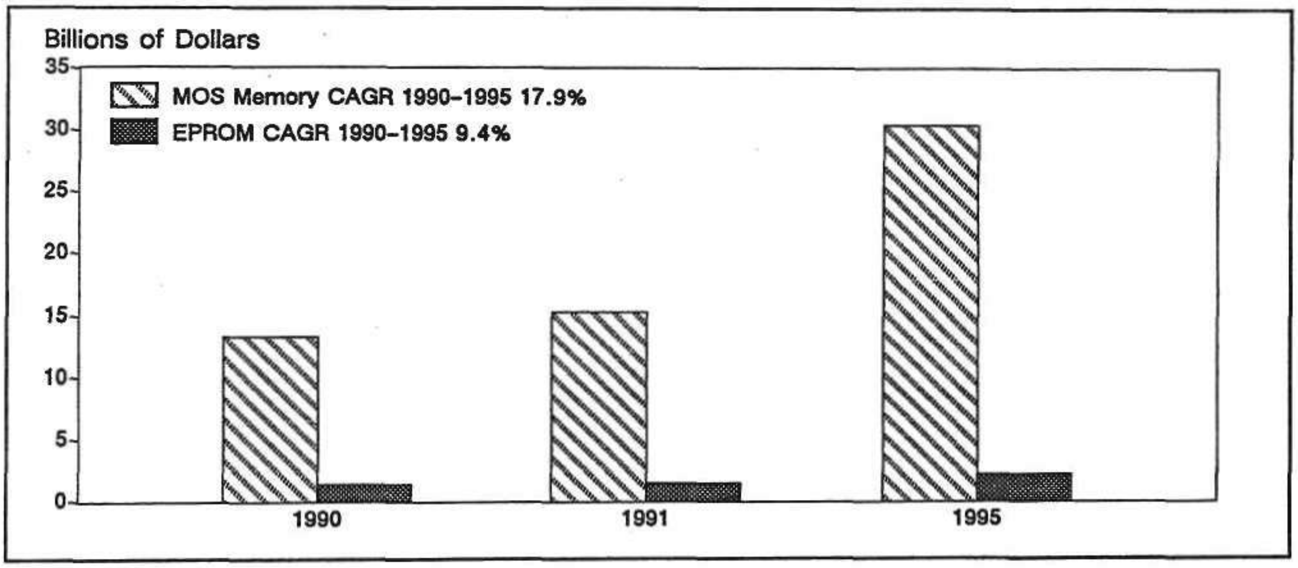
Potential conversion to other nonvolatile solutions and/or a slowdown in next-generation product development into new applications could interrupt this growth pattern, thus furthering decline of the EPROM market. The following developments offer further proof of the decline and possible demise of

FIGURE 2
Worldwide Nonvolatile Revenue—Market Projections



Source: Dataquest (September 1991)

FIGURE 3
MOS EPROM Revenue—Share of MOS Memory



Source: Dataquest (September 1991)

MOS EPROM products throughout the next decade:

- Shrinking vendor base
- Shrinking revenue per vendor
- Declining bit growth
- Maturing product base
- High cost of leading-edge technology
- Growth of replacement technologies
- Fragmented nonvolatile market
- Trade friction influences

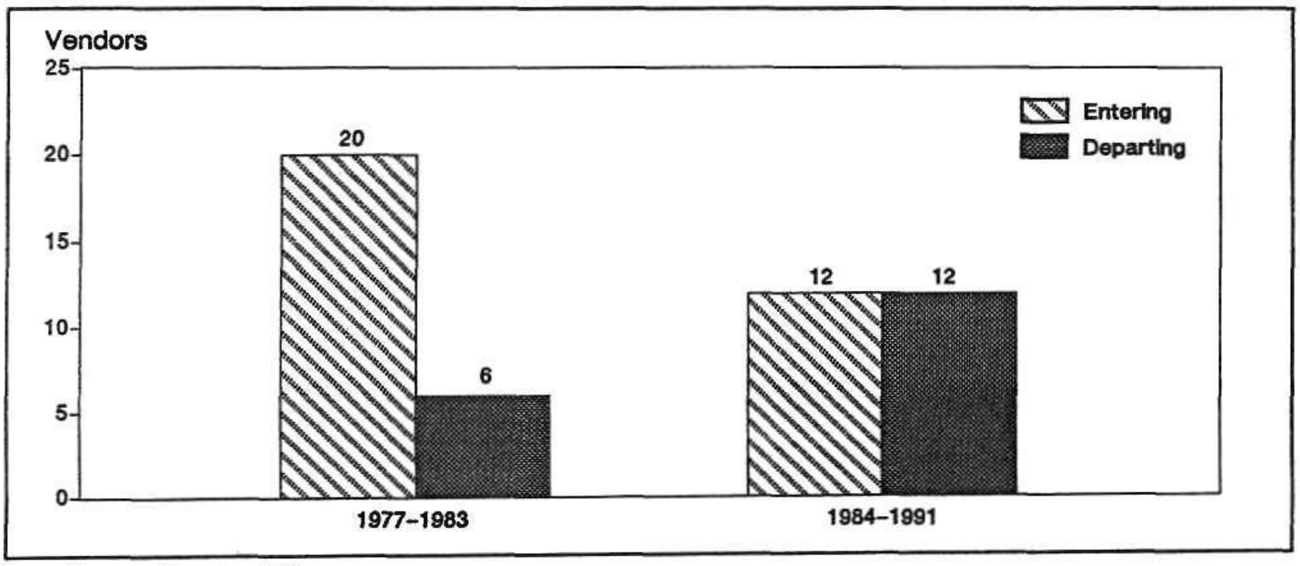
VENDOR-BASE ANALYSIS

Historically, the number of EPROM vendors entering the market has always surpassed the number of departing vendors until the 1988-through-1990 time frame (see Figure 4). Traditionally, companies that left the market represented a marginal share of the EPROM market. From 1982 through 1987, companies that entered the EPROM market made great gains in market share and revenue. From 1988 through 1990, the EPROM product area became a highly competitive and very commodity-oriented product area. Price erosion, other nonvolatile product competition, and a computer market downturn resulted in shrinking vendor revenue. Revenue distribution for the top 5 and top 10 companies in each region is shown in Table 1. Vendor revenue by region is shown in Table 2.

TECHNOLOGY ANALYSIS—LEARNING CURVES

The price learning curve is a strategic tool for forecasting and interpreting the sensitivity of EPROM prices to various factors such as business cycles and trade friction. Unlike cost-experience curves, price curves are heavily influenced by extraneous market forces such as competition, substitute technology, general economic conditions, and/or supply and demand dynamics. The price learning curve is defined by EPROM prices in millicents per bit and accumulated bit shipments. Figure 5 shows the accumulated bits shipped for total EPROMs from 1976 through 1990. Figure 6 illustrates how bit prices gravitate toward the declining slope of an experience curve over time. During the industry boom periods of 1978 and 1979 and again in 1983 and 1984, product shortages and vendor controls drove prices up above the 80 percent curve norm. During the 1980s and again in 1985 and 1986, the industry balloon burst. Capacity utilization rates declined, prices dropped—sometimes below cost—and the industry fell into a deep recession. A price-stabilization period, a result of the trade agreement between the United States and Japan, is reflected in the 1986-through-1987 time frame. Foreign market

FIGURE 4
MOS EPROM Entering and Departing Vendors



Source: Dataquest (September 1991)

TABLE 1
MOS EPROM Top 5/10 Revenue Distribution (Percentage)

Top 5 and 10 Shares	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Top 5													
United States	91.0	79.1	70.9	75.6	72.0	60.9	68.2	68.0	71.1	61.6	54.0	58.3	61.0
Japan	87.4	73.3	52.7	49.3	27.8	34.9	26.5	29.4	23.1	19.0	17.1	39.5	43.4
Europe	3.6	5.8	18.1	26.3	44.1	26.0	41.7	38.6	48.0	42.6	26.5	9.9	6.7
Korea	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	10.4	8.9	10.9
Next 5													
United States	8.2	18.0	20.0	20.8	23.9	25.9	27.1	27.8	24.8	29.7	32.8	29.6	25.6
Japan	5.8	10.9	15.6	16.5	21.1	14.2	17.8	9.4	14.8	18.6	27.5	10.7	6.7
Europe	2.4	7.1	4.4	4.3	2.8	10.5	9.3	15.0	6.9	5.2	5.2	18.9	14.4
Korea	NM	NM	NM	NM	NM	1.2	NM	3.5	3.1	5.9	NM	NM	4.5
Top 10													
United States	99.2	97.1	90.8	96.4	95.8	86.8	95.3	95.8	95.9	91.2	86.7	88.0	86.6
Japan	93.2	84.2	68.3	65.8	48.9	49.1	44.3	38.7	37.9	37.6	44.6	50.2	50.1
Europe	6.0	12.9	22.5	30.6	46.9	36.5	51.1	53.6	54.9	47.8	31.7	28.8	21.1
Korea	NM	NM	NM	NM	NM	1.2	0	3.5	3.1	5.9	10.4	8.9	15.4
Top 5/10 Concentration													
No. of Vendors	12	13	15	16	17	17	17	20	24	23	24	22	21
Average Revenue per Vendor ($M)	11.044	30.907	35.114	21.578	33.927	51.724	73.312	43.317	37.918	58.688	81.110	82.198	59.507
Top 10 Share	99	97	91	96	96	87	95	96	96	91	87	88	87
Top 5 Share	91	79	71	76	72	61	68	68	71	62	54	58	54

NM = Not meaningful
Source: Dataquest (September 1991)

values (FMVs) were stipulated in the agreement to act as minimum prices for EPROMs fabricated in Japan and sold in the United States. The trade agreement also called for narrowing the price differentials between US prices and those in Asia and Europe. Shortages and increased demand in 1987 and 1988 raised EPROM prices substantially. An economic downturn and a computer industry slowdown resulted in price erosion during 1989 and 1990, dropping the price per bit below the profit margin range. The CAGR of EPROM bit growth from 1975 through 1990 is shown as follows:

- 1975 to 1980—201.5 percent
- 1980 to 1985—98.1 percent
- 1985 to 1990—53.2 percent

LIFE CYCLES

Understanding product life cycles can be an important element of a company's strategic planning. How well semiconductor manufacturers and users implement the following EPROM life cycles may well determine their strength and future direction compared with worldwide competition. The actual life cycle curves for EPROMs and how they vary by density are shown in Figures 7a and 7b. Traditionally, the lower-density EPROMs peaked during their sixth year of production, although anomalies did occur in a few product areas as a result of package changes or industry downturns. Figure 8 illustrates the long-range forecast behavior of each EPROM density on an extended 13-year life cycle through the year 2000.

NONVOLATILE TRADE-OFFS

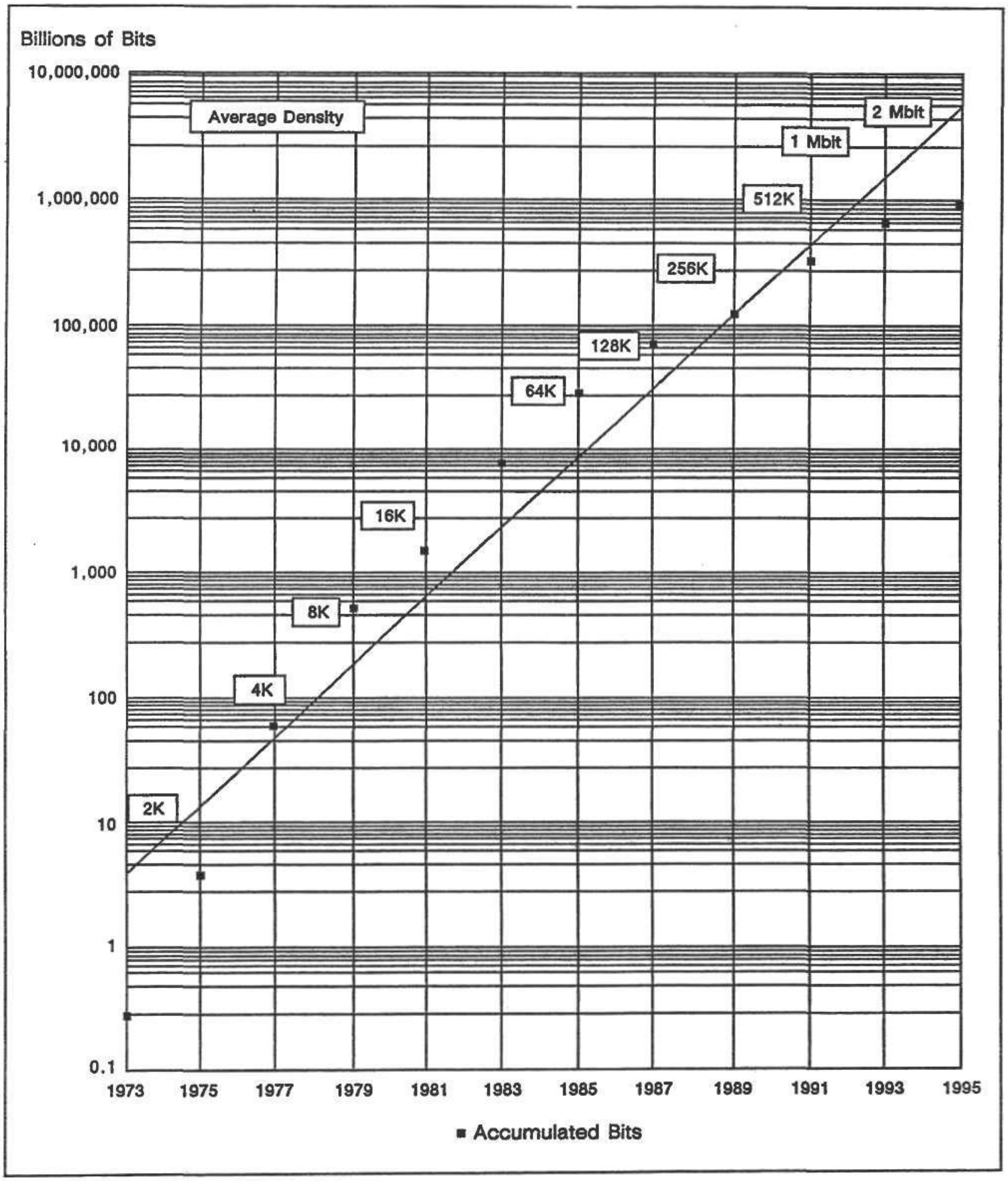
Dataquest believes that the next five years in the EPROM market will be characterized by moderate unit growth and slow bit growth. In the late 1970s, growth of both volatile and nonvolatile memory products resulted from a conversion from core memories. In the 1980s, memory growth was spurred by the PC market boom. Although more use of memory bits per system is expected, more memory devices with nonvolatile features, with or without a battery, will also be available. As shown

Table 2
MOS EPROM Regional Vendor Concentration

Regional Concentration	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Number of US Vendors	8	8	8	7	8	8	8	10	9	10	11	11	10
US Market Share (%)	92	88	72	66	52	49	46	40	40	44	52	58	61
Average Revenue per Vendor ($)	14,468	40,220	44,196	31,033	33,684	56,170	75,008	35,495	41,823	56,852	84,371	87,044	82,342
Number of Japanese Vendors	4	5	7	7	7	7	8	8	10	9	9	8	9
Japanese Market Share (%)	8	13	26	33	45	49	50	54	56	47	33	27	20
Average Revenue per Vendor ($)	1,957	11,568	23,837	15,493	37,431	58,751	86,054	59,106	50,285	76,402	76,366	78,377	44,445
Number of European Vendors	0	0	0	2	2	2	2	2	3	2	2	2	2
European Market Share (%)	0	0	3	0	3	3	4	6	5	8	15	15	15
Average Revenue per Vendor ($)	0	0	17,617	318	5,729	9,345	15,560	19,267	10,248	46,531	123,659	110,321	111,522
Number of Korean Vendors	0	0	0	0	0	0	0	0	2	2	2	1	0
Korean Market Share (%)	0	0	0	0	0	0	0	0	0	0	1	0	0
Average Revenue per Vendor ($)	0	0	0	0	0	0	0	0	13	315	3,793	3,224	0

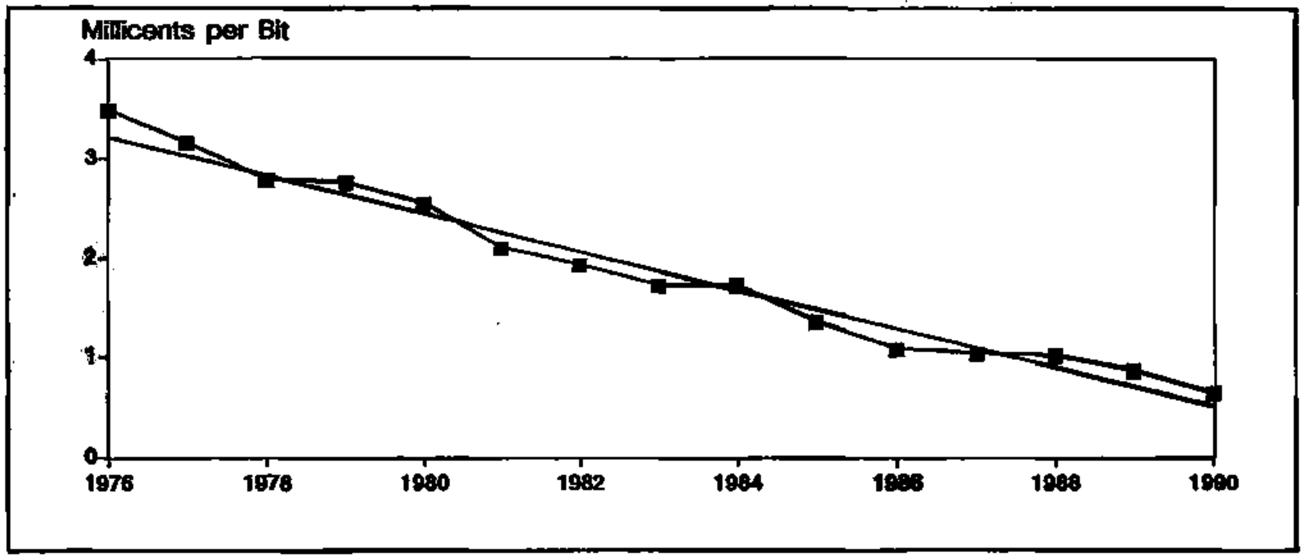
Source: Dataquest (September 1991)

FIGURE 5
MOS EPROM Bit Growth



Source: Dataquest (September 1991)

FIGURE 6
MOS EPROM Price Learning Curve



Source: Dataquest (September 1991)

in Figure 9, users are now offered a broad spectrum of nonvolatile selections that fulfill or surpass the need for EPROM density upgrades. High-speed megabit ROMs, emerging 5V/12V Flash, and more cost-efficient EEPROMs and battery-backed SRAMs provide the user with a variety of comparable performing nonvolatile solutions.

DATAQUEST CONCLUSIONS

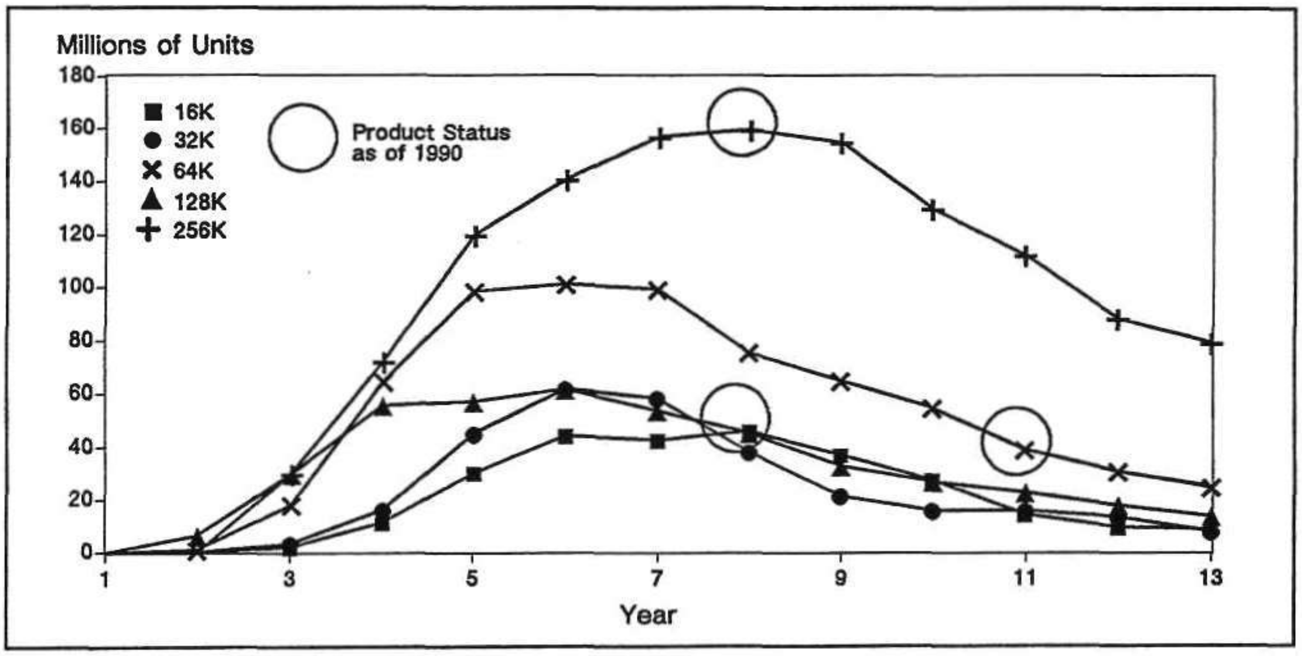
Dataquest has forecast increased EPROM revenue during the 1993-through-1995 time frame. This will be driven primarily by higher prices: a direct result of the advent of submicron products, as shown in Figure 10. These new submicron products will require greater capital investment, are technically more challenging to develop, and will demand more complex package and design expertise. All of these developments add up to increased costs and risks of financial recovery to the manufacturer. For these reasons, Dataquest expects a number of scenarios to occur during the next decade that could radically change the structure of the MOS EPROM market and vendor base:

- The EPROM vendor base will continue to decline as a result of increased R&D costs and trade restrictions.
- Shrinking EPROM revenue will force the need for memory partnering agreements.
- Surviving EPROM vendors will focus on specialty high-performance, more profitable, and risk-free EPROM products.
- EPROM products will be divided into two major segments—high-speed (85 to 120ns) EPROMs and specialty bipolar replacement (sub-70ns) devices.

In the midst of all this change, regional trade developments between the United States, Europe, and Japan in 1991 will continue to wreak havoc in the memory market for both users and suppliers. The officially released information on the new US–Japan trade agreement is as follows:

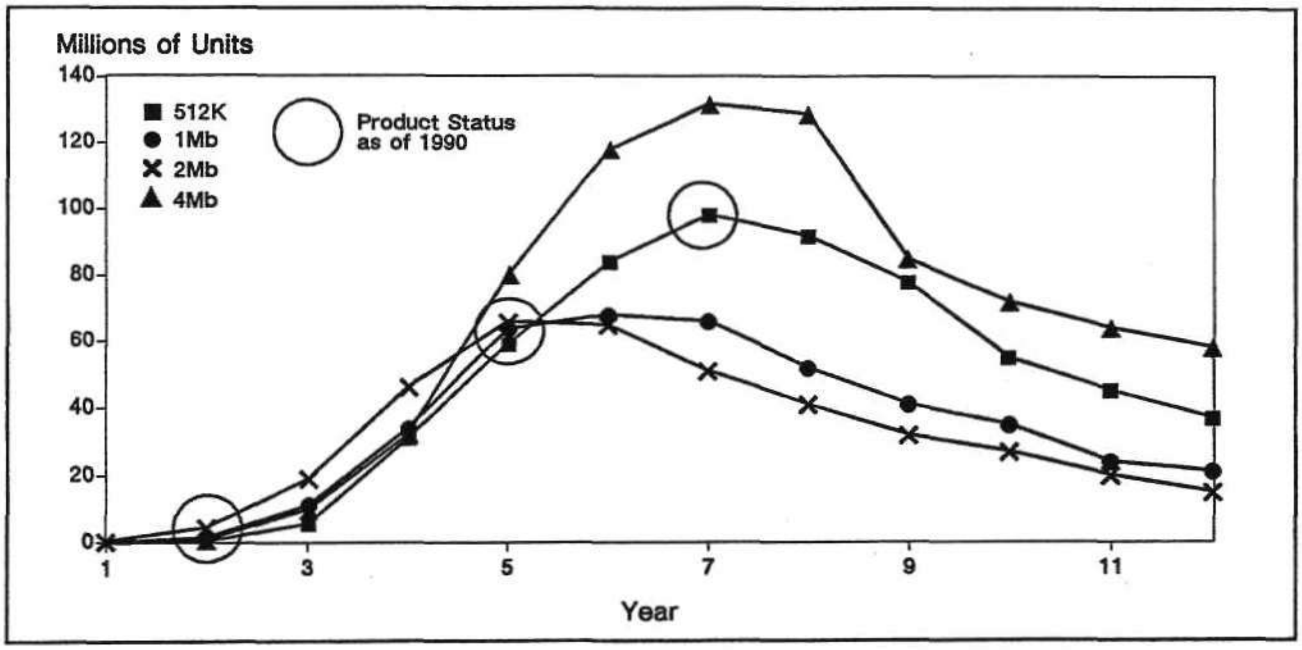
- It is a five-year, government-to-government agreement with an option to end the agreement in three years.
- The Japanese government reaffirms its commitment to an open market.
- There are no FMVs. Japanese companies will collect cost and price data to be reviewed by the U.S. government for dumping violations.
- Non-Japanese producers should achieve a 20 percent share of the Japanese semiconductor market by the end of 1992.
- There are two formulas to calculate market share—a US formula that excludes branded and captive data and a Japanese Ministry of International Trade and Industry formula that includes branded and captive data.

FIGURE 7a
MOS EPROM Product Life Cycle by Density



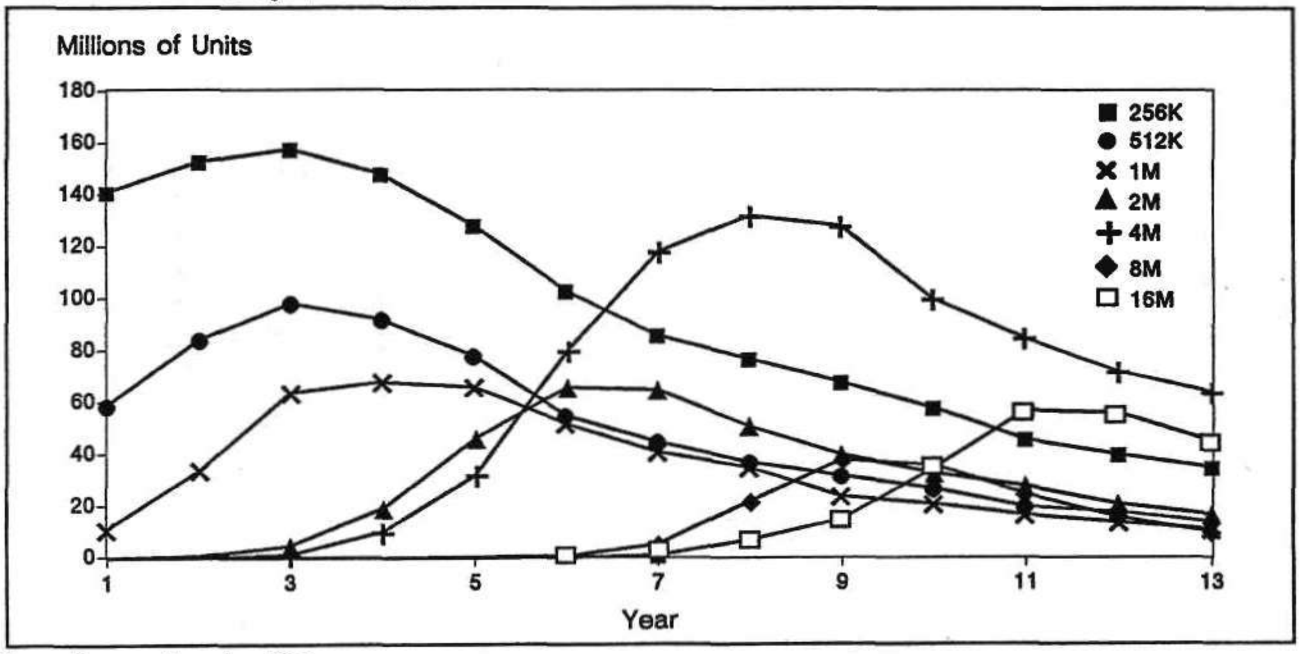
Source: Dataquest (September 1991)

FIGURE 7b
MOS EPROM Product Life Cycle by Density



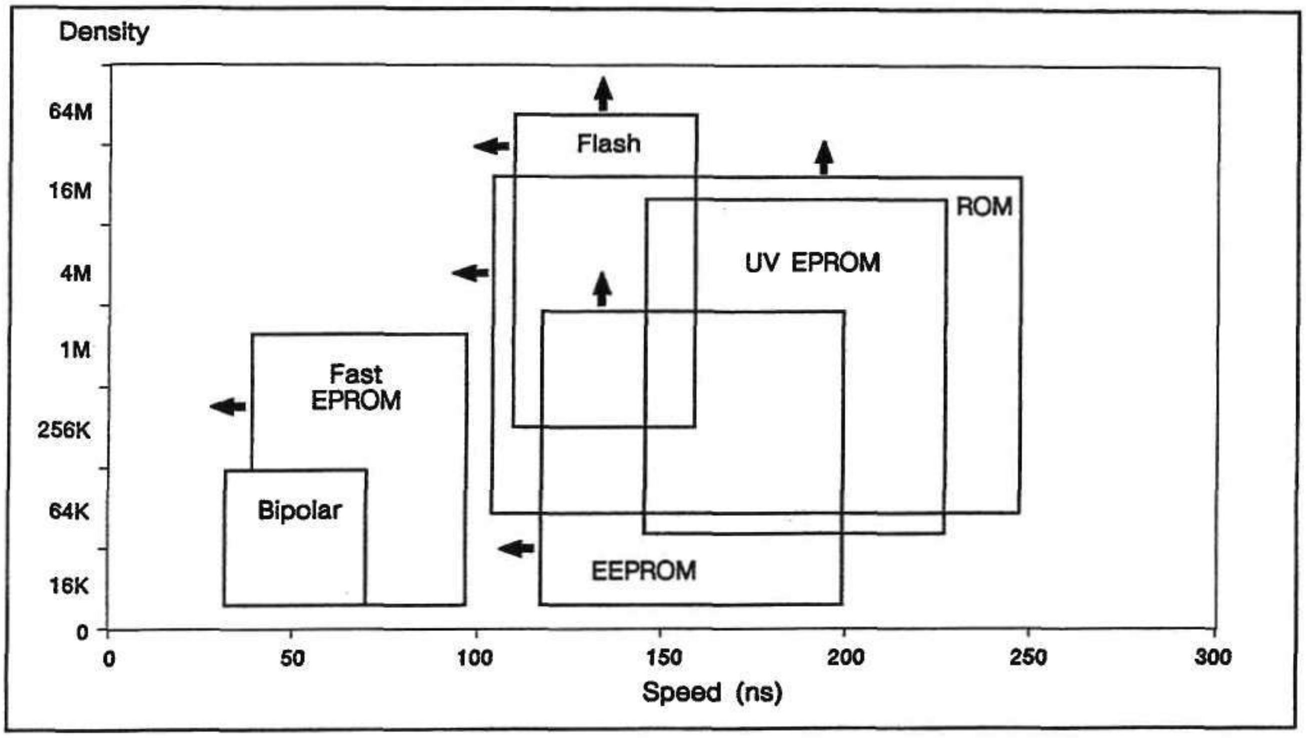
Source: Dataquest (September 1991)

FIGURE 8
MOS EPROM Life Cycle Forecast



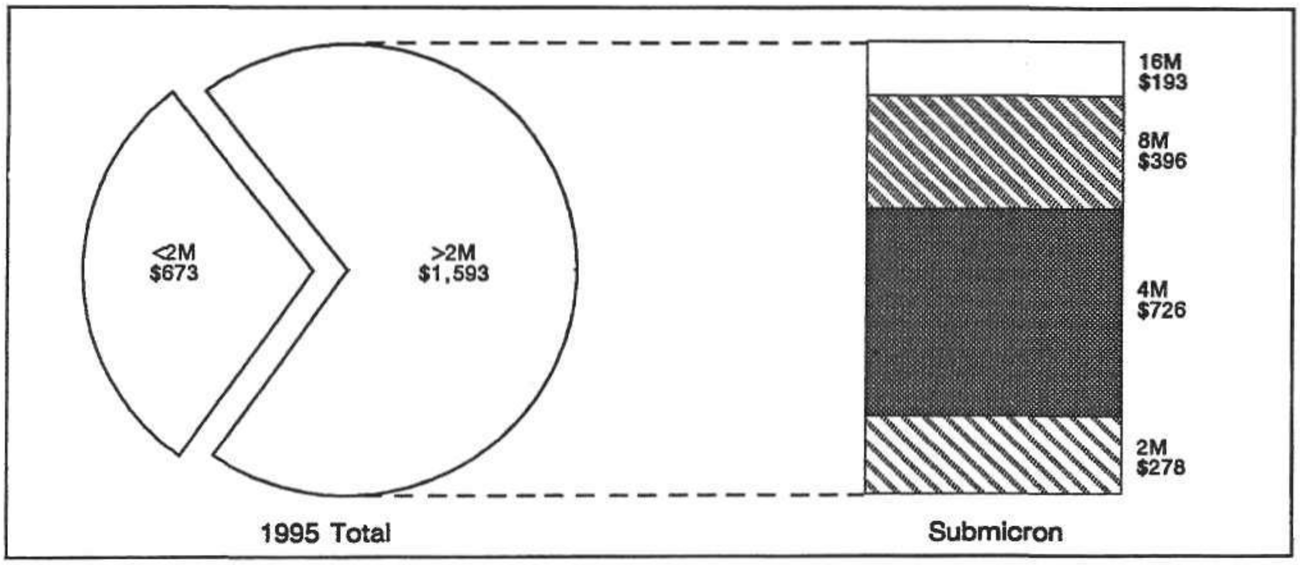
Source: Dataquest (September 1991)

FIGURE 9
Nonvolative Trade-Offs



Source: Dataquest (September 1991)

Figure 10
MOS EPROM Forecast—Submicron Revenue (Millions of Dollars)



Source: Dataquest (September 1991)

- The two governments will meet three times a year to evaluate the results of the agreement.

As a result of the agreement, the remaining sanctions of $165 million per year against Japanese products will be suspended. The suspension agreement on EPROMs will be extended.

The European Commission has introduced a definitive antidumping duty of 94 percent on all Japanese-manufactured EPROM products. Concurrently, the EC has agreed that seven Japanese EPROM manufacturers will undertake to abide by reference prices, providing for a conditional suspension of this duty. The regulation and undertakings came into effect in March this year. Further analysis on the trade agreements can be located in newsletter 1991-9, "EC EPROM Reference Price Agreement."

Are there any winners in government-enforced trade agreements? In the United States and Europe, users must pay higher prices for the memory products than they would in a free-trade environment. Since the implementation of the US–Japan trade agreement, US suppliers have regained EPROM market share; however, this share only relates to the lower 16K-through-256K mature densities. While Japanese EPROM suppliers pursued the higher 4M, 8M, and 16M EPROM densities, the US suppliers waged price wars against each other for market share instead of building technological infrastructure.

Successful vendors that choose to stay in the EPROM business will be those that continue to make product enhancements in speed, packaging, and power. Supplier staying power in the MOS EPROM market during the next decade will be a true test of a company's quality of management, strength of financing, and product innovation.

Byron Harding
Mary A. Olsson

(This newsletter was originally published by Dataquest's Semiconductor Industry Service.)

Research *Newsletter*

THE SINGLE EUROPE ACT DRIVES RESTRUCTURING OF SEMICONDUCTOR DISTRIBUTION

SUMMARY

Considerable acquisition and divestiture activity is taking place among semiconductor distribution companies in Europe at the moment. Both European and US electronics distribution groups have been buying up distributors in order to expand their positions in preparation for post-1992 Europe. For distributors, the Single Europe Act could mean substantial cost savings. It promises lower-distribution costs through centralized warehousing, cheaper transportation, and reduced bureaucracy. The Act will also affect how franchises are awarded across the European Community (EC). It will tend to standardize the contracts that distributors have with their franchises, and increase the pressure to move to standard European price lists.

Dataquest feels that some distributors may be setting their expectations too high. Much work still has to be done in Brussels and throughout the EC before the Single Europe Act can be fully effective. It may take several years, after 1993, before the full benefits of a unified European market will really be felt. Also, the Act will do little to change the fact that the EC consists of 12 separate countries with individual cultures. The distribution business, which is built on serving local customer needs, will still have to do business at this local level; a fact that non-European companies in particular should bear in mind.

This newsletter is an extract from a joint Dataquest/Europartners Consultants study on the component distribution market entitled *Worldwide Electronics Components Distribution*. It provides an analysis of top European distributors in Germany, the United Kingdom, France and Italy, and of the leading US distribution companies currently engaged in trying to penetrate the European market.

ACQUISITION AND MERGER ACTIVITY

In the last two years, substantial changes have taken place in the structure of the distribution industry for electronic components in Europe; and in the last six months the pace of change has quickened.

In late 1989, the Swiss group, Elektrowatt, acquired the Hamburg-based distributor, Enatechnik, from Unitech, signalling Unitech's final exit from the components area. A few months later, the Swiss Elbatex group acquired Jermyn (from Lex) and Omni Ray in Germany, Aquitech in France, and Veridata in Switzerland. These acquisitions, together with their existing component businesses, are likely to produce a turnover of more than $200 million in 1991. The giant Germany conglomerate, Veba, through its subsidiary, Rein Elektronik, has also embarked on an acquisition plan with its purchase of the MEMEC group in 1990. Rein Elektronik already enjoys substantial electronics sales, principally in the field of computer products.

On the US front, the two major groups in electronics components—Hamilton Avnet and Arrow—have been active in searching for suitable partners in Europe. Of the two, Arrow has been more successful. Two years ago, Arrow acquired Axiom, RR Electronics and Retron from Electrocomponents. It has now built up substantial holdings in Spoerle in Germany and in the Silverstar/Lasi group in Italy. In June this year, Arrow announced the acquisition of all the electronics components activities of the Lex group in the United States and Canada. With the European components businesses of Lex available for sale, it remains to be seen whether either Hamilton Avnet or Arrow purchase them to strengthen their worldwide portfolio. Compared with Arrow, Hamilton

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Avnet's activities have been limited. In June this year, it acquired Access from Diploma plc in the United Kingdom.

Semiconductor revenue for the top distribution groups in Europe and the United States in 1990 is shown in Table 1. From this table, the comparatively large size of the two leading US groups is visible. Table 2 compares the relative sizes of the leading Western semiconductor distribution markets. The four big European markets sum to $1,934 million, less than half the size of the US distribution semiconductor market.

COUNTRY ANALYSIS

Germany

The background to Germany's semiconductor distribution market in 1990 was one of change. That year witnessed German unification, and while today the initial euphoria has gone, unification did result in some positive market forces. The electronics market experienced a boom in demand for consumer and telecommunications goods, which fed through to the semiconductor market, making Germany the strongest semiconductor market in Europe for that year. Despite this, the overall distribution market for semiconductors dropped by 1.5 percent compared with 1989. This was caused primarily by price erosion in commodity memories. Semiconductor manufacturers began implementing initiatives aimed at taking costs out of the chain between manufacturer and end customer. These were primarily focused on stock reduction and are now having a positive effect on distribution sales. Examples of this are National Semiconductor's Prima program and SGS-Thomson's and Motorola's market price programs.

The leading semiconductor distributors in Germany are EBV and Spoerle. Together they held 45 percent of a distribution market that was estimated to be worth DM 950 million ($586 million) in 1990.

TABLE 1
Estimated Top European and US Distributors of Electronic Components*
Semiconductor Revenue 1990

Group	Sales 1990 (LC)	Sales 1990 ($M)	Market Share (%)
Germany			
EBV	DM 228 M	$141	24%
Spoerle	DM 200 M	$123	21%
United Kingdom			
Diploma	£73 M	$130	22%
MEMEC	£59 M	$105	18%
France			
Sonepar	FF 484 M	$89	22%
FHTEC	FF 374 M	$69	18%
Italy			
Silverstar/Lasi	L 85 B	$71	20%
United States			
Avnet	$601 M	$601	13%
Arrow	$416 M	$416	9%

* Complete top 10 rankings available in *Worldwide Electronics Components Distribution* report.
LC = local currency
Source: Dataquest (September 1991)

TABLE 2
Estimated Size of Total Semiconductor Distributor Resales 1990 by Major Country Market

Country	Sales 1990 (LC)	Sales 1990 ($M)
Germany	DM 950 M	$586
United Kingdom	£330 M	$589
France	FF 2200 M	$404
Italy	L 425 B	$355
United States	$4,625 M	$4,625

LC = local currency
Source: Dataquest/Europartners Consultants (September 1991)

EBV

EBV is the biggest semiconductor distributor in Germany; though in fact it is only the second-largest German distributor of components overall. The company is also the only major distributor in the country still in private hands. EBV is primarily engaged in semiconductors, with a very small distribution of VME boards from Motorola. It has nearly 180 employees; because of the private ownership structure of the company, it seldom publishes details of its sales or profitability. For 1990, Dataquest estimates that its total sales amounted to DM 250 million, of which DM 228 million was from semiconductor sales. The company has been consistently profitable over the last few years. The forecast for 1991 is for only a slight sales increase; this is because EBV's main customers deal in industrial electronics where export sales are currently difficult.

Spoerle

Spoerle is the second-largest semiconductor distributor in Germany. However, it is by far the largest German distributor of electronics components in both total turnover and number of franchises. In 1990, total sales of Spoerle, without its two subsidiaries, Unielectronic and Proelectron, were $225 million, or more than DM 330 million. However, estimated semiconductor sales in Germany were only DM 200 million. The US distributor, Arrow, holds 40 percent of Spoerle's shares. Spoerle's profitability is seldom published, but the company is, according to managing director Carlo Giersch: "The most profitable distributor in Germany." The profit for the portion of Spoerle accounted for in Arrow's annual report was $10 million (after tax).

United Kingdom

In the United Kingdom, the percentage of total sales of semiconductors through component distributors has fallen from 26 percent in 1988 to a current level of 24 percent. This has been caused by two major factors:

- The shift in the UK's manufacturing base of electronics equipment between 1988 and 1990. During this period, larger, mainly foreign-owned companies, such as Digital, IBM, and Sony, tended to form partnerships with selected semiconductor manufacturers in order to reduce costs. These partnerships have worked on "ship-to-line" deliveries for many commodity semiconductors. The programs have been successful, and have resulted in the semiconductor manufacturers handling virtually all the semiconductor sales to these companies directly.
- The "see-saw" of commodity memory prices: manufacturers that have attempted to avoid the risk of price protection claims by encouraging their distributors not to stock memory devices, but instead to rely on their own inventories, have sometimes come unstuck. As a result, regular availability of quantities of memory has suffered and sales have reduced.

The leading semiconductor distributors in the United Kingdom in 1990 were Diploma plc and MEMEC. Together they held a 40 percent share of a market estimated to be worth £330 million ($589 million).

Diploma

Diploma plc was the largest semiconductor distribution organization in the United Kingdom in 1990, with estimated sales of £73 million. The group was established with counter-phased business interests (building, steel and electronics), that is, businesses whose markets are cyclical but move out of phase with each other. This would ensure stable growth at the total group level. Diploma's electronics distributors have until recently been managed with a light rein, which has been a successful strategy. The group structure has been comparatively stable for many years, apart from the merging of DTV and Nortronic in 1988. However, in June 1991, Diploma sold the Access group to Hamilton Avnet for £13.8 million. At the time of divestiture Access' sales were running at about £21 million per annum. Diploma now consists of Anzac, Nortronic-DTV and Macro Marketing.

MEMEC

MEMEC is the second-largest semiconductor distributor in the United Kingdom with estimated semiconductor sales for 1990 of £59 million. It is a successful entrepreneurial operation founded in the 1970s and subsequently floated as a public company. The original strategy was to focus on high-technology suppliers; and MEMEC developed a strong agency business based on this principle. Over the years, the tendency has been to move into increasingly complex areas; and much of the group turnover is now more fairly described as being in systems rather than in components. In the component field, MEMEC acts as the holding company for Kudos, Thame Components, Ambar Cascom, Micro-call, Ambar Components, Logical Integration, and Versa-Dis. In 1991, the MEMEC group was purchased by the German Raab Karchar group.

France

In 1990, Dataquest estimates that sales of semiconductors through French components distributors fell by 10 percent compared with the 1989 level. This was symptomatic of the poor overall market conditions affecting the entire French electronics market. It was against this background that the Sonepar group consolidated its position as France's biggest semiconductor distributor, and the FHTEC group (consisting of RTF, Scientech, and Rea) took the number-two position from Tekelec. Together, the two groups hold 40 percent of a French distribution semiconductor market that was worth FF 2,200 million or $404 million in 1990.

Sonepar

Sonepar was the first French group to invest in electronics components when it acquired Almex in 1970. It is now the largest semiconductor distributor in France with estimated semiconductor sales of FF 484 million in 1990. The group, which is internationally involved in electrical parts distribution, has formed a special holding company, Sonepar Electronique, to encompass the subsidiaries operating as distributors of electronics components. The operating companies in France are Eprom, Almex, Franelec, Scaib, Rhonalco, ICC and PEP Techdis. Sonepar Electronique is the only French group that has both a pan-European and North American presence. It owns companies operating in Belgium, the Netherlands, Spain, the United Kingdom, and the United States.

FHTEC

The FHTEC group was formed in 1988 by merging the REA and RTF groups. It has a turnover of FF 750 million and has 400 employees. In 1990, Dataquest estimates that its semiconductor sales amounted to FF 374 million, or half of the group's total turnover. The main companies in this group were reorganized in 1990 and the companies selling electronics components are now grouped in a sub-holding company called FHTEC Composants. The headquarters and the warehouses of the three companies are located in Châtillon (near Paris) at the same address. Other companies in the group are trading, or value-added distributors in video, computers and instrumentation.

Italy

Distribution sales of semiconductors in Italy rose by just over 3 percent in 1990 compared with 1989, the opposite trend to that experienced in the other major European markets. However, it is fair to say that most of the major semiconductor distributors are experiencing severe profit-related problems and are currently adopting a number of cost-reduction measures. Because of this, the semiconductor distribution market in Italy has undergone more structural change in the past 18 months than it has experienced in the last decade. The combined activities of Silverstar and Lasi, part of the Silverstar group, represent the largest semiconductor distribution network in Italy. Their estimated total semiconductor sales in 1990 were L 85 billion, representing 20 percent of an Italian semiconductor distribution market worth L 425 billion. In 1991, the US distributor Arrow took a substantial stake in the Silverstar/Lasi group.

Silverstar

Silverstar is the oldest-established components distributor in Italy; founded in 1954, the company began as a "stocking rep." for RCA Tubes. During the 1950s and 1960s, Silverstar added both components and instrumentation lines. Indeed, for many years the company has been an exclusive representative for Tektronix, Scientifics Atlanta, and Spectrafisics in Italy. From 1970, the components division was separated out from the equipment franchises, and major efforts have been made to streamline the product range. With the acquisition of Lasi in December 1983, the group became the largest "broadliner" of active components in Italy. In the 1980s, the group acquired majority participation in another distributor, Claitron, which handles Japanese components and systems lines.

Lasi

As already explained, Lasi became part of the Silverstar group in 1983. At that time, the major lines were Thomson, Harris, MHS, RCA, National, AMD and GI. A major effort has been made in the past eight years to reorganize the product portfolio. The Intel franchise was acquired in 1986, and AMD was dropped. In 1988, following the merger of SGS and Thomson, the full SGS-Thomson line was acquired. At Lasi, the strategy is now to offer new lines like Datel, Amtel, Weltech, Actel, and ATT as a stocking-rep. Recently, IDT was also added. With the exception of Intel systems' products and 3M, the company is devoted to active components.

United States

The US semiconductor distribution market grew by just over 6 percent in 1990 compared with 1989, against an overall 11 percent growth in sales of all components handled by distribution. The top 10 distributors represented more than 60 percent of the total end-market sales. The semiconductor sector within distribution still remains the largest single element, but is diminishing in its dominance of the distribution market. In 1989, it represented 48 percent, and in 1990 it dropped to 46 percent. The entire US semiconductor industry, both manufacturers and distributors, were badly affected by commodity memory price erosion, especially in the 1M and 4M DRAM areas.

Avnet and Arrow are the two biggest semiconductor distributors in the United States. Together, they controlled 21 percent of a total semiconductor distribution market estimated to be worth $4.6 billion in 1990.

Avnet

Avnet Inc. was the largest semiconductor distribution group in the United States in 1990, with estimated semiconductor sales of $601 million. Incorporated in New York in 1955, Avnet is a public company traded on the New York Stock Exchange and on the Pacific Stock Exchange. Its prime mission is the distribution of electronics components and computer products to industrial and military customers, with components shipped as received or with value added. The company is also in the electrical and video communication distribution and manufacturing business. The electronics marketing group is the company's largest business, with sales of $1.4 billion. This represents 80 percent of its 1990 total sales revenue of nearly $1.8 billion. This means that semiconductors represent about one-third of the company's turnover.

Arrow

Arrow Electronics was the second-largest semiconductor distributor in the United States in 1990, with estimated sales of $416 million. The company was formed in 1946 and is now engaged in the distribution of electronics components, systems and related products. Arrow was also in the business of refining and selling lead through its subsidiary, Schuylhill Metals Corporation, which was sold for $33.5 million in September 1988. In January 1988, Arrow Electronics acquired Kierulff Electronics, Ducommun Data Systems and MTI Systems Corporation from Ducommun Incorporated for a cost of $113 million. The deal consisted of $80.5 million in cash and the balance in the company's stock. The company also includes a wholly owned subsidiary in Canada and the United Kingdom, a 50 percent joint venture in Japan, a 40 percent interest in Spoerle in Germany, and a substantial holding in Silverstar/Lasi in Italy. In 1991, it acquired Schweber from Lex. This will make it the largest semiconductor distributor in the United States based on 1990 sales data.

DATAQUEST ANALYSIS

Acquisition and divestiture activity among European and US components distributors is at fever pitch. The focus is on consolidation in Europe. The motivation behind it is preparation for the advent of the single European market. The expectation is for better margins through improvements in economies of scale. This is a key issue because, for many, profits are proving hard to achieve at the moment as sales are down.

For European distributors the Single Europe Act could mean substantial cost savings. It promises lower distribution costs through centralized warehousing, cheaper transportation, and reduced bureaucracy. The Act will also affect how franchises are awarded across the EC. It will tend to standardize the contracts that distributors have with their franchises, and increase the pressure to move to standard European price lists. It is highly likely that distributor contracts, which require exclusive sales territories, will become illegal, and the changes in rules on competition will help distributors with Europe-wide networks of offices, as they will be able to provide better service to their customers.

US distributors perceive a threat, and a possible opportunity. The threat is that if they do not have a presence in the EC before the end of 1992, they may find it very difficult to enter later. So the plans they may have made to establish worldwide distribution businesses would be affected. The opportunity is in the Single Europe Act itself, because it should lead to conducting business in a similar way to that of their home market, for the reasons already mentioned. The Americans feel that their experience in the United States, which is a large monolithic market with wide geographic regions, will enable them to compete more effectively against more nationally based organizations. Nevertheless, it must be remembered that these large US distributors have very low net margins compared with their European counterparts.

To those companies with the ambition of building pan-European distribution businesses, Dataquest would offer the following observations.

In June, the European Commission warned the 12 EC states that they are holding up the final stages of the single market plan. Their statistics show that of the 282 proposals contained in the Single Europe Act, 89 remain to be adopted, and only 11 proposals have been adopted fully in the past six months. Once the proposals have been adopted they must still be incorporated into national laws, and that often takes as long as two years. This could mean that many of the proposals will not be law in time for the completion deadline on December 31, 1992. Once the proposals have finally been incorporated in the constitutions of the 12 states it will probably take years for the full impact of the changes to take effect. So, nothing magic is going to happen on January 1, 1993. Change will be gradual.

The Single Europe Act may establish the legal structure for a unified market in the EC, but each of the 12 member nations have their own unique cultures. In a business sense, this means each nation will continue to have its own local market needs and its own particular way of doing business. This must be of paramount importance to distributors, which typically deal with small and medium-size customers who tend to be nationally focused. It would pay the US distributors well to remember this as they move into Europe.

Finally, a positive input: at a recent buyers' "round-table" discussion chaired by Dataquest at its European headquarters, procurement executives from multinational OEMs involved in computer and telecommunications equipment manufacture, expressed the common view that they were increasing the amount of business they did with distributors. They said that this was a facet of a general trend their companies were following: to subcontract as much of their production and procurement requirements as possible. For them, the rationale behind using a distributor was primarily to reduce inventory holding. However, a vital qualification for the distributor is the ability for him to provide direct ship-to-line. As such, they were choosing distributors who were financially stable, and able to supply an extensive kit of parts. Not just semiconductors.

Jim Eastlake

Note: This newsletter is an extract from a new Dataquest/Europartners Consultants study entitled *Worldwide Electronics Components Distribution*. The report provides detailed market studies on the electronics components markets and players in the United States, the United Kingdom, Germany, France, Italy and Japan. For further details, please contact Richard Noden at Dataquest's European headquarters in Denham, England. Telephone: +44 895 835 050, or Fax: +44 895 835 260

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Research Newsletter

MARKET UPDATE: ITALY

SUMMARY

This year the Italian semiconductor market will decline for the second successive year. The market is estimated to be worth L 1,372 billion, a 3 percent decline on 1990 (see Table 1). The cause of this lies in continued weakness in the electronic data processing (EDP) segment, which is due in part to a weak Italian economy close to recession in the second half of this year. However, in line with a general economic recovery, the Italian semiconductor market is expected to return to positive growth in 1992, increasing by 11 percent over 1991.

There are some growing concerns about the long-term strength of the Italian semiconductor market. This is due to the Italian government's apparent lack of interest in encouraging investment in electronics.

THE MARKET IN 1991

The decline of the semiconductor market this year follows a 5 percent decline in lira in 1990. The applications segments split for the Italian semiconductor market in 1990 are shown in Table 2. This table also shows that Datquest forecasts a downward trend in all but the transportation segment this year, which is expected to be flat in 1990.

The largest applications segment in Italy is EDP, and Table 3 shows that some important

TABLE 1
Italian Semiconductor Market

Currency	1990	1991	Percent Growth	1992	Percent Growth
Lira Billions	1,412	1,372	-3%	1,524	11%
ECU Millions	927	897	-3%	1,524	11%
US Dollars Millions	1,179	1,092	-7%	1,172	7%

Source: Dataquest (October 1991)

TABLE 2
Italian Applications Markets Analysis 1990

Currency	EDP	Comms.	Ind.	Cons.	Mil.	Trans.	Total
Percent	40%	23%	15%	13%	4%	5%	100%
Lira Billions	565	325	219	184	56	63	1,412
ECU Millions	371	213	139	121	37	46	927
US Dollars Millions	472	271	176	153	47	60	1,179
Trend in 1991	down	down	down	down	down	flat	down

Source: Dataquest (October 1991)

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TABLE 3
Leading Electronics Manufacturers in Italy

EDP	Comms.	Ind.	Cons.	Mil.	Trans.
Bull	Alcatel	Marelli	Samsung	Elmer	Marelli Autronica
Siemens	Fatme/Ericsson		Hoover		
IBM	ISC		Selco		
Mael	Italtel				
Olivetti	Larimat				
HP	Marconi				
	Telettra				

Source: Dataquest (October 1991)

multinational EDP companies are manufacturing in Italy. In this segment, increased purchases from IBM and Hewlett-Packard (HP) in 1991 have failed to offset the decline in semiconductor spend by Olivetti and Bull. This year, HP began production of laser printers in Bergamo, and is believed to be assembling 20,000 boards per month now. Also, IBM increased production of its workstations at its Vimercate factory. However, these increases failed to offset Olivetti's reduced spend caused particularly by a weak European PC market, and the fact that Bull virtually ceased production of its workstations in Italy, and now only makes printers.

The next most important segment is communications which represented 23 percent of the Italian semiconductor market last year. Reduced orders for telecoms exchange and transmission equipment from the Italian government, combined with high inventories at Italtel and Telettra, have led to a decline in the communications segment again this year.

As Table 4 shows, the Italian economy is close to, or in, recession in the second half of this year. As a result, semiconductor demand from the industrial, consumer and transportation segments have all been affected.

FORECAST FOR 1992

Dataquest's forecast for 1992 is based on a key assumption that an economic recovery will begin to take effect during the first quarter of 1992. Dun & Bradstreet's latest economic forecast for Italy and the other leading industrialized economies with substantial semiconductor markets is given in Table 4. Based on this, we expect the Italian semiconductor market to grow by 11 percent in lira in 1992 over 1991, reaching an estimated L 1,524 billion.

Olivetti is shortly to announce a new range of office automation products which should boost its order rate. Its PC business should pick up in 1992 in line with a general increase in high-end PC sales

TABLE 4
Economic Forecast GNP/GDP Growth Rates

		Percent Annual Growth			
Country	In or Near Recession?	1989	1990	1991	1992
France	Yes	4.5%	2.8%	1.4%	2.5%
Germany (West)	No	3.9%	4.5%	3.1%	3.0%
Italy	Yes	3.2%	2.0%	1.4%	2.5%
United Kingdom	Yes	1.7%	0.5%	-1.8%	1.9%
United States	Yes	2.5%	1.0%	0.0%	2.5%
Japan	No	4.7%	5.7%	3.8%	4.0%

Source: Dun & Bradstreet

in Europe. Demand for laser printers across Europe should stimulate production of printers by Hewlett-Packard, and also printer production by Bull and Olivetti which also make laser printers in Italy.

Current indications suggest orders from Italtel and Teletra will be flat in the first quarter of 1992, but once inventories have been reduced, we expect the communications segment to pick up.

Also, in line with economic recovery, we expect higher order rates in the industrial, consumer and transportation segments.

GOVERNMENT POLICY AND ELECTRONICS

Recent Dataquest research conducted into the Italian government's attitude towards investment in electronics in Italy has given us some cause for concern about future growth in the Italian semiconductor market. One view is widely held among the semiconductor community: that the government's lack of interest in attracting foreign electronics companies to locate factories in Italy will have a damaging long-term effect on the Italian semiconductor market. There seems to be no development agency (such as the Irish IDA, the Dutch Foreign Investment Agency, the Lower Saxony Ministry for Technology or Locate in Scotland), or regional technology park (like the Andalusia Technology Park in Spain, or Sofia Antipolis in France), with the goal of attracting investment in high technology. On this basis, Dataquest will be reducing its long-range forecast for the Italian semiconductor market in its next long-range forecast update.

DATAQUEST CONCLUSION

The increased presence of IBM and Hewlett-Packard is helping to stabilize the large Italian EDP segment which is still dominated by Olivetti. (Dataquest estimates that Olivetti's purchases represent approximately 20 percent of the entire Italian semiconductor market.) Economic recovery in 1992 will result in a return to positive growth for the market. But there is growing concern over the long-term future of the Italian semiconductor market because of an apparent lack of a clear government industrial policy focusing on electronics.

Jim Eastlake

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Research Newsletter

MARKET UPDATE: SPAIN

SUMMARY

The Spanish semiconductor market is forecast to be worth Pta 19,900 million in 1991, a decline of 1 percent compared with 1990. This is the second successive year of decline for Spain (see Table 1). The main reason for this has been a slowdown in the communications segment, caused by prevailing economic conditions leading to reduced orders from Telefónica.

However, the Spanish semiconductor market should recover in 1992, and is forecast to grow by 11 percent over 1991. Consumer demand will be stimulated by the Barcelona Olympics and the Expo '92 trade fair in Seville. This will lead to higher growth throughout the Spanish economy.

THE MARKET IN 1991

In 1990, the Spanish market declined by 4 percent. The single most important reason for this lies in the communications segment. The applications split for the Spanish market in 1990 is given in Table 2, indicating the trend in 1991 compared with 1990. As shown, the communications segment represents 46 percent of the total market. This substantial market share came about during the 1980s due to a large government investment program aimed at establishing a modern communications infrastructure in Spain. In theory, semiconductor demand should be stimulated further by the government's plan to liberalize the markets for terminal, fax and PBX equipment by 1994, breaking Telefónica's monopoly. In practice, this may not be the case if the example of telephone handsets is anything to go by.

TABLE 1
Spanish Semiconductor Market

Currency	1990	1991	Percent Growth	1992	Percent Growth
Pesetas Millions	20,100	19,900	-1%	22,090	11%
ECU Millions	155	155	0%	171	10%
US Dollars Millions	197	189	-4%	202	7%

Source: Dataquest (October 1991)

TABLE 2
Spanish Applications Analysis 1990

Currency	EDP	Comms.	Ind.	Cons.	Mil.	Trans.	Total
Percent	9%	46%	13%	27%	3%	2%	100%
Pesetas Millions	1,809	9,246	2,613	5,427	603	402	20,100
ECU Millions	14	71	20	42	5	3	155
US Dollars Millions	18	91	26	53	6	3	197
1991 Trend	down	down	flat	up	down	flat	down

Source: Dataquest (October 1991)

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The market for telephone handsets was liberalized in June this year. In the past, Telefónica bought telephones under license from Amper and Alcatel, both performed the complete manufacturing process (including procurement of semiconductors) in Spain. Indeed, Telefónica bought from these companies because they manufactured in Spain. Naturally, the effect of liberalization has been to allow other telephone manufacturers to enter the market. Of the new players, Ericsson and AT&T have been particularly successful in establishing a presence. These companies perform, at best, only a part of their telephone handset manufacturing process in Spain. In particular, they do not buy semiconductors for circuit-board assembly. This experience, combined with a slowdown in the Spanish economy, has led to some cutbacks in semiconductor orders from telecoms manufacturers in Spain. Thus the semiconductor market has declined.

The weakness in the communications segment over the past two years has been partly compensated for by strong growth in the consumer segment. This segment represented 27 percent of the total market in 1990, as shown in Table 2. A large increase in TV set production by Japanese companies, particularly Sony and Sharp, has driven this.

In comparison with the communications and consumer segments, the electronic data processing (EDP) segment is quite small; it represented only 9 percent of the market in 1990. Some of the leading electronics manufacturers in Spain are listed in Table 3 by applications segment (though not all of them procure semiconductors locally).

From Table 3 it is clear that the EDP segment comprises mainly non-Spanish companies. Also, the majority of them are experiencing considerable business difficulties at the moment. This has been reflected in their semiconductor orders this year.

The industrial segment, which represents 13 percent of the total market, will show no growth this year. It reflects the slower economic growth that Spain is experiencing. Dun & Bradstreet's latest GDP/GNP outlook is shown in Table 4. In 1991, the Spanish economy will only grow by 2.6 percent. This is a slow growth performance for Spain when compared with previous years.

Like the rest of the European transportation segment, the automotive electronics manufacturers in Spain have been affected by a Europe-wide slump in new car sales. In addition to Bendix, VDO and Valeo, Ford recently set up a factory to make ABS modules. It began production this year but at the moment appears to be showing no intent to procure semiconductors locally.

In Spain, five main military semiconductor users exist. Future demand from them will depend on the success of the European Fighter Aircraft (EFA) project, as these organizations are involved in design and manufacture of radar and military communications equipment for EFA. Currently EFA is progressing slowly.

Table 3
Leading Electronics Manufacturers in Spain

EDP	Comms.	Ind.	Cons.	Mil.	Trans.
Olivetti	Telefónica Y Electrónica	Crouzet	Elbe	Inisel	Ford
Bull	Amper	Fagor	Sharp	Seselsa	Bendix
IBM	Angel		Fagor	Casa	VDO
Fujitsu	Fagor		Sony	Ensa	Valeo
Siemens/Nixdorf	Televis		Sanyo	Eurotronic	
APD	Siemens		Panasonic		
Investrónica	Interesa		Samsung		
	Alcatel		Mitsubishi		
	Telettra		Philips		
	Ericsson (Intelsa)				

Source: Dataquest (October 1991)

TABLE 4
Economic Forecast GNP/GDP Growth Rates

		Percent Annual Growth			
Country	In or Near Recession?	1989	1990	1991	1992
Spain	No	4.9%	3.5%	2.6%	3.2%
France	Yes	4.5%	2.8%	1.4%	2.5%
Germany (West)	No	3.9%	4.5%	3.1%	3.0%
Italy	Yes	3.2%	2.0%	1.4%	2.5%
United Kingdom	Yes	1.7%	0.5%	-1.8%	1.9%
United States	Yes	2.5%	1.0%	flat	2.5%
Japan	No	4.7%	5.7%	3.8%	4.0%

Source: Dun & Bradstreet

FORECAST FOR 1992

Dataquest expects the Spanish semiconductor market to recover in 1992. The 1992 Barcelona Olympics and the Expo '92 trade fair in Seville will increase consumer spending, aiding more robust economic growth.

The confidence of communications equipment manufacturers will be boosted, which will lead to improved semiconductor orders. Increased demand for consumer electronics goods will support Sony's plans to double its TV set production next year to 1 million units, and Sharp's plans to produce 500,000 sets.

Economic recovery will lead to a pick up in the industrial and transportation segments. However, the EDP segment will at best be flat next year as we expect at least one of the EDP companies in Table 3 to cease production in Spain altogether in the near term.

GOVERNMENT POLICY

Spain is considered a European "newly industrializing economy" (NIE), drawing parallels with Southeast Asia. During the 1980s the Spanish government worked hard to encourage foreign manufacturers to locate factories in Spain by offering attractive subsidies and relocation packages. Foreign electronics manufacturers moved to Spain and this led to rapid growth in the semiconductor market. However, after two years of negative market growth, there appears to be growing criticism of government policy from the semiconductor community in Spain. Criticism is focused on three main points:

- The government is allowing Spanish companies to invest outside Spain too early. The electronics industry is still too weak and needs encouragement.
- The government is wasting money by:
  - Setting up the Seville Technology Park in competition with the Andalusia Technology Park.
  - Focusing on attracting pure R&D to Spain; this does not create local jobs, it simply attracts foreigners to conduct research and therefore is of little or no benefit to the country.
- Some foreign companies are closing their factories in Spain and moving production back to their own countries because their businesses are in difficulty.

DATAQUEST CONCLUSION

Dataquest considers the contraction of the Spanish semiconductor market in 1990 and 1991 simply as a period of correction following the high and sustained growth that the market experienced in the 1980s. Even a fast-growing economy like Spain's cannot be immune from a global economic recession. This correction of growth was inevitable. Dataquest expects that the long-term outlook for the Spanish semiconductor market is still for above-average growth compared with the rest of Europe.

As a member of the European Community Spain finds itself walking a tightrope. On one side are the liberalizing, market opening forces of the Single Europe Act, 1992, and on the other, the need to provide a "hot-house" environment to protect and nurture Spanish industry. The semiconductor market is clearly set to experience more turbulence of the kind caused by the liberalization of the telephone handset market, as Telefónica's monopoly is broken. But, with regions of Spain designated as development areas by the EC, the country should continue to attract considerable foreign investment. It is the Spanish government's job to ensure the right kind of investment to provide long-term growth rather that short-term jobs.

Jim Eastlake

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Research Newsletter

EC EMC MYSTERY IS CLOSE TO SOLUTION

INTRODUCTION

One of the aims of the European Community (EC) is the creation of a single market which ensures the free movement of goods and services between member countries. However, many subtle barriers to the free movement of goods presently exist, with legislation required for their removal. One such barrier is the varying approaches to electromagnetic compatibility (EMC) among countries. This newsletter examines the concept of EMC, the need for EMC testing, its impact on EC trade and the current (unserved) demand for EMC simulation tools.

BACKGROUND

At present, most EC member countries legislate on maximum permissible electromagnetic disturbance generated by electronic equipment. The problem is that many of these regulations are incompatible and constitute a hindrance to trade within the Community. Even though a piece of equipment may comply with one of the more stringent country regulations (for example, the German VDE regulations) it may fail to be accepted in another country because it does not bear the mark of approval for that specific country. This demonstrates one of the subtle barriers to trade which cannot be tolerated in post-1992 Europe.

EMC may be a hot political issue in Europe, but there are also sound engineering reasons why it will become still more important. Random errors within computer systems and annoying interference to TV reception are only two examples demonstrating the effects of unwelcome electromagnetic radiation. Such problems will multiply with increases in system clock speed and operating frequencies. Many circuits already operate at frequencies where EMC problems are apparent, yet microprocessor clock frequencies are forecast to rise 15-fold over the next decade (see Table 1).

As a result, Directive 89/336/EEC was issued on May 3, 1989 and enters into force (officially) on January 1, 1992 (although in reality a transition period of several years is likely to be agreed). The directive sets limits on maximum allowable radiated emissions, conducted emissions, susceptibility to power variations, common-mode radio frequency interference, electrostatic discharge and radio frequency fields. In this way, it legislates for the equipment's effect on the immediate environment and on the ability of the equipment to operate trouble-free during incoming interference.

TABLE 1
System Clock Speed Increases 1990 to 2000

	Current	Near Term 1993–1995	Long Term 1997–2000
MPU Speed	20 MHz	100 MHz	300 MHz
Memory	CMOS	BiCMOS	BiCMOS/FERRAM
Speed	2–80ns	9–60ns	<25ns
ECL (Logic/ASIC)	150–400ps	50–150ps	1.5–2.0ps (Photonic Logic)
GaAS Logic/ASIC	50–80ps	20–60ps	<5–10ps

Source: Dataquest (November 1991)

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At present, all apparatus is subject to the directive, with the exception of motor vehicle spark-ignition systems, certain electricity tariff meters and amateur radio apparatus (which are the subject of other directives containing EMC requirements). Apparatus meeting the requirements will bear the mark of approval shown in Figure 1.

FIGURE 1
The EC Conformity Mark*

* This mark will appear with the year in which it was affixed
Source: European Community

IMPLICATIONS ON DESIGN

Directive 89/336/EEC has generated intense interest throughout Europe and elsewhere on the subject of EMC. However, while many engineers are familiar with the design practices necessary to minimize electromagnetic interference (EMI), the acid test comes at the "conformance testing" stage after a prototype has been submitted for EMC-conformance testing. Such tests consist of directing an antenna at the equipment under test at a prescribed distance, while sweeping all frequencies with a spectrum analyser. Another test analyses energy transmitted along the power cord. Testing time varies from approximately two days for simple products to two weeks for complex products.

From a product design viewpoint, two implications arise:

- **Time to market.** Dataquest research has shown that most conformance tests fail at the first attempt, prompting a further design iteration in order to correct the problem. This leads to healthy business for the testing houses but increases products' time to market because of the delay involved with additional design iterations. In today's competitive environment this is a very serious issue.

- **Product cost.** In many cases, electronic products will require additional filtering or screening in order to comply with the legislation. This is most serious in high-volume, low-cost product sectors, such as consumer electronics. These sectors will be prepared to invest considerable sums into minimizing EMC effects within the electronic design to avoid extra filtering and screening costs.

Clearly, both issues affect all electronic systems companies, but Dataquest believes that small companies will be particularly badly affected since they do not have the resources to devote to EMC issues. German companies will fare better than most because they have been required for some time to comply with EMC regulations (originating from the German VDE standards body) which are at the least as stringent as 89/336/EEC.

EMC SIMULATION TOOLS

In view of companies' experience of electronic design automation (EDA) tools, engineers are increasingly asking the question: "Why can't we *simulate* electromagnetic interference effects before building a prototype?" This would minimize the number of design iterations but, at the present time, very few tools are available for this purpose. We believe this to be because:

- The technical problems of producing EMC simulation tools, based upon highly mathematical electric field theory, are considerable. A very small number of vendors have developed or acquired the technical expertise to produce such tools.

- Most users of EDA tools operate at the IC or PCB level, but EMC analysis cannot be carried out in full at this level because the key measure is field strength *outside the enclosure*. This means that engineers of many disciplines (including electronic, mechanical, thermal, electrical and materials) are involved. Individual requirements are therefore fragmented across these disciplines.

A key area of difficulty when analysing EMC is to identify and locate the source of the emission problem; it is insufficient to simply report that a problem exists. The problem is multiplied because its symptoms are usually separated from the root cause. For example, radiation can often be traced to the cables that interconnect subsystems, yet the circuitry on PCBs is usually ultimately responsible for the emissions—and this is where the problems must be solved. Problems can be purely electrical (edge transition times being too fast) or physical (bad practices in PCB layout such as ground-loop construction rather than star- or ground-plane construction). In order to analyse the sources of these problems the simulator must have knowledge of the dynamics of current and voltage in the circuit, together with information on the physical parameters (in three dimensions) and materials used. These points illustrate the difficulty of providing a viable EMC simulator.

THE IDEAL PRODUCT

Early EMC simulation products will operate at the PCB level. These products will partially satisfy user requirements, but a quantum leap in functionality is needed in order to fully cater for users' needs. Dataquest's end-user research shows that the solution to minimizing emissions lies partly with recognized design practices in terms of layout, line lengths, edge times, and so on, and partly with a design procedure more closely resembling a "black art." At this phase of the design, engineers ideally need "what-if" analysis tools which will simulate, in real time, the effects of (for example):

- Edge transition times (perhaps via the inclusion of series resistors to reduce the speed of a transition)
- Different clock frequencies
- Cable length and position variations
- Various enclosure coatings

The simulator should identify regions of high field intensity in three-dimensional space around the simulated equipment according to restrictions that correspond to a particular EMC standard (such as 89/336/EEC). The frequency characteristics and other parameters should be reported to the user. Directional vectors should be calculated and automatically used by the simulator to locate the sources of the emission. The engineer must then decide whether to undertake further tracing of the root cause or whether to employ shielding techniques around emission locations.

THE VENDORS

Right now, a demand for tools exists but no vendors are as yet shipping products. Therefore, the EMC simulation market *does not yet exist.* However, vendors are begining to take a keen interest in the topic and we expect several companies to introduce products within the next year. Companies that are active in this field include Swiftlogic (Cumbernauld, United Kingdom), Quantic Laboratories (Winnipeg, Canada), Siemens Nixdorf Informationssysteme (Munich, Germany) and Quad Design Technology (Camarillo, California). These companies are all active in the transmission-line analysis sector, which is mathematically related to EMC simulation.

One of the main problems faced by suppliers of EMC simulation tools is the performance/accuracy trade-off. Users ideally want instant (real-time) analysis to an accuracy within 5 to 10 percent. We believe this degree of accuracy will require considerable processing time and that more acceptable tools will emerge in the 1993 to 1994 time frame following considerable increases in workstation performance and more efficient algorithm development.

MARKET SIZE

In assessing the size of this not-yet-existent market, it is useful to consider the value companies would place upon such tools. Dataquest research has shown that, in Europe, for companies new to EMC, some 75 percent of products submitted for conformance testing fail at the first attempt. For experienced companies, 30 percent fail and overall, approximately 40 percent of all conformance tests fail at the first attempt.

Relating these figures to the product cost and time-to-market issues discussed earlier, we believe that a seat price of between $60,000 and $80,000 can be demanded. In the first year, we believe this translates into a European market valued at approximately $12 million.

DATAQUEST CONCLUSIONS

The EMC simulation market is ready to take off in Europe, triggered by EC legislation. Only the nonavailability of products is inhibiting this process. Tool technology is exceptionally difficult to develop but high rewards await those vendors ultimately offering workable solutions (both in Europe and elsewhere). The whole area of EMC is shrouded in mystery and is understood by a small number of experts using manual "rule of thumb" techniques. We believe that, spearheaded by a handful of innovative vendors, the mystery is soon to be solved, opening the field of EMC analysis to the mainstream electronic engineering community.

Jim Tully

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Research Newsletter

IBM AND INTEL ANNOUNCE THE SINGLE-CHIP PC

INTRODUCTION

The competition to supply microprocessors to PC manufacturers is becoming increasingly aggressive as more suppliers enter a market currently dominated by Intel. The majority of the PCs currently supplied are based on Intel's i386SX microprocessor, and until recently Intel was the sole supplier of the device to the merchant market. IBM also has the right to manufacture the device for internal consumption only. Intel's position in worldwide microprocessor market share rankings is shown in Table 1.

This exclusivity of supply has been challenged by Advanced Micro Devices (AMD), which is fighting a legal battle with Intel over its rights to manufacture and sell its own 386 microprocessor. Following on from this, other semiconductor manufacturers are now entering this market with their own designs for 386 microprocessors.

TABLE 1
1990 Worldwide Microprocessor Market Share Estimates

Rank	Company	Revenue ($M)
1	Intel	$1,382
2	Motorola	$291
3	Advanced Micro Devices	$89
4	Hitachi	$82
5	NEC	$80
6	National Semiconductor	$66
7	SGS-Thomson	$53
8	Toshiba	$48
9	Harris	$45
10	LSI Logic	$34

Source: Dataquest (November 1991)

As a result of the increased competition in both the microprocessor and personal computer markets, IBM and Intel have announced an agreement to develop a single-chip personal computer based on Intel's latest microprocessor. The agreement, valid for 10 years, also allows IBM to manufacture the Intel 486 microprocessor. This single-chip computer is expected to appear within two years and will boost both Intel's and IBM's presence in the personal computer market. This newsletter examines the announcement and gives Dataquest's view of the agreement's impact for both Intel and IBM.

INTEL

Intel is currently engaged in a series of legal battles with AMD over the right for the latter to manufacture and supply the 386 microprocessor. AMD has been supplying 386 microprocessors for a year, and Dataquest estimates the company to have received $110 million so far in revenue from the 386. Other suppliers are now entering this market, and these include Chips and Technologies, Cyrix, and Integrated Information Technology (IIT). The entry of these and other suppliers is increasing competition in the 386 market. So far the competition for 386 sockets has not been based on price, but on lower power consumption or higher performance.

Intel has continued its defense of the PC microprocessor market and has introduced higher-performance and higher-integration products. Included among these is a lower-specification version of its next-generation microprocessor, the i486SX and the i386SL, to compete with the 386 suppliers. The 486SX provides higher performance and a wider range of features than the 386SX microprocessor.

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THE PC MARKET

The tailing off of high growth in the PC market has caused significant pain for many PC manufacturers. New growth originally came from the introduction of laptop PCs, but this market is now declining sharply. However, the increase in the demand for portable products has added some stimulus to the PC market, as demand for notebook, hand-held, palmtop and pen-based PCs continues. These products require lower-power and higher-integration ICs. It is in this area that new suppliers of 386 microprocessors are entering the market.

The development of the PC chip set by Chips and Technologies did a great deal to reduce the cost and ease the design of the PC, but this was originally targeted at desk-based PCs. The introduction of portable products has given new growth to this market. However, there are many suppliers of chip sets, so margins on these products are thin. Chips and Technologies has seen what it considers to be its future, and has introduced a single-chip PC built around the 8086 processor core. This is more likely to be targeted at hand-held and palmtop computers, where performance is not an absolute requirement. Intel's single-chip PC will use the i486 processor as a core, positioning it away from the lower-performance hand-held and palmtop products. The computational requirements for pen-based PCs, however, are greater than for the smaller products, so these PCs would be better targets for Intel's product.

Dominance of the PC market by the Intel architecture is also under threat from the ACE consortium. This consortium is standardizing on two hardware platforms and two operating systems. The hardware platforms are built around either the Intel architecture or the MIPS R4000 architecture. Although Intel is a member of ACE, the introduction of a well-supported alternative can only cause Intel to lose some market share, especially as Intel's architecture was previously the only choice. This may well force prices down as Intel has to compete with an alternative supplier.

IBM

IBM's share of the PC market has been declining, partly due to other PC suppliers reducing costs, and hence prices. The introduction of chip sets by Chips and Technologies has reduced the number of chips required to manufacture a PC. Other suppliers have taken advantage of this, and entered the PC market with lower-cost products.

IBM developed the PC market with the introduction of its 8086-based PC in 1981. The performance of the personal computer was extended in 1984 with the introduction of the 80286-based PC-AT. Since then, IBM has lost market share as many other suppliers entered the market with lower-cost manufacture, and lower prices. IBM attempted to grow its share of the personal computer market again in 1987, with the introduction of its PS/2 range of computers. These machines differed from the original IBM PCs as they used a different internal architecture and operating system. The architecture and new advances in the operating system for this machine were not made as freely available as the original PC, making copying the machine more difficult for other suppliers. As a result, other manufacturers concentrated on the previous architecture, and IBM struggled to maintain a 20 percent value share of the personal computer market.

IBM recently announced an agreement with Apple Computer over the future development of computer products. This was seen as an attempt by IBM to distance itself from its existing partners, Intel and Micosoft. In fact, this was more in response to the ACE consortium, which presents a greater threat to IBM's PC and workstation market share. This new agreement shows IBM is still committed to Intel-based PCs.

DATAQUEST PERSPECTIVE

The PC market is becoming tougher as the growth enjoyed in recent years is not maintained. The development of portable computers is providing some stimulus, and is currently the highest-growth segment of the market. Pen-based computers are also likely to be in strong demand over the next few years. IBM is not yet entrenched in these markets, so the company needs to launch a stream of competitive products to be able to gain market share. This venture with Intel will give IBM the advantage of time, as other suppliers will have to wait before they can develop products based on single-chip computers. The agreement gives IBM four months after product introduction before other suppliers have access to the ICs. This time advantage will be crucial to profitability as product life-cycles decline dramatically for personal computer products. The computers will also be of the highest performance available, allowing IBM to demand a premium price.

Intel will also benefit from this agreement as it will be able to provide high-performance notebook and palmtop semiconductor products ahead of other suppliers. Intel has learnt a great deal from its management of the 386 market, and the efforts to move its customers and the PC user to 486-based products is also proving to be successful. Dell Computer, for example, will no longer supply 386-based PCs, as the 486-based PC provides higher performance for minimal increase in cost. Where Dell has moved, others will follow. As a result, the other 386 suppliers will find themselves fighting with an increased number of suppliers in a rapidly shrinking market. As the sole supplier of 486 microprocessors, Intel will be able to maintain its margins, and hence retain its profitability.

Intel's worldwide microcomponent revenue in 1990 was over twice that of its nearest competitor. In order to maintain this position Intel needs to continue in its new product development and maintain the two- to four-year lead it has over other microprocessor suppliers. The rate of introduction of new and advanced products has so far demonstrated Intel's commitment to maintaining this lead.

The only possible problem is likely to arise from the time taken to develop the products. Two years is a long time in the chip and computer industry. The ACE consortium will also be introducing products in this period, and IBM may lose the advantage it hopes to gain with this Intel development.

Mike Glennon

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Research Newsletter

INDUSTRY INVESTMENT LEVELS DROP

The unprecedented global expansion of the semiconductor industry over the last five years is on the wane. Between 1986 and 1991, capital spending on semiconductor plant and equipment grew from $5.1 billion to $14.4 billion. The incredible surge in capital spending is largely attributed to an exceptionally strong semiconductor investment boom in Japan fuelled by cheap money and double-digit growth in the global PC market.

The "go for broke" character of this boom has left excess capacity hanging over the market that will take time to work off. Consequently, we do not expect the current level of capital spending to be maintained. Dataquest forecasts that global capital spending will shrink by 3 percent and that wafer fab equipment sales will decline by 8 percent in 1992 (see Table 1). Growth of 14 percent in semiconductor production in 1992 might at first appear in contradiction to a declining wafer fab equipment market. However, with significant excess capacity to soak up, semiconductor manufacturers can easily grow their production revenue without spending additional capital.

We also believe that the end of the boom marks a major turning point for the global semiconductor industry. Worldwide five-year growth rates in capital spending and wafer fab equipment purchases will decelerate from historical double-digit growth to the single-digit regime.

THE OVERCAPACITY ISSUE

Since 1986, semiconductor companies have dramatically increased investment in new plants and equipment. Investment of $14.4 billion in 1991 is almost three times that of 1986. The lion's share of the spending went into submicron facilities, which by 1991 accounted for about a quarter of the total installed capacity as measured in millions of silicon square inches.

Dataquest does not believe that the 1991 level of capital spending is sustainable in 1992, given the semiconductor market dynamics of today. The capital spending binge has left several segments of the semiconductor industry with excess wafer fab capacity. With this hanging over the market, there is little opportunity to raise chip prices and the result will be downward pressure on company profits. Dataquest expects this squeeze to continue for several quarters. Poor profits in conjunction with a weak global economy will increasingly force

TABLE 1
Worldwide Forecast of Production, Capital Spending, and Wafer Fab Equipment (Millions of Dollars)

	1990	1991	1992	1993	1994	1995	CAGR (%) 1990-95	CAGR (%) 1985-90
Semiconductor Production	62,771	69,231	78,769	91,056	102,194	110,352	11.9%	18.3%
Percent Change	2%	10%	14%	16%	12%	8%		
Capital Spending	12,519	14,372	13,970	15,747	17,799	19,090	8.8%	11.4%
Percent Change	0%	15%	-3%	13%	13%	7%		
Wafer Fab Equipment	5,818	6,026	5,568	6,450	7,885	8,883	8.7%	11.7%
Percent Change	-3%	4%	-8%	16%	22%	12%		

Source: Dataquest (December 1991)

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many semiconductor companies to rethink their spending plans.

Several other signs indicate an overcapacity problem. The rate of fab closures is picking up. A number of companies recently announced the closure of several older lines typically running four-inch wafers. Also, increased foundry activity suggests that companies are scrambling to sell excess fab capacity to attain higher utilization rates.

DRAM DOLDRUMS

One sign of the capacity problem can be seen in the weak reception of the 4M DRAM. The slow ramp of the 4M is translating into low-capacity utilization for the fabs running this product. Dataquest anticipates wafer fab equipment spending in 1993 to be driven in part by demand for 0.5 μm equipment for the 16M production ramp. Although we believe that our forecast of 16 percent growth for 1993 is reasonable, there is a potential downside if 16M DRAM applications do not materialize as anticipated. Along with high-performance workstations, notebook and palmtop PCs are expected to be major consumers of 16M chips. However, for the high-volume notebook and palmtop PC markets to take off as forecast, the cost of component technologies such as flash memory and LCDs must come down. If the application markets for 16M DRAMs are weak, Dataquest's forecast for wafer fabrication equipment in 1993 would need to be moderated downward.

A TURNING POINT

The end of the Japanese-led boom signals a major turning point in the worldwide semiconductor industry. Perhaps the most significant structural change will be the lower rate of investment.

Investments of Japanese semiconductor companies overseas are expected to slow somewhat in the next few years. Dataquest expects some planned fabs in the United States and Europe to be delayed or put on hold. The migration of equipment and materials suppliers from Japan, which followed Japanese semiconductor companies overseas, is also expected to slow. As a result, Dataquest expects fewer acquisitions of, or investments in, local vendors by Japanese companies entering foreign markets. The irony is that US companies and entrepreneurs may be the biggest losers, given the importance Japanese capital has played in funding start-ups. Furthermore, Japanese semiconductor companies will increasingly move away from commodity products toward higher value-added products. As a result, chip design and manufacturing flexibility will grow in importance.

DATAQUEST PERSPECTIVE

Dataquest does not expect growth rates in semiconductor investment to return to the levels reached in the late 1980s until a major new product driver, such as HDTV, is commercialized or a new regional market such as China, India, Eastern Europe, or the Soviet Union is developed. These regions are characterized by fragile, infant market economics that will take years to develop the hard currency capital structure needed to fuel their domestic semiconductor industries.

However, we believe that there is a silver lining to this looming dark cloud of industry slowdown. Semiconductor pervasiveness and content in the entire spectrum of electronics markets such as data processing, communication, automotive, consumer, and military/aerospace continues its steady increase. Several emerging applications markets have the potential to kick the semiconductor industry back into high gear within the next several years. These applications include high-bandwidth/high-speed data communications, personal wireless communications networks, portable computer/communicator devices that incorporate pen-based input and fax/modem/voice communication, optical consumer multimedia systems based on CD-ROM, filmless electronic still photography, consumer video telephones, and electronic automotive controls. All these new product applications promise to extend the scope of the semiconductor industry well beyond the restricted office-automation PC market into the mass consumer market.

A new wave of manufacturing technologies that are time-to-market oriented, flexible and low-volume will diverge from traditional high-volume DRAM manufacturing within the next five years. Small and medium-size companies will explore different methods of flexible manufacturing seeking to overcome the tyranny of the billion-dollar megafab entry barrier. Players in the semiconductor industry attempting to parlay their core competencies into an exploding array of electronics applications will reap the rewards of a radically redefined market that is potentially quite large.

Peggy Wood
Jim Eastlake

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Research *Newsletter*

FIRST BUBBLES, NOW FLASH—SOLID STATE vs RIGID DISKS

INTRODUCTION

Over the past couple of years flash memory ICs have appeared which are nonvolatile, rewritable and substantially less costly than other solid-state memories such as battery-backed SRAM. Coinciding with flash's emergence was the formation of the Personal Computer Memory Card International Association (PCMCIA) and its joint release of a comprehensive solid-state memory card standard with the Japanese Electronics Industry Association (JEIDA).

Today the PC is the dominant source of demand for rigid disk drives and, not since the bubble memory fiasco of the mid-1970s have rigid disk manufacturers had so much cause to dust their crystal balls. In this newsletter we look at the critical strengths of each technology and assess how they will shape the future for PC mass storage.

Flash is an electrically rewriteable, nonvolatile form of semiconductor memory that is significantly cheaper than EEPROMs. Flash's distinction from EEPROM is that either a block or its entire contents must be erased before it can be electrically reprogammed. There are two classes of flash: the simpler and cheaper resembles a UV EPROM and is based on a single transistor per cell and needs split +5V and +12V supply rails; the other is more similar to an EEPROM and requires two transistors per cell, but can run off a single 5V supply. Currently, nearly 90 percent of the European flash market is in the split-rail version.

COST

Cost per performance is the most decisive issue in any comparison between rival technologies. Figure 1 shows costs per megabit for two rigid disk sizes: 15MB and 150MB. These are compared with the average raw (as opposed to packaged) memory card costs for flash ICs. We have to look much further out than our normal five-year horizon to find a crossover between the two. And so, for the purposes of this appraisal, we assume that the learning curves of both technologies for the latter half of the decade will resemble their respective curves today.

As the figure shows, today's cost improvements in rotating magnetic media are benefiting higher-capacity drives more than smaller ones. Small drives have a greater proportion of their total cost dedicated to slow price-declining overheads such as interface circuitry, electromechanics and casing. Consequently it is the small drives that will succumb first to the solid-state alternative, although on a raw cost-per-bit basis, even a 15MB rigid drive may not be undercut on price this century.

WRITEABILITY

There is a finite limit to how many times a flash memory cell can be written to before becoming unusable. This is the other major reason why flash EPROMs may not displace the *existing* rigid disk drive market for some while. Today that limit is around 10,000 to 100,000 times, and should increase in future products. By comparison, there is no practical limit to how frequently one may write to individual sectors in a rigid drive.

Although mass storage drives are buffered to reduce unnecessary writes it is impossible to guarantee that for any application a 10,000 or 100,000 write limit would not be exceeded. In fact, many applications do exist (such as real-time control systems) where frequent repetitive writes are made.

WHAT FUTURE RIGID?

Although rotating magnetic technology with large-capacity may have little to fear from solid state in the near future, optical drives may

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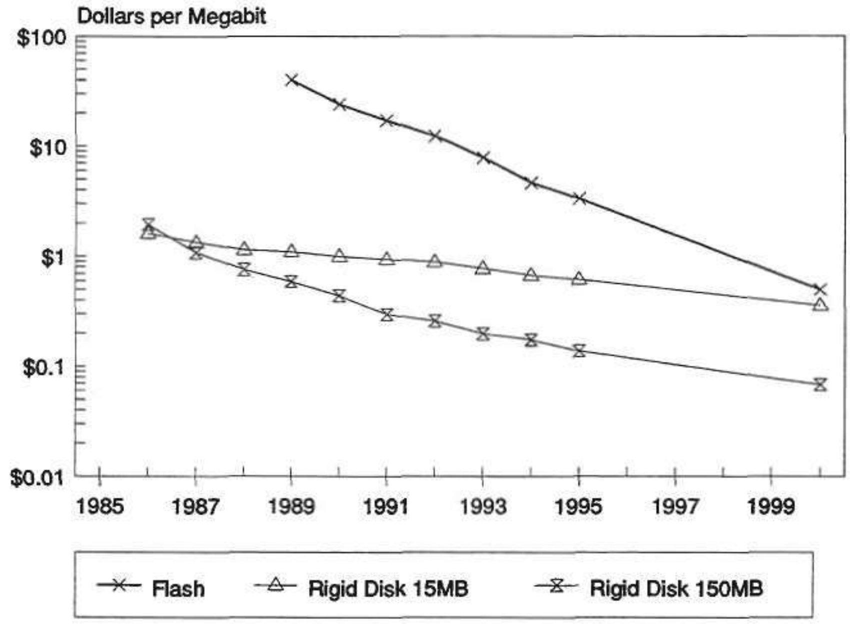
FIGURE 1

Solid State vs Rigid Disk Storage, Price Projections (Ex-Factory)



Source: Dataquest (December 1991)

represent a far greater hazard. Versions of 3.5 and 5.25 inches, from companies like IBM, Ricoh and Sony, are available today with capacities as high as 600MB. With access times today of around 35ms, magneto-optical is beginning to approach rigid disk speeds.

As for flash, writeability on magneto-optical drives is potentially a problem—although the limit for magneto-optical is much higher. Sony, for example, guarantees sectors on its disks for up to 1 million writes. However, with proper handling and storage away from ultraviolet light, writeability above this limit is not a problem.

Currently magneto-optical's cost (roughly $1 per megabit) is substantially higher than for conventional rigid disks, but this cost may fall rapidly as competition develops.

WHAT FUTURE FLASH?

Flash's differentiating features lie in its short access times and low power consumption. In these respects, flash leaves all rigid drives (magnetic or otherwise) and "flopticals" far behind. Many hand-held applications are emerging for which flash memories in small doses (more than 4MB) are the only solution. Examples are power-critical personal organizers or stylus-driven notepads that do not need the mass-storage capability of a normal PC. However, flash's need for dual +5V and +12V rails for large memory sizes breaks with the general trend in portable applications towards 3.3V and, consequently, they must provide DC-to-DC conversion if flash is to be accommodated.

Not all flash applications will be portable. One important application today is for desktop PC flash BIOS ROMs. It is often preferable to update a ROM electrically from a floppy disk than to unscrew a cover and replace it.

For removable memory sizes larger than a few megabytes flash will face strong competition from the new floptical disk manufacturers like Brier, Insite and Procom. Floptical drives use the same magnetic media as conventional floppy disks, but contain additional optically read track markers that allow their track densities to be increased. The first flopticals appearing on the market have capacites of around 20MB.

Flash will benefit, and enable the production of, many portable applications such as digital electronic cameras. And it is a rare camera, indeed, that has taken 10,000 pictures!

Jonathan Drazin

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Research Newsletter

FUJITSU OPENS NEW FAB

SUMMARY

On November 28, this year Fujitsu held a ceremony to officially open its new European fab at Newton Aycliffe, County Durham, England. Coincidentally, the fab had just gained internal qualification for its 4M DRAMs ahead of schedule. The facility is expected to start supplying customers in Europe early in 1992. In the past three years plans for a total of six new European submicron fabs have been announced, but this is only the second to be completed, the other being Texas Instruments' DRAM factory in Italy. This reflects the worldwide uncertainty that currently afflicts the semiconductor market and has led to semiconductor manufacturers changing product plans, and to industry-wide reduction in capital expenditure.

BACKGROUND

Fujitsu began a search for a European site in spring 1988. The company announced that it had chosen Newton Aycliffe the following spring. Construction began almost a year later and the building was handed over to Fujitsu in July 1991. The facility was then equipped and work began on qualifying it; qualification has now been obtained.

So far Fujitsu has made an outlay of a little over £100 million ($170 million). To assist it, a package of regional selective assistance worth £30 million ($50 million) from the UK government and the local council has been arranged by the Northern Development Company (NDC) and the County Durham Development Company (CDDC), £3 million of which has so far been released. This is to be balanced against the total planned investment in the site of £400 million ($680 million) promised by Fujitsu over the next five years. The site, which covers 43 hectares (106 acres), has enough land to be able to construct another three buildings of the same size as the new fab.

The key facts and figures of the facility are shown in Table 1.

PRODUCTION

The fab has been equipped to make 4M DRAMs on 6-inch wafers. As Table 1 shows, only about 80 percent of the fab is fitted out as a clean room, and the area that is clean room is about 70 percent equipped. If the current clean room area were fully equipped the factory could run 3,000 wafer starts per week. Calculations based on the fact that the facility is capable of processing 1,300 wafer starts per week would give maximum production of approximately 600,000 to 700,000 units of 4M DRAMs per month, depending on yields. Dataquest estimates that the market for 4M DRAMs in Europe in 1992 is 67 million units. The other 4M DRAM manufacturers in Europe are NEC, Siemens and Texas Instruments. Summing the total production of these four manufacturers we estimate that European fabs would be able to supply approximatly 30 percent of Europe's total demand for 4M DRAMs next year.

Thus it can be seen that Fujitsu's decision on when to complete equipping the rest of the clean room area, and for what product, depends very much on market conditions. Remembering that the new fab is part of the company's worldwide manufacturing capability, and that products made there will be supplied to markets outside Europe, including the United States, Fujitsu says that if the 4M DRAM market takes off strongly in 1992 it will expand 4M DRAM production. However, if 4M DRAM demand is weak, then the next phase of equipment installation will be for ASICs. The

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Table 1
Details of the Fujitsu Fab

Feature	Specification
Builder:	McAlpine
Clean Room Construction:	Several contractors, but pipe work was done by Crown House.
Equipment:	Nikon steppers, Canon projection/aligners, Avantest testers.
Silicon:	SEH from Japan, but Fujitsu wants to qualify SEH in Livingston, Scotland and MEMC in Italy.
Gases:	BOC
Size:	Clean room 4,190 m^2 (45,000 sq. ft.). However, the building is not fully fitted out, as there is an 800 m^2 (8,600 sq. ft.) expansion area.
Capacity:	With current equipment levels the fab is capable of running 1,300 wafer starts per week, of 0.8-µm gate width, and CMOS 4M DRAMs on 6-inch wafers. If the current clean room area was fully equipped the fab could process 3,000 wafers a week. Note that the fitted area is only 70 percent equipped.
Assembly/Test:	The factory has a small packaging facility that is assembling 4M DRAMs. When substantial volume has been achieved 4M DRAM output will be assembled and tested at the company's factory in Ireland. The Newton Aycliffe assembly and test area will then probably be used for ASICs.
Status:	The fab was qualified in November. It is now building inventory of 4M DRAMs. Shipments to customers have not begun yet.

Source: Fujitsu

facility has also been planned with 16M and 64M DRAMs in mind, so fitting out the spare 800 m^2 could be aimed at producing future DRAM generations on 8-inch wafers.

Dataquest Analysis

At least 12 semiconductor manufacturers were eagerly preparing plans for new fabs in Europe three years ago. Japanese semiconductor vendors, in particular, felt under pressure to establish a manufacturing presence within the European Community. The reasons included a perceived threat from a post-1992 "fortress Europe," and encouragement from Japanese customers who were themselves moving to Europe. These customers were placing great emphasis on increasing the amount of European-sourced components in their computers, printers, televisions, and so on. Since then, the worldwide semiconductor market has experienced two difficult years. The market for DRAMs, especially, has been weak, leading to cutbacks in capital expenditure across the semiconductor industry, even among the highly successful Japanese. Against this background only two companies have turned their European plans into finished factories—Texas Instruments and Fujitsu.

Fujitsu's fab is big, and world class; it is state-of-the-art. The company's investment is on a massive scale, particularly bearing in mind that only the first phase has been completed. The fab has also been completed in record time, even by Fujitsu standards. The commitment to Europe that Fujitsu has demonstrated in completing this facility will put the company in a strong position to service its European customers and increase its market share. Sadly, it is difficult to find an example of European company investment to compare.

Jim Eastlake