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Market Analysis

Preliminary 1992 European Semiconductor Market Share—Can Philips Maintain the Lead?

Dataquest has just completed its preliminary 1992 semiconductor market share survey, and the reuslts reveal some major changes in the ranking. The market grew by 11.1 percent following a strong final quarter. Intel has moved up three places with an astonishing 45 percent growth, to threaten the leadership held by Philips for more than 15 years. European companies have lost share of the market, growing by only 0.3 percent, while all other companies gained share. The article reviews the companies and products in the European semiconductor market in 1992, and analyses the factors behind the changes in the European market. In addition, European companies' performance in the worldwide semiconductor market is reviewed.

By Mike Glennon and Jim Eastlake *Page 1*

Market Analysis

Preliminary 1992 European Semiconductor Market Share—Can Philips Maintain the Lead?

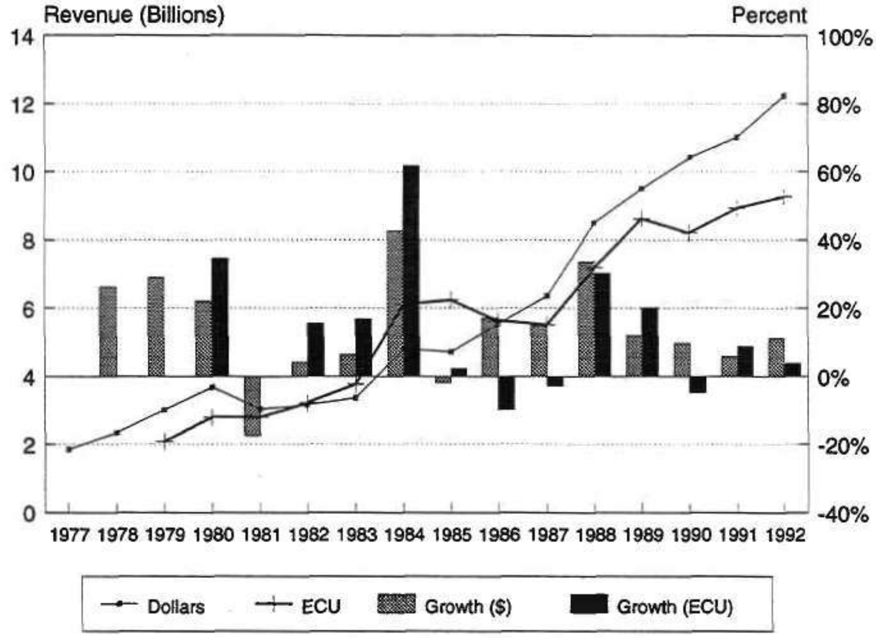
Summary

The European semiconductor market grew by 11.1 percent in 1992 when measured in US dollars. Much of the growth can be attributed to memory and microcomponents, and specifically their consumption in the PC. However, while this growth is healthy considering the condition of many of the end-user markets in Europe, the growth when measured in local currency (ECU) was not as bright. An 11.1 percent growth in dollars is translated into a 3.7 percent growth in ECU. Figure 1 shows the effect of exchange rates on semiconductor revenues for Europe over the period 1977 to 1992, and the variations of these rates over time has clearly shown swings in growth for local currencies, contrary to growth in US dollars.

There were several significant changes in the rankings in 1992, with Siemens and SGS-Thomson (ST) being displaced two places by a joint effort from Intel and Motorola, which rise to second and third places respectively. Table 1 (tables positioned at the end of the analysis for space reasons) shows the European total semiconductor market share ranking for 1992.

Intel's improvement clearly comes from the PC, and the general shift in emphasis from 386-based systems to 486-based machines. Motorola's improvement is across the board, from MOS memory, microcomponents, logic, analog, and discrete products. In this respect Motorola's improvement is more sustainable, whereas Intel's is tied almost exclusively to the PC.

Figure 1
European Total Semiconductor Market Revenue and Growth



Source: Dataquest (December 1992 Estimates)

Company Performance

Philips has retained the top position, but only just. A strong challenge from Intel has weakened Philips' leading position considerably, with only $16 million separating the two companies. Considering this is only 1.4 percent of Philip's revenue, this advantage is a weak one. Intel's 45 percent growth is remarkable, especially taking into account the size of the company. Among the top 20 suppliers, only AT&T has grown more, at 69 percent. However, Intel has added $344 million of revenue compared with only $49 million added by AT&T, an exceptional performance by Intel.

Philip's dependency on consumer markets at a time when these markets are especially weak resulted in its 1.7 percent decline. It is Philips' analog and discrete revenue that have let the company down. While its IC business has grown by 2.5 percent, as shown in Table 2, its discrete business declined by 2.6 percent. As this represents nearly 30 percent of its total business, this has weakened the company's position. The 6.1 percent decline in Philips' analog revenue lost the company its first place in the total IC rankings.

Intel's growth is mainly in microprocessor, obviously from the shift to the i486 from the i386 in PC applications. The higher price of the 486 has grown Intel's revenue greater than its processor unit shipments, and the exclusivity of supply for this processor should retain the higher selling price for at least the first half of 1993. Flash memory is another major growth opportunity for Intel, but the value of this market in 1992 was low, relatively speaking, and it had little effect on Intel's overall revenue during the year.

Motorola's growth was among the highest of the top 20 suppliers. The growth was across a range of products, and not restricted to a few star performers. In memory, Motorola grew both its DRAM and SRAM revenue significantly. The company's DRAM revenue grew a little below average, but the introduction of high-value fast SRAMs made a major contribution to its memory portfolio. In microcomponents, the success of Apple Computer's products and the growth of microcontrollers in automotive applications helped Motorola approach Intel's high growth in this product. In logic the company's ASIC business improved above average, following a focus on specific key accounts in high-growth applications.

Siemens' low growth in memory cost it two positions in the total semiconductor market share ranking. The company's memory revenue grew by only 2.7 percent in 1992, when the memory market grew by 24.1 percent. This is because of Siemens' main focus in 1M DRAMs, when the market moved to 4M as the preferred device.

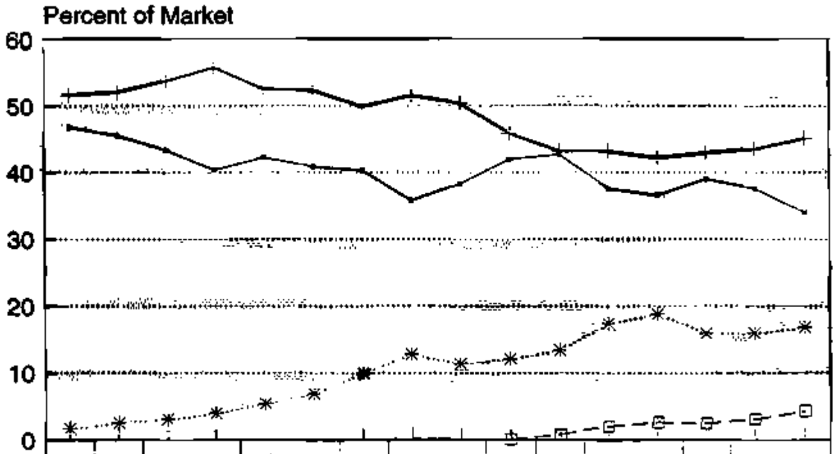
SGS-Thomson also lost two positions in the ranking. This is partly because ST chiefly supplies nonvolatile memory, which has grown less than the total memory market; but mainly because the company's microcomponent revenue has actually declined by 0.9 percent in Europe at a time when the market has grown by 30.6 percent. The strength of the automotive market has improved controller sales for ST; but this has been offset by the weakness of the consumer market in Europe. In addition, one of the company's major customers for microcontrollers in Europe has moved production outside the region, further reducing SGS-Thomson's European microcontroller sales. To compensate for this, controller sales for the company in the Rest of World (ROW) region have grown appreciably.

Vendor Base Share in Europe

The strong performance of Motorola and Intel has reasserted the North American dominance of the European market, following a period when it appeared that this dominance had a limited life. US companies grew above average in the market, gaining market share. In fact, North American, Japanese and Rest of World companies all grew above average, leaving only European companies to lose share. This can be seen in Figure 2, which shows the share of the European revenue attributable to the vendor base regions. The decline in revenue made by Philips and Siemens was only just compensated for by the growth of the other European companies, such as SGS-Thomson.

The reason for the loss of share by European companies is because of their relative weakness in PCs compared with Japanese and North American suppliers. The removal of Intel and AMD from the North American share reduces the influence of the PC-related growth, and reduces the North American suppliers' growth from 15.4 percent to 8.2 percent for non-PC-related revenue. Even this still includes Texas

Figure 2
European Total Semiconductor Market Share by Vendor Base Region



	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Tot. Market $M	1,853	2,339	3,018	3,686	3,041	3,167	3,370	4,805	4,720	5,532	6,355	8,491	9,498	10,415	11,014	12,238
Asia-Pac./ROW										0.1	0.8	1.9	2.5	2.3	3	4.2
Japanese	1.6	2.4	3	3.9	5.3	6.8	9.9	12.7	11.3	12	13.3	17.3	18.7	15.8	15.9	16.7
North American	51.6	52	53.7	55.7	52.5	52.3	49.9	51.5	50.4	45.9	43.2	43.2	42.2	42.9	43.5	45.1
European	46.8	45.5	43.3	40.4	42.2	40.9	40.3	35.8	38.3	42	42.7	37.6	36.6	39	37.6	34

European — North American — Japanese — Asia-Pac./ROW

Source: Dataquest (December 1992 Estimates)

Instruments' (TI) memory growth of 18 percent, and further confirms the significant effect of the PC on vendors' semiconductor sales.

Most Japanese suppliers have memory products, and were able to grow this revenue well because of the increasing memory needs of the PC; the strong demand for memory is related to the increasing memory demands of Windows from Microsoft. Much of this has been shipped as upgrade modules, as existing PC owners increase their memory, though base memory configurations increased as well, since many high-end PCs are now shipped with Windows already installed.

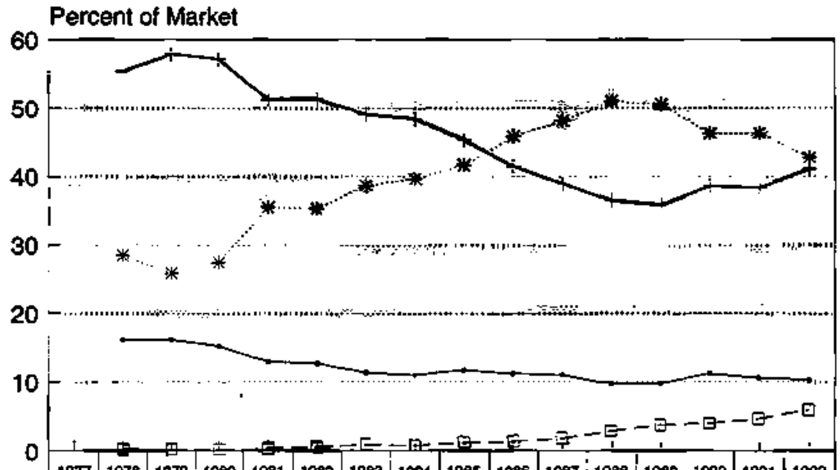
The high growth of ROW suppliers is also due to their strong presence in the memory market. Memory represents over 90 percent of Rest of World companies' revenue. This growth has been found by the European Commission to have been achieved by dumping, though, and the Commission imposed antidumping duties on Korean suppliers during 1992 as a result of its findings.

European Companies' Worldwide Performance

European companies lost share of the worldwide market in 1992, mainly as a result of their focus on low-growth product sectors such as analog and discrete products. Figure 3 shows the share of the worldwide market taken by European companies, and Table 3 shows European companies' position in the worldwide semiconductor market share ranking. Four additional European companies have been identified this year: EM Microelectronics–Marin, a consumer IC manufacturer based in Switzerland; Westcode, a specialist power discretes manufacturer based in the United Kingdom; Dialog Semiconductor, part of the TEMIC group and specializing in mixed signal ASICs, based in the United Kingdom; and Micronas, a manufacturer of ASICs and specialist standard products, based in Finland.

The products which exhibited the highest growth on a worldwide basis were microcomponents and memory. These two product categories were the only ones to grow above average, and together they represent 45 percent of the total semiconductor market worldwide.

Figure 3
Worldwide Total Semiconductor Market Share by Vendor Base Region



	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Tot. Market $M	6,935	8,953	11,114	14,118	14,828	15,288	19,736	28,766	24,266	30,776	38,250	50,859	54,339	54,545	59,694	65,573
Asia-Pac./ROW		0.2	0.2	0.2	0.3	0.6	0.9	0.8	1.2	1.4	1.8	2.8	3.7	3.9	4.6	5.9
Japanese		28.4	25.8	27.4	35.5	35.3	38.7	39.7	41.7	45.9	48.2	51	50.6	46.3	46.4	42.8
North American		55.4	57.9	57.2	51.3	51.4	49.1	48.5	45.4	41.5	39	36.5	35.9	38.6	38.4	41,1
European		16.1	16.1	15.2	12.9	12.7	11.3	11	11.7	11.2	11	9.7	9.8	11.2	10.6	10.2

Source: Dataquest (December 1992 Estimates)

European companies have a poor representation worldwide in the microcomponents market, collectively accounting for only 4.5 percent of worldwide microcomponent sales. Even then, European companies lost share of the market, growing below average. A large proportion of this market is for microprocessors, where Europe has no major presence. The European companies are stronger in microcontrollers, but a large part of this is in consumer markets, which are weak in Europe.

In the memory market the picture is similar, where European companies' share of worldwide memory sales was only 4.6 percent. The largest market for memory is DRAMs, and only one European company, Siemens, had any real DRAM presence in 1992. The company was late to enter the market with a 4M DRAM, though, and so paid the price in market share. SRAM products have shown reasonable growth, and there are at least some Europe-based suppliers, although their products presence is still not significant when compared with Japanese and North American companies. The part of the market where European suppliers have a noticeable share is in nonvolatile products, with SGS-Thomson taking a large share of the market. However, the nonvolatile market, and EPROM products in particular, has not shown the same level of growth as DRAM or SRAM.

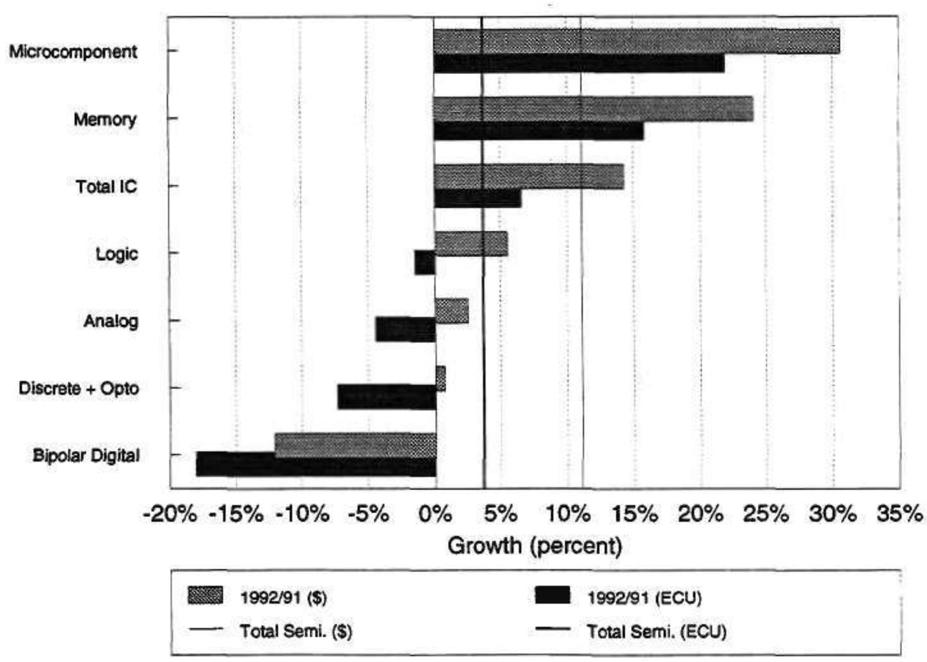
The logic market paints a better picture for European companies, where they accounted for 9.4 percent of the worldwide market in 1992, but this market grew below average. European companies have an even larger share of the worldwide analog market, but this also grew below average, and European companies again gained share of this market.

European companies have therefore concentrated much of their revenue in low-growth markets. With over 60 percent of European companies' revenue concentrated into only 34 percent of the worldwide market, which only grew by 2.9 percent, it is no surprise that European companies lost share of the worldwide semiconductor market in 1992.

European Market Product Performance

The growth of the various product categories is shown in Figure 4, with Table 4 giving the revenue details for the various products.

Figure 4
European Semiconductor Market 1992 Product Growth



Source: Dataquest (December 1992 Estimates)

The product with the lowest growth was bipolar digital. This market declined by 12.1 percent in 1992, and this reflects the replacement of bipolar technology by CMOS in many applications. The performance advantage offered by bipolar is gradually being eroded by MOS, which offers additional benefits of low power and high integration. There will always be niche applications for the highest performance, and these applications included some PC applications in 1992.

The majority of this market in 1992 went to North American suppliers, with Texas Instruments retaining its leading position, despite growth well below average growth for this market. Philips was one of only four suppliers to grow its bipolar revenue, despite the company pulling out of many of the bipolar standard logic markets in 1992. Table 5 shows the European bipolar market share rankings for 1992.

The product category with the highest growth was microcomponent, and microprocessor in particular. The moderate growth seen in PC manufacture in Europe, coupled with an increase in average prices for the processor as users switch to the higher-priced 486, have contributed to the high growth in this market. Since Intel is the dominant supplier in this market, it has seen the greatest increase in revenue, as can be seen in Tables 6 and 8. However, AMD has also benefited, as the company has attracted the majority of the remaining 386 users who are not supported by Intel. In addition, AMD has seen considerable success with its 29000 family, which has added to the company's high growth in microcomponents.

Motorola enjoyed high growth in microcomponent revenue as well, principally in microcontrollers, as its embedded controller family has seen considerable success in a variety of applications, particulary automotive and digital signal processing.

The memory market also showed high growth, as Windows usage increased PC memory requirements. The main beneficiaries from this growth are Japanese and Korean suppliers, since these companies provide the high-growth product: 4M DRAM. Siemens' late and slow introduction of a 4M product reduced the potential growth for the company, and strong competition in the 1M sector from Korean suppliers added to the company's difficulty in this market. Table 7 shows the market share ranking for the memory market in Europe in 1992.

Next in order of growth is MOS logic, with a growth of 5.5 percent. This is below average for the market, and is a clearer reflection of the condition of the non-PC-related market. Allowing for the exchange rate influence on the market, this represents a 1.5 percent decline in ECU. The demand for this market is related to Europe's traditional areas of strength—telecoms and consumer applications. PC demand has also influenced the market, adding growth in areas such as ASIC and high-speed standard logic. Telecoms applications have added stability, as growth has been moderate. The consumer sector was not a major user of logic components in 1992, as this market was weak and contributed little to the overall growth.

Table 9 shows the market share ranking for the European MOS logic market in 1992. Philips' performance in this market was good, growing at nearly twice the average, but this was bettered by both Motorola and Texas Instruments. Motorola's 40 percent growth was achieved through a strong performance in all the MOS logic categories of ASIC, standard logic and other logic, whereas TI's growth was in ASIC and standard logic only. Philips' growth was mainly from the MOS other logic category, as its standard products achieve success in a broad range of applications.

Analog has shown only token growth, as a large part of this market is related to consumer products. Some telecoms demand has kept growth above zero, and automotive applications have added to the market, but in general the analog market in Europe is weak. Table 10 shows the market share ranking for the European analog market in 1992.

Those companies which supply to the analog market have suffered from the weak market. This is mainly European companies, which represent over half the market. North American companies supply most of the rest, leaving only 5.7 percent to Japanese and Rest of World companies. However, analog represents 30 percent of European companies' revenue, whereas for North American companies analog represents only 18 percent. This means the effect of the weak market has a larger influence on European companies, and this is reflected in their relatively poor growths in total semiconductor.

A similar position occurs in discrete and optoelectronic products. Here European companies have an even larger share, and the market actually declined. Adding together analog, discrete and optoelectronic revenue shows 62 percent of European companies' revenue is in this combined market, which only grew by 0.9 percent in 1992, whereas only 31 percent of North American companies revenue is in this low-growth market. Tables 11 and 12 show the market share rankings for the European discrete and optoelectronic markets respectively.

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Despite the appearance of a return to growth in the European semiconductor market, the reality of the situation is that much of the increase in revenue is due to a favorable exchange rate. In addition to this, the apparent growth is largely attributable to the demands of the PC. This is a dangerous position to be in. PC unit shipments in Europe remained almost flat in 1992—although PC production has grown—and the rise in semiconductor demand was because of the upgrading of these products. When this upgrading is complete, the semiconductor demand should return to normal. In addition, prices have been held up on the semiconductors sold due to a combination of a monopoly supply and a shortage of capacity.

The monopoly supply of processors enjoyed by Intel is likely to come to an end in 1993 for 486 products, and Intel is unlikely to be able to move the majority of the market to the next generation in just one year. Therefore the high growth in microprocessors will probably not be repeated to the same extent in 1993. To compensate for this, the antidumping measures of the European Commission have reduced considerably the pressure on memory prices, and as the natural increase in bit consumption offsets any overcapacity, average prices for the parts should decline more slowly than bit consumption rises. There is a risk of shortages, which will increase unit prices, but the increases in production capacity announced by Japanese suppliers should counter this risk.

Semiconductor demand is fundamentally weak at the moment, as can seen from poor consumer equipment sales, and the knock-on effect on semiconductor sales is seen in the analog and discrete markets. There is unlikely to be a dramatic recovery in the market next year for consumer equipment, so the future of semiconductor demand hangs again on the PC, and a tightly controlled supply of memory components keeping average selling prices high.

On a worldwide basis, the concentration of European companies into low-growth markets can only accelerate the loss of share these companies have of the worldwide market. While Europeans are still a long way from taking the smallest share of the worldwide market, the high growth enjoyed by ROW manufacturers make that event more likely. Unless Europeans can invest in high-growth products, they are in grave danger of being relegated to the "also-rans" of the worldwide semiconductor market.

By Mike Glennon
Jim Eastlake

Table 1
Preliminary 1992 European Total Semiconductor Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Philips	1,144	1,125	-1.7	1,125	9.2	9.2
5	2	3	Intel	765	1,109	45.0	2,234	9.1	18.3
4	3	1	Motorola	776	976	25.8	3,210	8.0	26.2
2	4	-2	Siemens	970	908	-6.4	4,118	7.4	33.6
3	5	-2	SGS-Thomson Microelectronics	855	895	4.7	5,013	7.3	41.0
6	6	0	Texas Instruments	632	705	11.6	5,718	5.8	46.7
8	7	1	NEC	405	481	18.8	6,199	3.9	50.7
7	8	-1	Toshiba	441	476	7.9	6,675	3.9	54.5
9	9	0	National	400	415	3.8	7,090	3.4	57.9
10	10	0	AMD	294	346	17.7	7,436	2.8	60.8
11	11	0	Hitachi	276	333	20.7	7,769	2.7	63.5
12	12	0	Samsung	242	331	36.8	8,100	2.7	66.2
15	13	2	GEC Plessey Semiconductors	215	227	5.6	8,327	1.9	68.0
16	14	2	Fujitsu	148	192	29.7	8,519	1.6	69.6
17	15	2	Mitsubishi	143	186	30.1	8,705	1.5	71.1
14	16	-2	Telefunken	222	176	-20.7	8,881	1.4	72.6
18	17	1	Harris	141	143	1.4	9,024	1.2	73.7
19	18	1	Analog Devices	136	142	4.4	9,166	1.2	74.9
13	19	-6	ITT	240	140	-41.7	9,306	1.1	76.0
28	20	8	AT&T	71	120	69.0	9,426	1.0	77.0
21	21	0	LSI Logic	100	115	15.0	9,541	0.9	78.0
20	22	-2	Mietec	102	110	7.8	9,651	0.9	78.9
24	23	1	Oki	90	105	16.7	9,756	0.9	79.7
22	24	-2	Matra-MHS	93	102	9.7	9,858	0.8	80.6
25	25	0	VLSI Technology	89	95	6.7	9,953	0.8	81.3
23	26	-3	Hewlett-Packard	90	91	1.1	10,044	0.7	82.1
46	27	19	Goldstar	33	86	160.6	10,130	0.7	82.8
26	28	-2	International Rectifier	76	82	7.9	10,212	0.7	83.4
52	29	23	Hyundai	25	73	192.0	10,285	0.6	84.0
27	30	-3	Eupec	73	68	-6.8	10,353	0.6	84.6
30	31	-1	Austria Mikro Systeme	62	64	3.2	10,417	0.5	85.1
29	32	-3	Semikron	67	63	-6.0	10,480	0.5	85.6
31	33	-2	Sony	61	62	1.6	10,542	0.5	86.1
33	34	-1	General Instrument	55	59	7.3	10,601	0.5	86.6
38	35	3	Micron Technology	45	58	28.9	10,659	0.5	87.1
32	36	-4	Ericsson	55	54	-1.8	10,713	0.4	87.5
34	37	-3	Cypress	49	51	4.1	10,764	0.4	88.0
35	38	-3	Matsushita	49	48	-2.0	10,812	0.4	88.3
36	39	-3	ABB-IXYS	47	43	-8.5	10,855	0.4	88.7
45	40	5	IDT	34	43	26.5	10,898	0.4	89.1

(Continued)

Table 1 (Continued)
Preliminary 1992 European Total Semiconductor Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
41	41	0	Sharp	39	43	10.3	10,941	0.4	89.4
37	42	-5	TCS	46	43	-6.5	10,984	0.4	89.8
-	43	NA	EM Microelectronics-Marin	0	40	NA	11,024	0.3	90.1
40	44	-4	Siliconix	41	40	-2.4	11,064	0.3	90.4
39	45	-6	Burr-Brown	43	36	-16.3	11,100	0.3	90.7
49	46	3	Rohm	30	36	20.0	11,136	0.3	91.0
43	47	-4	Powerex	37	35	-5.4	11,171	0.3	91.3
-	48	NA	Westcode	0	35	NA	11,206	0.3	91.6
42	49	-7	Western Digital	38	34	-10.5	11,240	0.3	91.8
47	50	-3	ABB-HAFO	32	33	3.1	11,273	0.3	92.1
44	51	-7	Rockwell	36	29	-19.4	11,302	0.2	92.4
48	52	-4	Sanyo	31	29	-6.5	11,331	0.2	92.6
51	53	-2	European Silicon Structures	27	26	-3.7	11,357	0.2	92.8
56	54	2	Zilog	21	25	19.0	11,382	0.2	93.0
54	55	-1	Honeywell	21	23	9.5	11,405	0.2	93.2
50	56	-6	Allegro Microsystems	28	22	-21.4	11,427	0.2	93.4
57	57	0	Fagor Electrotécnica	20	18	-10.0	11,445	0.1	93.5
58	58	0	Mitel	18	18	0.0	11,463	0.1	93.7
55	59	-4	TAG	21	18	-14.3	11,481	0.1	93.8
-	60	NA	Dialog Semiconductor	0	17	NA	11,498	0.1	94.0
60	61	-1	Eurosil	15	16	6.7	11,514	0.1	94.1
53	62	-9	Unitrode	24	15	-37.5	11,529	0.1	94.2
61	63	-2	Zetex	14	14	0.0	11,543	0.1	94.3
63	64	-1	Seiko Epson	9	11	22.2	11,554	0.1	94.4
-	65	NA	Micronas	0	10	NA	11,564	0.1	94.5
62	66	-4	Raytheon	10	9	-10.0	11,573	0.1	94.6
64	67	-3	NMB	5	3	-40.0	11,576	0.0	94.6
59	-	NA	STC	18	0	-100.0	11,576	0.0	94.6
			Other European Companies	48	55	14.6	11,631	0.4	95.0
			Other North American Companies	470	542	15.3	12,173	4.4	99.5
			Other Japanese Companies	29	34	17.2	12,207	0.3	99.7
			Other ROW Companies	32	31	-3.1	12,238	0.3	100.0
			Total All Companies	11,014	12,238	11.1	100.0		
			Total European Companies	4,146	4,160	0.3	34.0		
			Total North American Companies	4,780	5,518	15.4	45.1		
			Total Japanese Companies	1,756	2,039	16.1	16.7		
			Total ROW Companies	332	521	56.9	4.3		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 2
Preliminary 1992 European Integrated Circuit Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
2	1	1	Intel	765	1,109	45.0%	1,109	11.2%	11.2%
1	2	-1	Philips	775	794	2.5%	1,903	8.0%	19.1%
6	3	3	Motorola	577	768	33.1%	2,671	7.7%	26.9%
3	4	-1	SGS-Thomson Microelectronics	666	694	4.2%	3,365	7.0%	33.8%
5	5	0	Texas Instruments	601	677	12.6%	4,042	6.8%	40.7%
4	6	-2	Siemens	634	615	-3.0%	4,657	6.2%	46.8%
8	7	1	NEC	375	450	20.0%	5,107	4.5%	51.4%
7	8	-1	National	394	408	3.6%	5,515	4.1%	55.5%
9	9	0	Toshiba	353	378	7.1%	5,893	3.8%	59.3%
10	10	0	AMD	294	346	17.7%	6,239	3.5%	62.8%
12	11	1	Samsung	236	326	38.1%	6,565	3.3%	66.0%
11	12	-1	Hitachi	263	315	19.8%	6,880	3.2%	69.2%
13	13	0	GEC Plessey Semiconductors	187	197	5.3%	7,077	2.0%	71.2%
16	14	2	Fujitsu	119	160	34.5%	7,237	1.6%	72.8%
17	15	2	Mitsubishi	119	160	34.5%	7,397	1.6%	74.4%
15	16	-1	Analog Devices	136	142	4.4%	7,539	1.4%	75.8%
20	17	3	LSI Logic	100	115	15.0%	7,654	1.2%	77.0%
19	18	1	Mietec	102	110	7.8%	7,764	1.1%	78.1%
18	19	-1	Harris	111	104	-6.3%	7,868	1.0%	79.1%
23	20	3	Oki	89	104	16.9%	7,972	1.0%	80.2%
22	21	1	Matra-MHS	93	102	9.7%	8,074	1.0%	81.2%
24	22	2	VLSI Technology	89	95	6.7%	8,169	1.0%	82.2%
28	23	5	AT&T	54	90	66.7%	8,259	0.9%	83.1%
14	24	-10	ITT	180	90	-50.0%	8,349	0.9%	84.0%
35	25	10	Goldstar	33	86	160.6%	8,435	0.9%	84.9%
21	26	-5	Telefunken Electronic	95	75	-21.1%	8,510	0.8%	85.6%
41	27	14	Hyundai	25	73	192.0%	8,583	0.7%	86.3%
25	28	-3	Austria Mikro Systeme	62	64	3.2%	8,647	0.6%	87.0%
26	29	-3	Sony	60	61	1.7%	8,708	0.6%	87.6%
30	30	0	Micron Technology	45	58	28.9%	8,766	0.6%	88.2%
27	31	-4	Ericsson	55	54	-1.8%	8,820	0.5%	88.7%
29	32	-3	Cypress	49	51	4.1%	8,871	0.5%	89.2%
34	33	1	IDT	34	43	26.5%	8,914	0.4%	89.7%
-	34	NA	EM Microelectronics–Marin	0	40	NA	8,954	0.4%	90.1%
31	35	-4	Burr-Brown	43	36	-16.3%	8,990	0.4%	90.4%
36	36	0	Matsushita	31	34	9.7%	9,024	0.3%	90.8%
32	37	-5	Western Digital	38	34	-10.5%	9,058	0.3%	91.1%
33	38	-5	Rockwell	36	29	-19.4%	9,087	0.3%	91.4%
39	39	0	Sharp	26	28	7.7%	9,115	0.3%	91.7%

(Continued)

Table 2 (Continued)
Preliminary 1992 European Integrated Circuit Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
38	40	-2	European Silicon Structures	27	26	-3.7%	9,141	0.3%	92.0%
37	41	-4	TCS	30	25	-16.7%	9,166	0.3%	92.2%
44	42	2	Zilog	21	25	19.0%	9,191	0.3%	92.5%
42	43	-1	Sanyo	25	23	-8.0%	9,214	0.2%	92.7%
43	44	-1	ABB-HAFO	21	22	4.8%	9,236	0.2%	92.9%
45	45	0	Hewlett-Packard	19	22	15.8%	9,258	0.2%	93.1%
40	46	-6	Allegro Microsystems	25	19	-24.0%	9,277	0.2%	93.3%
46	47	-1	Mitel	18	18	0.0%	9,295	0.2%	93.5%
50	48	2	Rohm	15	18	20.0%	9,313	0.2%	93.7%
47	49	-2	Siliconix	18	18	0.0%	9,331	0.2%	93.9%
-	50	NA	Dialog Semiconductor	0	17	NA	9,348	0.2%	94.0%
49	51	-2	Eurosil	15	16	6.7%	9,364	0.2%	94.2%
51	52	-1	Unitrode	14	12	-14.3%	9,376	0.1%	94.3%
53	53	0	Seiko Epson	9	11	22.2%	9,387	0.1%	94.4%
-	54	NA	Micronas	0	10	NA	9,397	0.1%	94.5%
52	55	-3	Raytheon	10	8	-20.0%	9,405	0.1%	94.6%
54	56	-2	NMB	5	3	-40.0%	9,408	0.0%	94.6%
55	57	-2	Honeywell	1	1	0.0%	9,409	0.0%	94.6%
48	-	NA	STC	16	0	-100.0%	9,409	0.0%	94.6%
			Other European Companies	11	12	9.1%	9,421	0.1%	94.8%
			Other North American	429	490	14.2%	9,911	4.9%	99.7%
			Other Japanese	6	8	33.3%	9,919	0.1%	99.8%
			Other ROW	22	22	0.0%	9,941	0.2%	100.0%
			Total All Companies	8,701	9,941	14.3%	100.0%		
			Total European Companies	2,789	2,873	3.0%	28.9%		
			Total North American Companies	4,101	4,808	17.2%	48.4%		
			Total Japanese Companies	1,495	1,753	17.3%	17.6%		
			Total ROW Companies	316	507	60.4%	5.1%		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 3
Preliminary 1992 Worldwide Total Semiconductor Rankings of European-Owned Semiconductor Suppliers (Millions of US Dollars)

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Growth (%)
10	9	1	Philips	2,022	2,109	4
13	13	0	SGS-Thomson Microelectronics	1,436	1,605	12
16	17	-1	Siemens	1,263	1,220	-3
29	31	-2	GEC Plessey Semiconductors	392	427	9
33	33	0	Telefunken Electronic	300	277	-8
61	59	2	Matra-MHS	104	122	17
60	63	3	Mietec	105	113	8
56	64	-8	Semikron	108	103	-5
65	78	-13	Eupec	93	83	-11
77	85	-12	Ericsson	74	75	1
81	86	-5	Austria Mikro Systeme	70	74	6
87	93	-6	ABB-IXYS	54	49	-9
141	95	46	TCS	0	48	NA
-	102	NA	EM Microelectronics-Marin	0	45	NA
97	106	-9	ABB-HAFO	38	41	8
-	113	NA	Westcode	0	35	NA
107	115	-8	TAG	30	31	3
111	117	-6	Eurosil	29	30	3
114	118	-4	European Silicon Structures	28	30	7
117	123	-6	Zetex	26	27	4
110	129	-19	Fagor Electrotécnica	29	25	-14
-	140	NA	Dialog Semiconductor	0	17	NA
-	153	NA	Micronas	0	10	NA

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 4
European Semiconductor Market 1992 Product Growth

Product Sector	1991 Sales ($M)	1992 Sales ($M)	Growth (%) 1992/1991
Total Semiconductor	**11,014**	**12,238**	**11.1**
Total Integrated Circuit	8,701	9,941	14.3
Bipolar Digital	486	427	-12.1
MOS Digital	5,853	7,094	21.2
MOS Memory	2,129	2,642	24.1
MOS Microcomponent	2,082	2,719	30.6
MOS Logic	1,642	1,733	5.5
Analog	2,362	2,420	2.5
Discrete	1,828	1,836	0.4
Optoelectronic	485	461	-4.9

Source: Dataquest (December 1992 Estimates)

Table 5
Preliminary 1992 European Bipolar Digital IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Texas Instruments	131	99	-24.4	99	23.2	23.2
2	2	0	AMD	75	64	-14.7	163	15.0	38.2
4	3	1	Philips	54	56	3.7	219	13.1	51.3
3	4	-1	National	59	52	-11.9	271	12.2	63.5
5	5	0	Motorola	41	41	0.0	312	9.6	73.1
6	6	0	Siemens	38	37	-2.6	349	8.7	81.7
7	7	0	NEC	24	26	8.3	375	6.1	87.8
8	8	0	GEC Plessey Semiconductors	21	17	-19.0	392	4.0	91.8
9	9	0	Fujitsu	8	9	12.5	401	2.1	93.9
12	10	2	Hitachi	4	4	0.0	405	0.9	94.8
14	11	3	Raytheon	2	4	100.0	409	0.9	95.8
-	12	NA	AT&T	0	2	NA	411	0.5	96.3
-	13	NA	SGS-Thomson Microelectronics	0	2	NA	413	0.5	96.7
13	14	-1	Toshiba	4	2	-50.0	415	0.5	97.2
16	15	1	Matsushita	1	1	0.0	416	0.2	97.4
17	16	1	Mitsubishi	1	1	0.0	417	0.2	97.7
15	-	NA	IDT	1	0	-100.0	417	0.0	97.7
10	-	NA	STC	7	0	-100.0	417	0.0	97.7
11	-	NA	Telefunken	7	0	-100.0	417	0.0	97.7
			Other European Companies	4	4	0.0	421	0.9	98.6
			Other North American Companies	4	6	50.0	427	1.4	100.0
			Total All Companies	486	427	-12.1	100.0		
			Total European Companies	131	116	-11.5	27.2		
			Total North American Companies	313	268	-14.4	62.8		
			Total Japanese Companies	42	43	2.4	10.1		
			Total ROW Companies	0	0	NA	0.0		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 6
Preliminary 1992 European MOS Digital IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Intel	765	1,109	45.0	1,109	15.6	15.6
3	2	1	Motorola	431	594	37.8	1,703	8.4	24.0
4	3	1	Texas Instruments	366	460	25.7	2,163	6.5	30.5
2	4	-2	Siemens	444	443	-0.2	2,606	6.2	36.7
5	5	0	NEC	346	416	20.2	3,022	5.9	42.6
8	6	2	Philips	312	354	13.5	3,376	5.0	47.6
6	7	-1	Toshiba	321	351	9.3	3,727	4.9	52.5
7	8	-1	SGS-Thomson Microelectronics	313	332	6.1	4,059	4.7	57.2
10	9	1	Samsung	232	324	39.7	4,383	4.6	61.8
9	10	-1	Hitachi	253	305	20.6	4,688	4.3	66.1
11	11	0	AMD	190	247	30.0	4,935	3.5	69.6
13	12	1	National	150	154	2.7	5,089	2.2	71.7
14	13	1	Mitsubishi	110	151	37.3	5,240	2.1	73.9
16	14	2	Fujitsu	104	143	37.5	5,383	2.0	75.9
17	15	2	LSI Logic	100	115	15.0	5,498	1.6	77.5
15	16	-1	GEC Plessey Semiconductors	105	104	-1.0	5,602	1.5	79.0
18	17	1	Oki	89	104	16.9	5,706	1.5	80.4
20	18	2	Matra-MHS	88	94	6.8	5,800	1.3	81.8
19	19	0	VLSI Technology	89	93	4.5	5,893	1.3	83.1
27	20	7	Goldstar	33	86	160.6	5,979	1.2	84.3
22	21	1	AT&T	50	81	62.0	6,060	1.1	85.4
12	22	-10	ITT	152	80	-47.4	6,140	1.1	86.6
31	23	8	Hyundai	25	73	192.0	6,213	1.0	87.6
24	24	0	Micron Technology	45	58	28.9	6,271	0.8	88.4
23	25	-2	Cypress	49	51	4.1	6,322	0.7	89.1
28	26	2	IDT	33	43	30.3	6,365	0.6	89.7
21	27	-6	Harris	56	41	-26.8	6,406	0.6	90.3
25	28	-3	Western Digital	38	34	-10.5	6,440	0.5	90.8
33	29	4	Sony	23	29	26.1	6,469	0.4	91.2
30	30	0	Sharp	26	28	7.7	6,497	0.4	91.6
32	31	1	Matsushita	25	27	8.0	6,524	0.4	92.0
29	32	-3	European Silicon Structures	27	26	-3.7	6,550	0.4	92.3
26	33	-7	Austria Mikro Systeme	33	25	-24.2	6,575	0.4	92.7
36	34	2	Zilog	21	25	19.0	6,600	0.4	93.0
34	35	-1	ABB-HAFO	21	22	4.8	6,622	0.3	93.3
37	36	1	Hewlett-Packard	19	22	15.8	6,644	0.3	93.7
35	37	-2	Mietec	21	21	0.0	6,665	0.3	94.0
38	38	0	TCS	19	17	-10.5	6,682	0.2	94.2
44	39	5	Analog Devices	7	16	128.6	6,698	0.2	94.4

(Continued)

Table 6 (Continued)
Preliminary 1992 European MOS Digital IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
39	40	-1	Ericsson	16	15	-6.3	6,713	0.2	94.6
40	41	-1	Sanyo	11	11	0.0	6,724	0.2	94.8
43	42	1	Seiko Epson	9	11	22.2	6,735	0.2	94.9
42	43	-1	Eurosil	9	10	11.1	6,745	0.1	95.1
-	44	NA	Micronas	0	10	NA	6,755	0.1	95.2
46	45	1	Rohm	5	7	40.0	6,762	0.1	95.3
-	46	NA	Dialog Semiconductor	0	5	NA	6,767	0.1	95.4
45	47	-2	NMB	5	3	-40.0	6,770	0.0	95.4
47	48	-1	Rockwell	4	3	-25.0	6,773	0.0	95.5
41	49	-8	Telefunken	10	3	-70.0	6,776	0.0	95.5
-	50	NA	Mitel	0	2	NA	6,778	0.0	95.5
49	51	-2	Allegro Microsystems	1	1	0.0	6,779	0.0	95.6
48	-	NA	STC	4	0	-100.0	6,779	0.0	95.6
			Other North American Companies	237	304	28.3	7,083	4.3	99.8
			Other Japanese Companies	2	3	50.0	7,086	0.0	99.9
			Other ROW Companies	9	8	-11.1	7,094	0.1	100.0
			Total All Companies	5,853	7,094	21.2	100.0		
			Total European Companies	1,422	1,481	4.1	20.9		
			Total North American Companies	2,803	3,533	26.0	49.8		
			Total Japanese Companies	1,329	1,589	19.6	22.4		
			Total ROW Companies	299	491	64.2	6.9		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 7
Preliminary 1992 European MOS Digital Memory IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Samsung	226	322	42.5	322	12.2	12.2
3	2	1	Toshiba	199	236	18.6	558	8.9	21.1
2	3	-1	Siemens	224	230	2.7	788	8.7	29.8
5	4	1	NEC	164	218	32.9	1,006	8.3	38.1
6	5	1	Hitachi	159	207	30.2	1,213	7.8	45.9
4	6	-2	Texas Instruments	171	202	18.1	1,415	7.6	53.6
7	7	0	SGS-Thomson Microelectronics	134	146	9.0	1,561	5.5	59.1
9	8	1	Mitsubishi	86	126	46.5	1,687	4.8	63.9
8	9	-1	Intel	93	109	17.2	1,796	4.1	68.0
10	10	0	Motorola	72	96	33.3	1,892	3.6	71.6
11	11	0	Fujitsu	67	91	35.8	1,983	3.4	75.1
15	12	3	Goldstar	33	86	160.6	2,069	3.3	78.3
12	13	-1	AMD	61	73	19.7	2,142	2.8	81.1
20	14	6	Hyundai	25	73	192.0	2,215	2.8	83.8
13	15	-2	Oki	57	68	19.3	2,283	2.6	86.4
14	16	-2	Micron Technology	45	58	28.9	2,341	2.2	88.6
16	17	-1	Matra-MHS	32	32	0.0	2,373	1.2	89.8
18	18	0	Cypress	26	29	11.5	2,402	1.1	90.9
17	19	-2	National	27	27	0.0	2,429	1.0	91.9
22	20	2	IDT	22	26	18.2	2,455	1.0	92.9
21	21	0	Sharp	23	25	8.7	2,480	0.9	93.9
23	22	1	Sony	21	25	19.0	2,505	0.9	94.8
19	23	-4	Philips	26	11	-57.7	2,516	0.4	95.2
24	24	0	Matsushita	8	9	12.5	2,525	0.3	95.6
25	25	0	Sanyo	8	8	0.0	2,533	0.3	95.9
29	26	3	Rohm	3	5	66.7	2,538	0.2	96.1
26	27	-1	Harris	5	3	-40.0	2,541	0.1	96.2
28	28	0	NMB	5	3	-40.0	2,544	0.1	96.3
30	29	1	Seiko Epson	3	3	0.0	2,547	0.1	96.4
32	30	2	Eurosil	1	2	100.0	2,549	0.1	96.5
27	31	-4	ITT	5	2	-60.0	2,551	0.1	96.6
31	32	-1	AT&T	1	1	0.0	2,552	0.0	96.6
			Other North American Companies	93	87	-6.5	2,639	3.3	99.9
			Other ROW Companies	4	3	-25.0	2,642	0.1	100.0
			Total All Companies	2,129	2,642	24.1	100.0		
			Total European Companies	417	421	1.0	15.9		
			Total North American Companies	621	713	14.8	27.0		
			Total Japanese Companies	803	1,024	27.5	38.8		
			Total ROW Companies	288	484	68.1	18.3		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 8
Preliminary 1992 European MOS Digital Microcomponent IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Intel	663	991	49.5	991	36.4	36.4
2	2	0	Motorola	264	365	38.3	1,356	13.4	49.9
3	3	0	NEC	150	165	10.0	1,521	6.1	55.9
4	4	0	Philips	115	141	22.6	1,662	5.2	61.1
6	5	1	Texas Instruments	107	125	16.8	1,787	4.6	65.7
5	6	-1	SGS-Thomson Microelectronics	108	107	-0.9	1,894	3.9	69.7
9	7	2	AMD	65	99	52.3	1,993	3.6	73.3
7	8	-1	Siemens	87	85	-2.3	2,078	3.1	76.4
8	9	-1	Hitachi	75	79	5.3	2,157	2.9	79.3
10	10	0	National	58	61	5.2	2,218	2.2	81.6
11	11	0	Toshiba	56	58	3.6	2,276	2.1	83.7
22	12	10	AT&T	13	48	269.2	2,324	1.8	85.5
13	13	0	VLSI Technology	34	34	0.0	2,358	1.3	86.7
12	14	-2	Western Digital	38	34	-10.5	2,392	1.3	88.0
14	15	-1	Matra-MHS	29	32	10.3	2,424	1.2	89.2
16	16	0	Zilog	21	25	19.0	2,449	0.9	90.1
20	17	3	Fujitsu	15	20	33.3	2,469	0.7	90.8
18	18	0	Oki	18	19	5.6	2,488	0.7	91.5
19	19	0	Matsushita	17	18	5.9	2,506	0.7	92.2
24	20	4	Analog Devices	7	16	128.6	2,522	0.6	92.8
21	21	0	Mitsubishi	15	16	6.7	2,538	0.6	93.3
15	22	-7	ITT	23	15	-34.8	2,553	0.6	93.9
17	23	-6	Harris	18	10	-44.4	2,563	0.4	94.3
27	24	3	LSI Logic	2	8	300.0	2,571	0.3	94.6
23	25	-2	TCS	9	8	-11.1	2,579	0.3	94.9
29	26	3	IDT	1	6	500.0	2,585	0.2	95.1
25	27	-2	Cypress	5	5	0.0	2,590	0.2	95.3
26	28	-2	Rockwell	4	3	-25.0	2,593	0.1	95.4
28	29	-1	GEC Plessey Semiconductors	1	1	0.0	2,594	0.0	95.4
30	30	0	Rohm	1	1	0.0	2,595	0.0	95.4
31	31	0	Samsung	1	1	0.0	2,596	0.0	95.5
32	32	0	Sanyo	1	1	0.0	2,597	0.0	95.5
33	33	0	Sharp	1	1	0.0	2,598	0.0	95.5
			Other North American Companies	58	119	105.2	2,717	4.4	99.9
			Other ROW Companies	2	2	0.0	2,719	0.1	100.0
			Total All Companies	2,082	2,719	30.6	100.0		
			Total European Companies	349	374	7.2	13.8		
			Total North American Companies	1,381	1,964	42.2	72.2		
			Total Japanese Companies	349	378	8.3	13.9		
			Total ROW Companies	3	3	0.0	0.1		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 9
Preliminary 1992 European MOS Digital Logic IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Philips	171	202	18.1	202	11.7	11.7
6	2	4	Motorola	95	133	40.0	335	7.7	19.3
7	3	4	Texas Instruments	88	133	51.1	468	7.7	27.0
2	4	-2	Siemens	133	128	-3.8	596	7.4	34.4
5	5	0	LSI Logic	98	107	9.2	703	6.2	40.6
4	6	-2	GEC Plessey Semiconductors	104	103	-1.0	806	5.9	46.5
8	7	1	SGS-Thomson Microelectronics	71	79	11.3	885	4.6	51.1
11	8	3	AMD	64	75	17.2	960	4.3	55.4
10	9	1	National	65	66	1.5	1,026	3.8	59.2
3	10	-7	ITT	124	63	-49.2	1,089	3.6	62.8
12	11	1	VLSI Technology	55	59	7.3	1,148	3.4	66.2
9	12	-3	Toshiba	66	57	-13.6	1,205	3.3	69.5
16	13	3	NEC	32	33	3.1	1,238	1.9	71.4
13	14	-1	AT&T	36	32	-11.1	1,270	1.8	73.3
19	15	4	Fujitsu	22	32	45.5	1,302	1.8	75.1
18	16	2	Matra-MHS	27	30	11.1	1,332	1.7	76.9
15	17	-2	Harris	33	28	-15.2	1,360	1.6	78.5
17	18	-1	European Silicon Structures	27	26	-3.7	1,386	1.5	80.0
14	19	-5	Austria Mikro Systeme	33	25	-24.2	1,411	1.4	81.4
20	20	0	ABB-HAFO	21	22	4.8	1,433	1.3	82.7
22	21	1	Hewlett-Packard	19	22	15.8	1,455	1.3	84.0
21	22	-1	Mietec	21	21	0.0	1,476	1.2	85.2
23	23	0	Hitachi	19	19	0.0	1,495	1.1	86.3
24	24	0	Cypress	18	17	-5.6	1,512	1.0	87.2
26	25	1	Oki	14	17	21.4	1,529	1.0	88.2
25	26	-1	Ericsson	16	15	-6.3	1,544	0.9	89.1
27	27	0	IDT	10	11	10.0	1,555	0.6	89.7
-	28	NA	Micronas	0	10	NA	1,565	0.6	90.3
30	29	1	Intel	9	9	0.0	1,574	0.5	90.8
31	30	1	Mitsubishi	9	9	0.0	1,583	0.5	91.3
28	31	-3	TCS	10	9	-10.0	1,592	0.5	91.9
32	32	0	Eurosil	8	8	0.0	1,600	0.5	92.3
33	33	0	Seiko Epson	6	8	33.3	1,608	0.5	92.8
-	34	NA	Dialog Semiconductor	0	5	NA	1,613	0.3	93.1
38	35	3	Sony	2	4	100.0	1,617	0.2	93.3
29	36	-7	Telefunken	10	3	-70.0	1,620	0.2	93.5
-	37	NA	Mitel	0	2	NA	1,622	0.1	93.6
36	38	-2	Sanyo	2	2	0.0	1,624	0.1	93.7
37	39	-2	Sharp	2	2	0.0	1,626	0.1	93.8

(Continued)

Table 9 (Continued)
Preliminary 1992 European MOS Digital Logic IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
39	40	-1	Allegro Microsystems	1	1	0.0	1,627	0.1	93.9
40	41	-1	Rohm	1	1	0.0	1,628	0.1	93.9
34	42	-8	Samsung	5	1	-80.0	1,629	0.1	94.0
35	-	NA	STC	4	0	-100.0	1,629	0.0	94.0
			Other North American Companies	86	98	14.0	1,727	5.7	99.7
			Other Japanese Companies	2	3	50.0	1,730	0.2	99.8
			Other ROW Companies	3	3	0.0	1,733	0.2	100.0
			Total All Companies	1,642	1,733	5.5	100.0		
			Total European Companies	656	686	4.6	39.6		
			Total North American Companies	801	856	6.9	49.4		
			Total Japanese Companies	177	187	5.6	10.8		
			Total ROW Companies	8	4	-50.0	0.2		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 10
Preliminary 1992 European Analog IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Philips	409	384	-6.1	384	15.9	15.9
2	2	0	SGS-Thomson Microelectronics	353	360	2.0	744	14.9	30.7
3	3	0	National	185	202	9.2	946	8.3	39.1
4	4	0	Siemens	152	135	-11.2	1,081	5.6	44.7
6	5	1	Motorola	105	133	26.7	1,214	5.5	50.2
5	6	-1	Analog Devices	129	126	-2.3	1,340	5.2	55.4
7	7	0	Texas Instruments	104	118	13.5	1,458	4.9	60.2
8	8	0	Mietec	81	89	9.9	1,547	3.7	63.9
10	9	1	GEC Plessey Semiconductors	61	76	24.6	1,623	3.1	67.1
9	10	-1	Telefunken	78	72	-7.7	1,695	3.0	70.0
11	11	0	Harris	55	63	14.5	1,758	2.6	72.6
-	12	NA	EM Microelectronics-Marin	0	40	NA	1,798	1.7	74.3
17	13	4	Austria Mikro Systeme	29	39	34.5	1,837	1.6	75.9
13	14	-1	Ericsson	39	39	0.0	1,876	1.6	77.5
12	15	-3	Burr-Brown	43	36	-16.3	1,912	1.5	79.0
16	16	0	AMD	29	35	20.7	1,947	1.4	80.5
14	17	-3	Sony	37	32	-13.5	1,979	1.3	81.8
15	18	-3	Rockwell	32	26	-18.8	2,005	1.1	82.9
19	19	0	Toshiba	28	25	-10.7	2,030	1.0	83.9
20	20	0	Allegro Microsystems	24	18	-25.0	2,048	0.7	84.6
22	21	1	Siliconix	18	18	0.0	2,066	0.7	85.4
21	22	-1	Mitel	18	16	-11.1	2,082	0.7	86.0
-	23	NA	Dialog Semiconductor	0	12	NA	2,094	0.5	86.5
23	24	-1	Sanyo	14	12	-14.3	2,106	0.5	87.0
24	25	-1	Unitrode	14	12	-14.3	2,118	0.5	87.5
26	26	0	Rohm	10	11	10.0	2,129	0.5	88.0
18	27	-9	ITT	28	10	-64.3	2,139	0.4	88.4
29	28	1	Fujitsu	7	8	14.3	2,147	0.3	88.7
32	29	3	Matra-MHS	5	8	60.0	2,155	0.3	89.0
27	30	-3	Mitsubishi	8	8	0.0	2,163	0.3	89.4
34	31	3	NEC	5	8	60.0	2,171	0.3	89.7
25	32	-7	TCS	11	8	-27.3	2,179	0.3	90.0
36	33	3	AT&T	4	7	75.0	2,186	0.3	90.3
30	34	-4	Eurosil	6	6	0.0	2,192	0.2	90.6
31	35	-4	Hitachi	6	6	0.0	2,198	0.2	90.8
33	36	-3	Matsushita	5	6	20.0	2,204	0.2	91.1
28	37	-9	Raytheon	8	4	-50.0	2,208	0.2	91.2
37	38	-1	Samsung	4	2	-50.0	2,210	0.1	91.3
-	39	NA	VLSI Technology	0	2	NA	2,212	0.1	91.4

(Continued)

Table 10 (Continued)
Preliminary 1992 European Analog IC Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
38	40	-2	Honeywell	1	1	0.0	2,213	0.0	91.4
35	-	NA	STC	5	0	-100.0	2,213	0.0	91.4
			Other European Companies	7	8	14.3	2,221	0.3	91.8
			Other North American Companies	188	180	-4.3	2,401	7.4	99.2
			Other Japanese Companies	4	5	25.0	2,406	0.2	99.4
			Other ROW Companies	13	14	7.7	2,420	0.6	100.0
			Total All Companies	2,362	2,420	2.5	100.0		
			Total European Companies	1,236	1,276	3.2	52.7		
			Total North American Companies	985	1,007	2.2	41.6		
			Total Japanese Companies	124	121	-2.4	5.0		
			Total ROW Companies	17	16	-5.9	0.7		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 11
Preliminary 1992 European Discrete Semiconductor Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Philips	340	331	-2.6	331	18.0	18.0
3	2	1	Motorola	195	204	4.6	535	11.1	29.1
4	3	1	SGS-Thomson Microelectronics	189	201	6.3	736	10.9	40.1
2	4	-2	Siemens	200	160	-20.0	896	8.7	48.8
5	5	0	International Rectifier	76	82	7.9	978	4.5	53.3
6	6	0	Eupec	73	68	-6.8	1,046	3.7	57.0
10	7	3	Toshiba	58	68	17.2	1,114	3.7	60.7
7	8	-1	Semikron	67	63	-6.0	1,177	3.4	64.1
11	9	2	General Instrument	55	59	7.3	1,236	3.2	67.3
9	10	-1	ITT	60	50	-16.7	1,286	2.7	70.0
8	11	-3	Telefunken	62	44	-29.0	1,330	2.4	72.4
12	12	0	ABB-IXYS	47	43	-8.5	1,373	2.3	74.8
15	13	2	Harris	27	36	33.3	1,409	2.0	76.7
13	14	-1	Powerex	37	35	-5.4	1,444	1.9	78.6
-	15	NA	Westcode	0	35	NA	1,479	1.9	80.6
14	16	-2	GEC Plessey Semiconductors	28	30	7.1	1,509	1.6	82.2
17	17	0	Fujitsu	23	25	8.7	1,534	1.4	83.6
18	18	0	Mitsubishi	23	25	8.7	1,559	1.4	84.9
16	19	-3	NEC	24	25	4.2	1,584	1.4	86.3
19	20	-1	Siliconix	23	22	-4.3	1,606	1.2	87.5
22	21	1	Texas Instruments	20	20	0.0	1,626	1.1	88.6
21	22	-1	Fagor Electrotécnica	20	18	-10.0	1,644	1.0	89.5
20	23	-3	TAG	21	18	-14.3	1,662	1.0	90.5
23	24	-1	Rohm	14	17	21.4	1,679	0.9	91.4
28	25	3	Hitachi	8	13	62.5	1,692	0.7	92.2
24	26	-2	Zetex	13	13	0.0	1,705	0.7	92.9
26	27	-1	Hewlett-Packard	10	10	0.0	1,715	0.5	93.4
25	28	-3	Matsushita	11	8	-27.3	1,723	0.4	93.8
29	29	0	National	6	7	16.7	1,730	0.4	94.2
30	30	0	Samsung	6	5	-16.7	1,735	0.3	94.5
31	31	0	ABB-HAFO	4	4	0.0	1,739	0.2	94.7
-	32	NA	AT&T	0	4	NA	1,743	0.2	94.9
32	33	-1	Allegro Microsystems	3	3	0.0	1,746	0.2	95.1
33	34	-1	Sanyo	3	3	0.0	1,749	0.2	95.3
27	35	-8	Unitrode	10	3	-70.0	1,752	0.2	95.4
-	36	NA	Raytheon	0	1	NA	1,753	0.1	95.5
35	37	-2	Sony	1	1	0.0	1,754	0.1	95.5
34	-	NA	STC	2	0	-100.0	1,754	0.0	95.5
36	-	NA	TCS	1	0	-100.0	1,754	0.0	95.5

(Continued)

Table 11 (Continued)
Preliminary 1992 European Discrete Semiconductor Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
			Other European Companies	30	35	16.7	1,789	1.9	97.4
			Other North American Companies	13	20	53.8	1,809	1.1	98.5
			Other Japanese Companies	23	26	13.0	1,835	1.4	99.9
			Other ROW Companies	2	1	-50.0	1,836	0.1	100.0
			Total All Companies	1,828	1,836	0.4	100.0		
			Total European Companies	1,097	1,063	-3.1	57.9		
			Total North American Companies	535	556	3.9	30.3		
			Total Japanese Companies	188	211	12.2	11.5		
			Total ROW Companies	8	6	-25.0	0.3		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 12
Preliminary 1992 European Optoelectronics Semiconductor Rankings

1991 Rank	1992 Rank	Change in Rank	Ranked Companies	1991 Sales ($M)	1992 Sales ($M)	1991-92 Annual Growth (%)	1992 Cum. Sum ($M)	1992 Market Share (%)	1992 Cum. Sum (%)
1	1	0	Siemens	136	133	-2.2	133	28.9	28.9
3	2	1	Hewlett-Packard	61	59	-3.3	192	12.8	41.6
2	3	-1	Telefunken	65	57	-12.3	249	12.4	54.0
4	4	0	Toshiba	30	30	0.0	279	6.5	60.5
7	5	2	AT&T	17	26	52.9	305	5.6	66.2
6	6	0	Honeywell	20	22	10.0	327	4.8	70.9
8	7	1	TCS	15	18	20.0	345	3.9	74.8
9	8	1	Sharp	13	15	15.4	360	3.3	78.1
10	9	1	Texas Instruments	11	8	-27.3	368	1.7	79.8
11	10	1	ABB-HAFO	7	7	0.0	375	1.5	81.3
13	11	2	Fujitsu	6	7	16.7	382	1.5	82.9
12	12	0	Matsushita	7	6	-14.3	388	1.3	84.2
14	13	1	NEC	6	6	0.0	394	1.3	85.5
15	14	1	Hitachi	5	5	0.0	399	1.1	86.6
16	15	1	Motorola	4	4	0.0	403	0.9	87.4
17	16	1	Harris	3	3	0.0	406	0.7	88.1
18	17	1	Sanyo	3	3	0.0	409	0.7	88.7
19	18	1	Mitsubishi	1	1	0.0	410	0.2	88.9
20	19	1	Oki	1	1	0.0	411	0.2	89.2
21	20	1	Rohm	1	1	0.0	412	0.2	89.4
22	21	1	Zetex	1	1	0.0	413	0.2	89.6
5	-	NA	Philips	29	0	-100.0	413	0.0	89.6
			Other European Companies	7	8	14.3	421	1.7	91.3
			Other North American Companies	28	32	14.3	453	6.9	98.3
			Other ROW Companies	8	8	0.0	461	1.7	100.0
			Total All Companies	485	461	-4.9	100.0		
			Total European Companies	260	224	-13.8	48.6		
			Total North American Companies	144	154	6.9	33.4		
			Total Japanese Companies	73	75	2.7	16.3		
			Total ROW Companies	8	8	0.0	1.7		

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9213 December 25, 1992

In This Issue...

Pricing Analysis

European Pricing Update

Price changes are nominal or nonexistent for most products, but the antidumping action is beginning to affect memory prices. The growth in PC-related consumption is extending lead times for some products, with the automotive sector also contributing to the increase in demand. Flash memory is in very short supply, due to increasing demand and low production capacity.

By Mike Glennon and Adrian Walker *Page 2*

Market Analysis

State of the Industry

The SIA flash European book-to-bill ratio for November was 1.12, improving on October's revised 1.09. The 12-month moving-average billings growth continues its climb unabated, reaching 11.8 percent for November. Billings have been over the $1 billion mark for two successive months now, and this should continue following the high level of bookings.

By Mike Glennon *Page 4*

The 1991 Data You Missed

As we near the end of 1992 we are taking the opportunity to ship you a compendium of data that time has not permitted us to present to you in the way we would normally intend. The material includes the following.

European MOS Memory Market Share Rankings

This report presents the final 1991 MOS memory market share rankings. Dataquest produces MOS memory market share estimates for DRAMs, SRAMS, EPROMs, other nonvolatile memories and speciality MOS memory. The category "other nonvolatile memory" includes flash, EEPROM, and mask ROM. The "speciality MOS memory" category includes other memory products not included above, such as cache-tag RAM, FIFOs, LIFOs, CAM and ferroelectric memory.

By Jim Eastlake *Page 7*

European Companies' Capital and R&D Expenditure

Dataquest prepares estimates of annual semiconductor-related investment in research and development, and capital projects by company. In order to do this we use data from companies' annual reports, monitor major capital and R&D projects, and conduct a survey among companies. Here we present the results of the European company analysis for 1991, with a projection for 1992.

By Jim Eastlake *Page 15*

Major Users' Semiconductor Spending in 1992

For the past three years Dataquest has published estimates of the annual semiconductor spends of major OEMs in Europe. This section provides the 1992 update. We produce two sets of estimates: European-headquartered companies' worldwide semiconductor spends, and "worldwide" companies' semiconductor spends in Europe.

By Jim Eastlake *Page 19*

Pricing Analysis

European Pricing Update

Most prices are little changed, with the exception of memory, where the imposition of antidumping duties is beginning to have an effect. Table 1 shows European semiconductor booking trends for orders of 1,000 and 10,000 units, and volume orders.

Standard Logic

Prices are relatively stable in general-purpose logic, with no change since last month. There is the possibility of some price rises, but this is due to exchange rate changes, rather than an attempt by suppliers to take advantage of the shortage of small-outline (SO) parts. Conflicting reports about when the shortage of parts will come to an end give an earliest date of next March, and a latest date of the end of 1993. PDIP parts are still available, but demand is for SO packaged parts.

Analog

The market for regulators is improving, with demand increasing mainly in the automotive sector. Prices are unchanged, but lead times have extended a little. The range is still four to eight weeks, but quoted delivery times are nearer eight weeks for some suppliers.

Microcomponents

The demand across the market varies with device. The efforts of Advanced Micro Devices (AMD) to introduce a 486 product have met with a blow, following the loss of the microcode litigation. This has delayed the introduction of its 486 by six months, and gives Intel a bigger breathing space for its 486, thus reducing pressure on Intel to lower prices. In the meantime, the 386 market is healthy, with long lead times for 386SX and DX at the higher clock speeds.

There is little change in demand or prices for MIPS processors, but demand for Motorola's 68040 is still good, coming from PC products.

Memory

DRAM

The changes forecast in last month's pricing update for Europe are now present in the marketplace. The expected firming of prices seems evident across both 1M and 4M densities, as suppliers come to terms with the increased activity levels in the market, brought about by the US and EC rulings on antidumping issues, and the greater-than-forecast demand surge from the PC and workstation segments.

There are definite signs of lengthening lead times on many 4M DRAM products, as suppliers' capacity is booked up. The 60ns devices are showing the longest lead times—up to 14 weeks for 4M.

The forecast activity level for the first quarter of 1993 shows a degree of uncertainty. Any EC announcements due in January and February are sure to affect the supply and demand situation. The key variable will be the level of activity in the PC segment. Since the final quarter of any year usually yields the highest PC shipments, the first quarter will be a key outlook indicator for the forecast "recovery" of the electronics market in 1993.

VRAM prices seem firm, with some lead times lengthening.

Flash

Supply problems in the flash market are now very evident, and this is resulting in very long lead times for both the 1M and 2M devices. Adding to the delivery issues is the increased take-up of flash within different applications: for example, in computers for BIOS memory; and in networking for board-level programming.

The longer-term outlook is one of overdemand, as end-user demand increases and new and established suppliers attempt to rationalize and ramp up their production lines.

EPROM

There are some signs of an increase in prices for the 2M EPROM. Delivery and demand issues are involved in the price rises being seen.

SRAM

SRAM products tracked by Dataquest are showing little change, with only a slight downward trend in 1M density, as competition and the number of users increases. In other

Table 1
European Semiconductor Pricing December 1992
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (%)	1K Adder (%)	Lead Time (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.37	10%	15%	4-12
74F244	PDIP	100K	0.21	10%	15%	4-12
Analog						
78L05	TO92	100K	0.14	10%	20%	4-8
IMSG171D 35-MHz Video DAC		100K	3.05	15%	25%	8-12
Microcomponents						
80386SX-20	PQFP	5K	45.00	0%	5%	10-16
80386DX-40	CPGA	5K	94.00	0%	10%	10-16
80486DX-33	CPGA	5K	350.00	-5%	5%	8-12
68040-25	CPGA	5K	370.00	-5%	10%	4-6
R3000-25	CPGA	5K	80.00	-5%	15%	4-10
DRAM						
1M×1-80 (1M)	SOJ	100K	3.30	5%	15%	2-6
4M×1-80 (4M)	SOJ	100K	10.30	5%	15%	6-8
512K×9-80 (4M)	SOJ	100K	13.25	5%	15%	10-12
256K×16-80 (4M)	SOJ	100K	12.75	5%	15%	10-12
4M×4-70 (16M)	SOJ	10K	92.00	0%	5%	8-14
(4M×1)×2+1M-60	SIMM	50K	26.50	5%	10%	8-10
128×8-80 VRAM	SOJ	100K	6.95	5%	15%	4-6
Flash						
1M-17 (128K×8)	PDIP	10K	5.85	0%	10%	4-8
2M-17 (256K×8)	PDIP	10K	13.50	0%	30%	12-16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	4.30	10%	20%	8-12
SRAM						
256K-70 (32K×8)	PDIP	50K	3.00	5%	15%	2-4
256K-25 (64K×4)	PDIP	20K	4.50	5%	10%	6-8
1M-70 (128K×8)	PDIP	5K	8.00	-5%	15%	4-6

Source: Dataquest (December 1992 Estimates)

worldwide regions there are signs of delivery tightening on 256K SRAM. This could produce a knock-on effect, increasing lead times from the normal two to four weeks. Longer lead times are already indicated for TSOP devices due to imbalances between capacity and demand, and this may change as supply ramps up.

Current Exchange Rates

1 US dollar =
- 0.646 UK pounds
- 1.571 deutsche marks
- 5.359 French francs
- 0.802 ECU

By Mike Glennon
Adrian Walker

Market Analysis

State of the Industry

The SIA flash three-month average bookings for the month of November were $1,229.0 million; this is the third consecutive month where bookings were over $1 billion, and is a 10.7 percent increase over last month's restated $1,110 million. Actual billings for November also grew by 7.2 percent over October, reaching $1,095.8 million. The three-month average book-to-bill ratio for November stays at October's previous level of 1.12, but the minor changes in the bookings and billings figures for October have reduced that month's book-to-bill ratio to 1.09. Figure 1 shows the book-to-bill ratio for the past 13 months, and the three-month average bookings and three-month average billings for the semiconductor market in Europe.

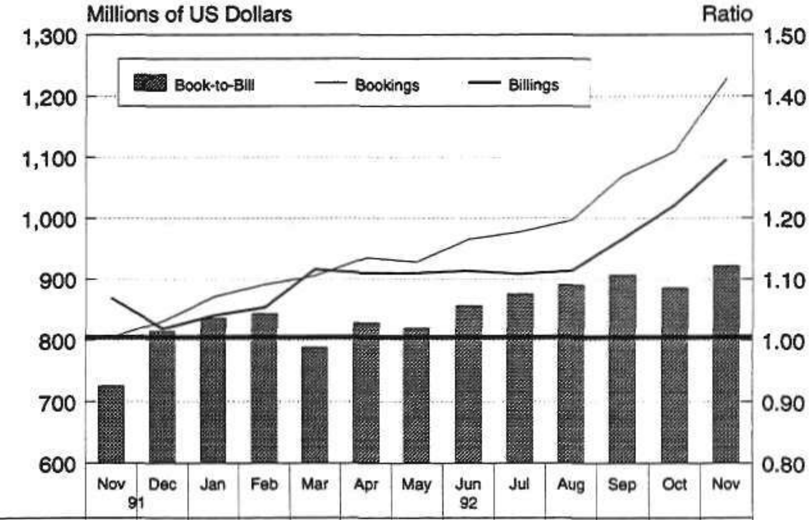
November's billings represent a 33 percent increase over November the previous year, and continue to outperform all but the most optimistic predictions. Bookings growth exceeds even this, with November's three-month average data growing by 53 percent over the same month the previous year.

The PC's insatiable demand for semiconductors is still growing, and semiconductor demand will continue into 1993, as the momentum built up in bookings converts to actual billings. This is clear from the 12-month moving-average growth for bookings and billings, shown in Figure 2. From this it can be seen that 12-month average bookings act as a good leading indicator for future billings, and as the bookings trend continues upwards, there are no signs of a slowing of growth for billings for the next few months at least.

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billings and three-month average bookings figures for Europe. The model calculates trend and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billings and three-month average bookings figures. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends. See Figures 3, 4 and 5.

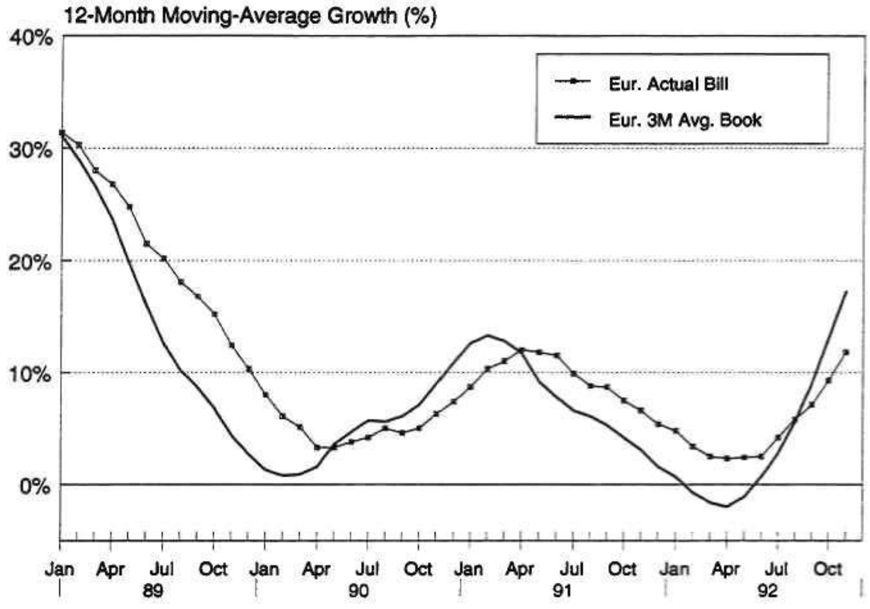
Figure 1
European Total Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Nov 91	Dec	Jan	Feb	Mar	Apr	May	Jun 92	Jul	Aug	Sep	Oct	Nov
Book-to-Bill	0.93	1.02	1.04	1.04	0.99	1.03	1.02	1.06	1.08	1.09	1.11	1.09	1.12
Bookings	805	831	871	891	905	935	928	966	977	996	1,070	1,110	1,229
Billings	869	819	841	854	916	910	910	914	908	913	966	1,022	1,096

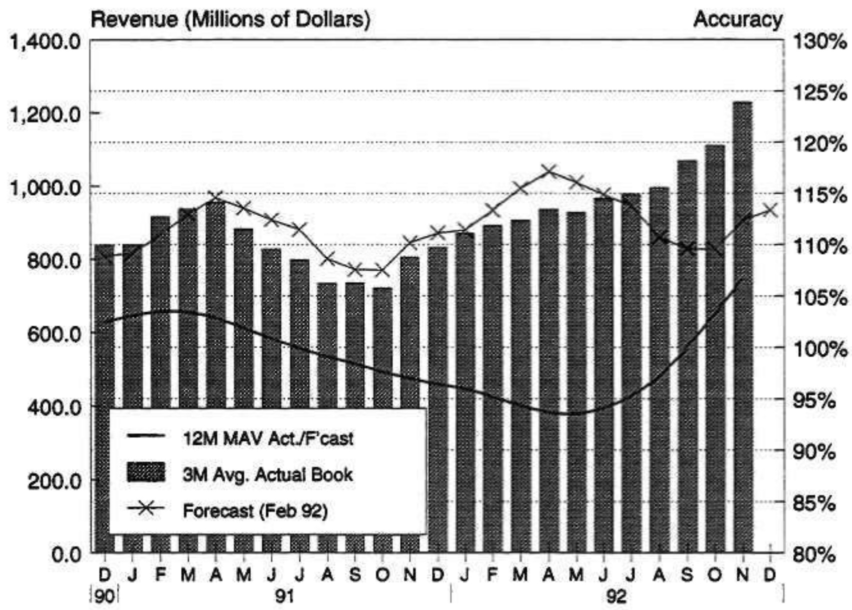
Note: Last two months are preliminary
Source: WSTS, SIA

Figure 2
European Total Semiconductor Bookings and Billings Growth
(12-Month Average)



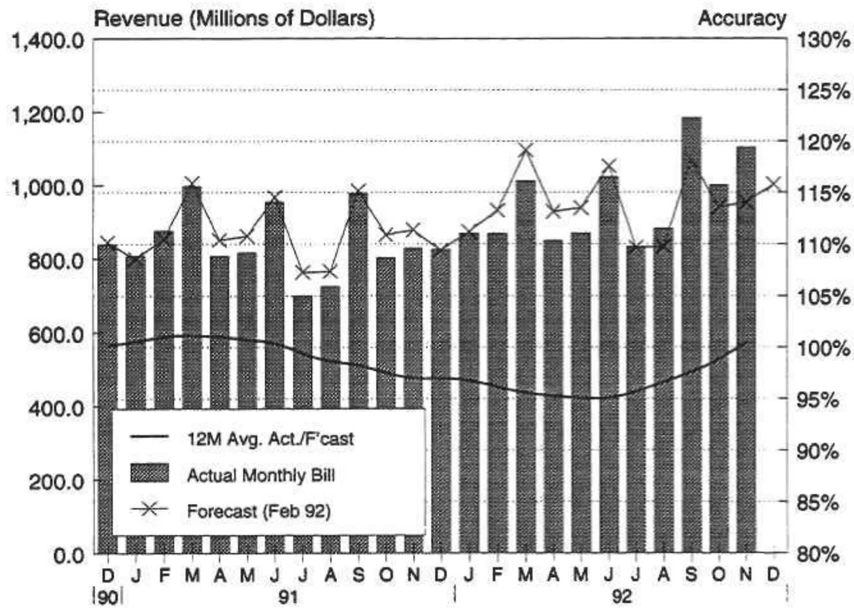
Source: WSTS, SIA, Dataquest (December 1992)

Figure 3
European Total Three-Month Average Bookings



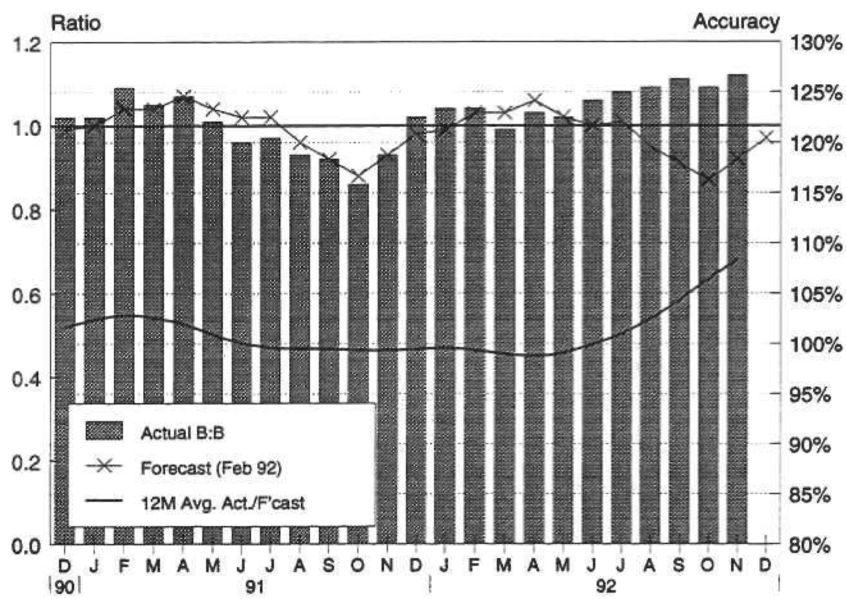
Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (December 1992)

Figure 4
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (December 1992)

Figure 5
European Total Semiconductor Three-Month Average Book-to-Bill Ratio



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (December 1992)

Bookings continue to exceed the model predictions, as shown in Figure 3, with a 6 percent difference now appearing between forecast and actual data. The model suggests three-month average bookings should be rising, and in fact they are, but this is a continuation of a trend which began in June. Looking forward into 1993, average bookings should continue their rise until April. If the actual data follow the model, and bookings rise from their already heady heights, 1993 should be a bumper year.

The build-up of bookings pressure is forcing its way into billings, and the actual billings data are now exceeding the forecast data on a 12-month average basis, as can be seen in Figure 4. With bookings growth for the year to date at 17 percent, compared with 12 percent for billings, there is already a 5 percentage point bonus added to next year, if all the excess bookings convert to billings. Some bookings will be cancelled no doubt, but a significant percentage should convert to billings.

The high growth in bookings has obviously had a significant effect on the book-to-bill ratio, and this has stayed above one since April. The model suggests this should have fallen below one in August, and should stay there until January 1993; thus the build-up of booking pressure, which will be released as billings during 1993.

Dataquest Perspective

Three weak years have not prepared suppliers for the sudden rise in semiconductor demand, and consequently lead times for many products are increasing significantly. This is allowing suppliers to maintain prices and improve the utilization of their manufacturing facilities. Some suppliers have been using the slowdown in activity to rationalize older plants and focus their manufacturing in more cost-effective, modern plants. As a result, they are better equipped to cope with the increase in demand, with lower-cost manufacturing.

In addition to the sudden increase in demand, political activity has reduced capacity by pricing some suppliers out of the market, and further squeezing supply. In memory in particular, antidumping action has electrified the remaining suppliers, and administered electric-shock treatment to the Korean manufacturers. It is interesting to note Japanese manufacturers have now announced increased capacity in response to the growing demand and tightening of supply. This will allow greater growth in the market, and ensure a good recovery to the market in Europe.

The prospect of recovery raises the key question: can the growth continue? An improvement in conditions is heavily reliant on only one or two products. This may stimulate sales of other equipment, or the market could suddenly collapse in the same manner as it boomed. Consumer markets are still depressed, and the spectre of recession is stalking the economies of countries which have so far escaped the worst effects of a general downturn in market demand. At the same time, while capacity has been reduced, and lead times are lengthening, there is still considerable latent, unused capacity available, which could be turned on to meet a longer-term increase in demand, should this appear.

By Mike Glennon

European MOS Memory Market Share Rankings

The Rankings—Total MOS Memory

The year 1991 marked a watershed for Samsung. It rose above Siemens and Toshiba to become Europe's leading supplier of memories by growing its business by some 22.8 percent, as Table 2 indicates (see the end of this article). The company's success was built on exceptionally strong DRAM sales, while its SRAM business declined slightly. Among the other top five, Siemens', Toshiba's and Texas Instruments' sales all declined, and NEC's sales were flat. The overall performance of these four vendors again reflected their DRAM business. Samsung clearly gained share from its four rivals through a strong presence in the DRAM memory module business, and an aggressive pricing policy.

MOS DRAM

Siemens retained top spot in the European DRAM market in 1991, as Table 3 shows, though its sales declined by 5.9 percent. This table also shows Samsung's impressive 25.5 percent growth in DRAMs. Elsewhere, Mitsubishi achieved a growth rate of 58.3 percent through success in workstation applications, and good DRAM module business. However, Oki's 129.2 percent growth came about through Dataquest's restatement of the company's European business, after discovering new European sales channels.

MOS SRAM

Hitachi takes credit for growing both its DRAM and SRAM businesses well above the market average in 1991. The company was particularly successful in SRAM, where it rose two places in the rankings to become Europe's leading vendor. Table 4 shows that Hitachi surpassed NEC and Toshiba, growing its business by some 14.6 percent to $47 million. The other notable performance in SRAM came from Motorola. The company's line of very high-speed SRAMs sold particularly well in 1991, establishing their presence in Europe. Elsewhere in the rankings most companies in the top saw their sales decline in 1991.

MOS EPROM

Price wars marred the EPROM market in 1991. It was also the year that Intel's focus moved more towards flash memory as its primary nonvolatile offering. Bearing these factors in mind, the ranking given in Table 5 shows a struggle for market share, and realignment occurring at a time when business was weak. Most companies showed either flat or declining sales. Of the leading players, only AMD showed growth, increasing sales by 14 percent. While this enabled AMD to surpass Intel, it could not catch SGS-Thomson. SGS-Thomson retained first place with sales of $74 million, a decline of 7.5 percent over 1990.

Other Nonvolatile Memory

Among the EEPROM, flash and mask ROM vendors fortunes differed greatly in 1991. Table 5 shows SGS-Thomson passing Toshiba to become Europe's leading vendor, growing its business by some 26.1 percent. However, Intel achieved exceptional growth in flash EPROM sales which, if repeated in 1992, will put SGS-Thomson's position under pressure. SGS-Thomson and Intel's success came at the expense of Toshiba, which slipped down slightly in the rankings as its sales declined by 16.7 percent.

Speciality MOS Memory

Speciality MOS memory includes memory products which do not fit into the other defined categories. These products include content-addressable memory (CAM), cache-tag RAM, FIFOs and LIFOs. IDT retained Europe's top spot in 1991 by growing its business by 30 percent with sales of $13 million, as Table 7 shows. Its nearest challenger SGS-Thomson sold $8 million worth of products, a decline of 20 percent over 1990. Cypress and AMD both grew their businesses though the absolute numbers were small.

Dataquest Perspective

The European MOS memory market grew by only 3.9 percent in dollars in 1991. The overall rankings were very much determined by the leading DRAM players. It was Samsung that came from among them to lead the field for the first time. The company has come a long way in a short time, and it must now concentrate on broadening its European portfolio of products to provide a stable base for the future. With the notable exception of Mitsubishi, the other DRAM vendors had another tough year, but 1992 looks like being brighter for everyone.

Dataquest would point to 1991 as a notable year for three other companies. Firstly, for Siemens, 1991 was something of a peak, as the 1M DRAM market passed its maximum unit shipments. Because the company has a limited offering in 4M DRAM we must expect it to lose share in the memory market in the short term.

Next, regarding Intel: its more than six-times growth in flash memory sales (in the "other nonvolatile" category) marks the beginning of what promises to be a very important new product/technology area for the semiconductor market. By the end of 1992, this had become a key component in GSM mobile telephone handsets—made the more so by shortages—but flash memory is now designed into PCs for BIOS and to several other high-growth applications.

Finally, Motorola: while the company's DRAM business declined by 22 percent in 1991, it started to show its capabilities in SRAM, where it achieved sales of $26 million. The company has now become a signatory to the Japanese DRAM reference price agreement, which means it will now be able to offer 4M DRAM in Europe. Increasing SRAM capability combined with 4M DRAM will undoubtedly increase Motorola's competitive position in Europe in the future.

By Jim Eastlake

Table 2
European Semiconductor Market Share Rankings—MOS Memory
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Company	1990 Sales ($M)	1991 Sales ($M)	1990-91 Growth (%)	1991 Cum. Sum ($M)	1991 Share (%)	1991 Cum. Sum (%)
3	1	2	Samsung	184	226	22.8	226	10.6	10.6
1	2	-1	Siemens	238	224	-5.9	450	10.5	21.1
2	3	-1	Toshiba	222	199	-10.4	649	9.3	30.5
4	4	0	Texas Instruments	181	171	-5.5	820	8.0	38.5
5	5	0	NEC	164	164	0.0	984	7.7	46.2
7	6	1	Hitachi	140	159	13.6	1,143	7.5	53.7
6	7	-1	SGS-Thomson	143	134	-6.3	1,277	6.3	60.0
9	8	1	Intel	84	93	10.7	1,370	4.4	64.3
11	9	2	Mitsubishi	63	86	36.5	1,456	4.0	68.4
10	10	0	Motorola	76	72	-5.3	1,528	3.4	71.8
8	11	-3	Fujitsu	87	67	-23.0	1,595	3.1	74.9
12	12	0	AMD	61	61	0.0	1,656	2.9	77.8
17	13	4	Oki	30	57	90.0	1,713	2.7	80.5
14	14	0	Micron Technology	46	45	-2.2	1,758	2.1	82.6
24	15	9	Goldstar	8	33	312.5	1,791	1.6	84.1
15	16	-1	Matra-MHS	32	32	0.0	1,823	1.5	85.6
16	17	-1	National Semiconductor	31	27	-12.9	1,850	1.3	86.9
19	18	1	Cypress	28	26	-7.1	1,876	1.2	88.1
18	19	-1	Philips Semiconductors	29	26	-10.3	1,902	1.2	89.3
21	20	1	Sharp	22	23	4.5	1,925	1.1	90.4
22	21	1	IDT	18	22	22.2	1,947	1.0	91.5
20	22	-2	Sony	23	21	-8.7	1,968	1.0	92.4
13	23	-10	Matsushita	46	8	-82.6	1,976	0.4	92.8
28	24	4	Sanyo	1	8	700.0	1,984	0.4	93.2
23	25	-2	NMB	10	5	-50.0	1,989	0.2	93.4
-	26	NA	ITT	0	5	NA	1,994	0.2	93.7
26	27	-1	Harris	3	5	66.7	1,999	0.2	93.9
-	28	NA	Rohm	0	3	NA	2,002	0.1	94.0
-	29	NA	Seiko Epson	0	3	NA	2,005	0.1	94.2
-	30	NA	Eurosil	0	1	NA	2,006	0.0	94.2
-	31	NA	AT&T	0	1	NA	2,007	0.0	94.3
27	36	-9	VLSI Technology	3	0	-100.0	2,007	0.0	94.3
25	63	-38	GEC Plessey	5	0	-100.0	2,007	0.0	94.3
			Others North America	60	93	55.0	2,100	4.4	98.6
			Others Rest of World	12	29	141.7	2,129	1.4	100.0
			Total European	447	417	-6.7		19.6	
			Total Japanese	808	803	-0.6		37.7	
			Total North American	591	621	5.1		29.2	
			Total Rest of World	204	288	41.2		13.5	
			Total All Companies	2,050	2,129	3.9		100.0	

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 3
European Semiconductor Market Share Rankings—MOS DRAM
(Millions of Dollars)

1990 Rank	1991 Rank	Change In Rank	Company	1990 Sales ($M)	1991 Sales ($M)	1990-91 Growth (%)	1991 Cum. Sum ($M)	1991 Share (%)	1991 Cum. Sum (%)
1	1	0	Siemens	238	224	-5.9	224	18.6	18.6
2	2	0	Samsung	157	197	25.5	421	16.3	34.9
3	3	0	Toshiba	149	135	-9.4	556	11.2	46.1
4	4	0	Texas Instruments	122	127	4.1	683	10.5	56.7
5	5	0	NEC	110	106	-3.6	789	8.8	65.5
6	6	0	Hitachi	89	99	11.2	888	8.2	73.7
11	7	4	Mitsubishi	36	57	58.3	945	4.7	78.4
12	8	4	Oki	24	55	129.2	1,000	4.6	83.0
7	9	-2	Motorola	61	45	-26.2	1,045	3.7	86.7
8	10	-2	Fujitsu	55	43	-21.8	1,088	3.6	90.3
10	11	-1	Micron Technology	36	35	-2.8	1,123	2.9	93.2
14	12	2	Goldstar	7	32	357.1	1,155	2.7	95.9
15	13	2	Intel	5	11	120.0	1,166	0.9	96.8
9	14	-5	Matsushita	46	8	-82.6	1,174	0.7	97.4
-	15	NA	Sanyo	0	7	NA	1,181	0.6	98.0
13	16	-3	NMB	10	5	-50.0	1,186	0.4	98.4
16	17	-1	Sharp	4	2	-50.0	1,188	0.2	98.6
			Others North America	0	4	NA	1,192	0.3	98.9
			Others Rest of World	6	13	116.7	1,205	1.1	100.0
			Total European	238	224	-5.9		18.6	
			Total Japanese	523	517	-1.1		42.9	
			Total North American	224	222	-0.9		18.4	
			Total Rest of World	170	242	42.4		20.1	
			Total All Companies	1,155	1,205	4.3		100.0	

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 4
European Semiconductor Market Share Rankings—MOS SRAM
(Millions of Dollars)

1990 Rank	1991 Rank	Change In Rank	Company	1990 Sales ($M)	1991 Sales ($M)	1990-91 Growth (%)	1991 Cum. Sum ($M)	1991 Share (%)	1991 Cum. Sum (%)
3	1	2	Hitachi	41	47	14.6	47	12.5	12.5
1	2	-1	NEC	44	46	4.5	93	12.2	24.7
2	3	-1	Toshiba	42	39	-7.1	132	10.3	35.0
4	4	0	Matra-MHS	32	32	0.0	164	8.5	43.5
11	5	6	Motorola	14	26	85.7	190	6.9	50.4
5	6	-1	SGS-Thomson	30	23	-23.3	213	6.1	56.5
6	7	-1	Mitsubishi	24	22	-8.3	235	5.8	62.3
7	8	-1	Samsung	23	22	-4.3	257	5.8	68.2
8	9	-1	Sony	23	21	-8.7	278	5.6	73.7
10	10	0	Cypress	14	13	-7.1	291	3.4	77.2
9	11	-2	Fujitsu	16	12	-25.0	303	3.2	80.4
13	12	1	Micron Technology	10	10	0.0	313	2.7	83.0
14	13	1	IDT	8	9	12.5	322	2.4	85.4
15	14	1	Sharp	5	8	60.0	330	2.1	87.5
-	15	NA	Intel	0	7	NA	337	1.9	89.4
17	16	1	Harris	3	5	66.7	342	1.3	90.7
-	17	NA	Seiko Epson	0	3	NA	345	0.8	91.5
16	18	-2	Philips Semiconductors	4	3	-25.0	348	0.8	92.3
22	19	3	National Semiconductor	1	2	100.0	350	0.5	92.8
12	20	-8	AMD	10	2	-80.0	352	0.5	93.4
21	21	0	Goldstar	1	1	0.0	353	0.3	93.6
18	22	-4	Oki	3	1	-66.7	354	0.3	93.9
23	23	0	Sanyo	1	1	0.0	355	0.3	94.2
-	24	NA	AT&T	0	1	NA	356	0.3	94.4
20	25	-5	VLSI Technology	2	0	-100.0	356	0.0	94.4
19	26	-7	GEC Plessey	2	0	-100.0	356	0.0	94.4
			Others North America	7	8	14.3	364	2.1	96.6
			Others Rest of World	5	13	160.0	377	3.4	100.0
			Total European	68	58	-14.7		15.4	
			Total Japanese	199	200	0.5		53.1	
			Total North Americans	69	83	20.3		22.0	
			Total Rest of World	29	36	24.1		9.5	
			Total All Companies	365	377	3.3		100.0	

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 5
European Semiconductor Market Share Rankings—MOS EPROM
(Millions of Dollars)

1990 Rank	1991 Rank	Change In Rank	Company	1990 Sales ($M)	1991 Sales ($M)	1990-91 Growth (%)	1991 Cum. Sum ($M)	1991 Share (%)	1991 Cum. Sum (%)
1	1	0	SGS-Thomson	80	74	-7.5	74	25.3	25.3
3	2	1	AMD	50	57	14.0	131	19.5	44.7
2	3	-1	Intel	76	55	-27.6	186	18.8	63.5
4	4	0	Texas Instruments	45	33	-26.7	219	11.3	74.7
5	5	0	Philips Semiconductors	17	17	0.0	236	5.8	80.5
6	6	0	National Semiconductor	16	15	-6.3	251	5.1	85.7
9	7	2	Fujitsu	6	7	16.7	258	2.4	88.1
7	8	-1	Cypress	10	6	-40.0	264	2.0	90.1
8	9	-1	Toshiba	7	5	-28.6	269	1.7	91.8
12	10	2	Hitachi	2	3	50.0	272	1.0	92.8
11	11	0	Mitsubishi	3	3	0.0	275	1.0	93.9
10	12	-2	NEC	5	2	-60.0	277	0.7	94.5
13	-	NA	Oki	1	0	-100.0	277	0.0	94.5
			Others North America	11	16	45.5	293	5.5	100.0
			Others Rest of World	1	0	-100.0	293	0.0	100.0
			Total European	97	91	-6.2		31.1	
			Total Japanese	24	20	-16.7		6.8	
			Total North Americans	208	182	-12.5		62.1	
			Total Rest of World	1	0	-100.0		0.0	
			Total All Companies	330	293	-11.2		100.0	

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 6
European Semiconductor Market Share Rankings—MOS Other Nonvolatile
(Millions of Dollars)

1990 Rank	1991 Rank	Change In Rank	Company	1990 Sales ($M)	1991 Sales ($M)	1990-91 Growth (%)	1991 Cum. Sum ($M)	1991 Share (%)	1991 Cum. Sum (%)
2	1	1	SGS-Thomson	23	29	26.1	29	13.2	13.2
1	2	-1	Toshiba	24	20	-16.7	49	9.1	22.4
12	3	9	Intel	3	20	566.7	69	9.1	31.5
5	4	1	Sharp	13	13	0.0	82	5.9	37.4
4	5	-1	Texas Instruments	14	11	-21.4	93	5.0	42.5
3	6	-3	National Semiconductor	14	10	-28.6	103	4.6	47.0
9	7	2	NEC	5	10	100.0	113	4.6	51.6
7	8	-1	Hitachi	8	10	25.0	123	4.6	56.2
10	9	1	Samsung	4	7	75.0	130	3.2	59.4
8	10	-2	Philips Semiconductors	8	6	-25.0	136	2.7	62.1
6	11	-5	Fujitsu	10	5	-50.0	141	2.3	64.4
-	12	NA	ITT	0	5	NA	146	2.3	66.7
-	13	NA	Mitsubishi	0	4	NA	150	1.8	68.5
-	14	NA	Rohm	0	3	NA	153	1.4	69.9
-	15	NA	Eurosil	0	1	NA	154	0.5	70.3
13	16	-3	Oki	2	1	-50.0	155	0.5	70.8
14	17	-3	Motorola	1	1	0.0	156	0.5	71.2
15	-	NA	VLSI Technology	1	0	-100.0	156	0.0	71.2
11	-	NA	GEC Plessey	3	0	-100.0	156	0.0	71.2
			Others North America	40	60	50.0	216	27.4	98.6
			Others Rest of World	0	3	NA	219	1.4	100.0
			Total European	34	36	5.9		16.4	
			Total Japanese	62	66	6.5		30.1	
			Total North American	73	107	46.6		48.9	
			Total Rest of World	4	10	150.0		4.6	
			Total All Companies	173	219	26.6		100.0	

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 7
European Semiconductor Market Share Rankings—MOS Speciality Memory
(Millions of Dollars)

1990 Rank	1991 Rank	Change InRank	Company	1990 Sales ($M)	1991 Sales ($M)	1990-91 Growth (%)	1991 Cum. Sum ($M)	1991 Share (%)	1991 Cum. Sum (%)
1	1	0	IDT	10	13	30.0	13	37.1	37.1
2	2	0	SGS-Thomson	10	8	-20.0	21	22.9	60.0
3	3	0	Cypress	4	7	75.0	28	20.0	80.0
4	4	0	AMD	1	2	100.0	30	5.7	85.7
			Others North America	2	5	150.0	35	14.3	100.0
			Others Rest of World	0	0	0.0	35	0.0	100.0
			Total European	10	8	-20.0		22.9	
			Total Japanese	0	0	0.0			
			Total North American	17	27	58.8		77.1	
			Total Rest of World	0	0	0.0			
			Total All Companies	27	35	29.6		100.0	

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

European Companies' Capital and R&D Expenditure

Definitions

National accounting practices vary greatly. The information a US company is required by law to declare in its annual report under the headings of capital and R&D expenditure differ greatly from, say, that required by a German or Japanese company. Also, Dataquest's estimates are for calendar years, when many companies have financial years that straddle two calendar periods. With this in mind, Dataquest uses the following broad definitions in preparing its estimates:

- **Capital Expenditure**: All expenditures related to the manufacture and packaging of semiconductor devices
- **R&D Expenditure**: All expenditures related to the development of new semiconductor designs, process technology or packaging technology

European Companies

The data given in this section provide estimates of historical expenditure for 1989, 1990 and 1991, and give a projection for 1992. The capital and R&D data are expressed as a percentage of the companies' annual semiconductor sales, and in actual dollars spent.

Table 8 summarizes Dataquest's estimates of European companies' annual worldwide semiconductor sales since 1989.

Table 9 gives European companies' worldwide semiconductor-related capital expenditure since 1989. The total at the foot of the table shows that European companies have decreased their combined expenditure as a percentage of sales for the past three years. Cutbacks at Philips were the primary contributor to the drop in 1991. We expect the company to increase investment substantially in 1992. Europe's big three, Philips, Siemens and SGS-Thomson, represented 75 percent of European companies' combined investment in 1991. SGS-Thomson was Europe's big spender last year, investing $241 million or 16.8 percent of sales back into capital projects.

Table 10 gives European companies' worldwide semiconductor-related research and development expenditure since 1989. The picture is somewhat similar to capital expenditure. There was a significant decrease in European companies' combined R&D investment in 1991, and it was primarily caused by cutbacks at Philips. It is interesting to note that total R&D expenditure is consistently larger than capital expenditure over the three-year period. Europe's big spender in 1991 was Siemens, which spent $328 million or 26 percent of sales on R&D activities. Europe's big three represented 81 percent of Europe's R&D outlay last year.

By Jim Eastlake

Table 8
European Companies' Worldwide Semiconductor Sales
(Millions of Dollars)

Company	1989	1990	1991
ABB-HAFO	37	42	38
ABB-IXYS	50	58	54
Austria Mikro Systeme	56	59	70
Ericsson Components AB	54	56	74
Eupec	NA	96	93
European Silicon Structures	18	27	28
Eurosil	30	39	29
Fagor Electrotécnica	29	30	29
GEC Plessey	300	390	392
Matra-MHS	85	100	104
Mietec Alcatel	52	92	105
Philips Semiconductors	1,643	1,955	2022
Semikron International	95	106	108
SGS-Thomson	1,271	1,441	1,436
Siemens	1,154	1,204	1,263
STC Components Ltd	19	24	18
Tag Semiconductors	22	25	30
Telefunken Electronic	299	295	300
Thomson Composants	45	45	51
Zetex	NA	24	26
Total Worldwide Sales	$5,259	$6,084	$6,244

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 9
European Companies' Worldwide Semiconductor-Related Capital Expenditure
(Millions of US Dollars/Percentage of Sales)

Company	1989 ($M)	1989 (%)	1990 ($M)	1990 (%)	1991 ($M)	1991 (%)	1992 (%)
ABB-HAFO	5	13.5%	14	33.6%	9	22.4%	14.6%
ABB-IXYS	7	14.0%	7	12.1%	8	14.0%	10.0%
Austria Mikro Systeme	10	17.9%	11	18.7%	8	11.4%	18.0%
Ericsson Components AB	7	13.0%	8	14.3%	4	6.0%	12.0%
Eupec	-	NA	-	NA	-	NA	8.0%
European Silicon Structures	3	16.7%	6	22.2%	5	18.2%	12.0%
Eurosil	4	13.3%	5	11.9%	4	13.4%	10.0%
Fagor Electrotécnica	2	6.9%	3	10.0%	3	11.0%	7.0%
GEC Plessey	26	8.7%	34	8.7%	38	9.7%	9.8%
Matra-MHS	12	14.1%	13	13.0%	14	13.5%	14.5%
Mietec Alcatel	8	15.4%	22	23.9%	18	16.7%	63.4%
Philips Semiconductors	280	17.0%	282	14.4%	146	7.2%	13.0%
Semikron International	8	8.4%	11	10.4%	11	10.0%	11.0%
SGS-Thomson	234	18.4%	236	16.4%	241	16.8%	16.0%
Siemens	187	16.2%	172	14.3%	164	13.0%	16.0%
STC Components Ltd	2	10.5%	3	12.5%	2	10.0%	8.0%
TAG Semiconductors	2	9.1%	3	12.0%	4	12.0%	10.0%
Telefunken Electronic	39	13.0%	46	15.6%	48	16.0%	14.2%
Thomson Composants	20	44.4%	14	31.1%	13	25.0%	13.8%
Zetex	-	NA	1	3.0%	1	5.0%	7.0%
Total	856	16.3%	890	14.6%	738	11.8%	

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Table 10
European Companies' Worldwide Semiconductor-Related Research and Development Expenditure
(Millions of US Dollars/Percentage of Sales)

Company	1989 ($M)	1989 (%)	1990 ($M)	1990 (%)	1991 ($M)	1991 (%)	1992
ABB-HAFO	4	10.8%	10	22.6%	9	24.2%	20.7%
ABB-IXYS	5	10.0%	7	12.1%	7	13.0%	10.0%
Austria Mikro Systeme	7	12.5%	8	13.6%	9	12.1%	12.5%
Ericsson Components AB	6	11.1%	7	12.5%	15	20.0%	9.0%
Eupec	-	NA	-	NA	-	NA	10.0%
European Silicon Structures	8	44.0%	9	33.0%	5	17.8%	15.7%
Eurosil	3	10.0%	6	16.5%	5	16.4%	12.0%
Fagor Electrotécnica	2	6.9%	2	6.7%	2	8.0%	6.0%
GEC Plessey	25	8.3%	43	11.0%	48	12.2%	12.3%
Matra-MHS	9	10.6%	21	21.0%	22	20.8%	21.5%
Mietec Alcatel	7	13.5%	13	14.1%	13	12.4%	11.4%
Philips Semiconductors	378	23.0%	413	21.1%	273	13.5%	14.0%
Semikron International	5	5.3%	8	7.5%	8	7.0%	7.0%
SGS-Thomson	205	16.1%	274	19.0%	244	17.0%	16.0%
Siemens	304	26.4%	329	27.3%	328	26.0%	22.0%
STC Components Ltd	1	5.3%	2	8.3%	1	8.0%	6.0%
TAG Semiconductors	2	9.1%	2	8.0%	3	9.0%	6.0%
Telefunken Electronic	28	9.4%	42	14.2%	43	14.5%	14.2%
Thomson Composants	7	15.6%	7	15.6%	7	12.9%	12.5%
Zetex	-	NA	1	3.0%	1	4.0%	6.0%
Total	1,007	19.1%	1,203	19.8%	1,041	16.7%	

NA = Not Applicable
Source: Dataquest (December 1992 Estimates)

Major Users' Semiconductor Spending in 1992

Methodology

For each company, annual reports were chosen where the fiscal year most closely matched the 1991 calendar year. Reported revenues were listed by category of sales and converted to US dollars. Each company's revenue was then interpreted to extract those electronic hardware components that originated from its own manufacturing operations. These revenues were then subdivided into the six main applications segments:

- EDP
- Communications
- Industrial
- Consumer
- Military/Aerospace
- Transportation

The appropriate I/O ratios (the ratio of the value of semiconductor content to end equipment value) for each segment, were taken from the **Semiconductor Application Markets Europe** service, and applied to this revenue to derive a value for semiconductor content. A further estimation was made to ascertain the proportion of semiconductor value that was derived in Europe. This was achieved by estimating production in Europe.

The results reflected the situation in 1991. In order to arrive at an estimate for companies' semiconductor spending in 1992 we made adjustments based on the following sources:

- The results of our 1991/92 annual procurement survey, where some buyers had told us of their spending plans for 1992
- Results from equipment production surveys that we conducted regularly on a variety of electronics equipment
- Inputs from fellow Dataquest analysts in the following research groups:
  - European Personal Computers
  - European Telecommunications
  - European Document Management
  - European Computer Systems
- Public sources such as press clippings

These best estimates were then sent to contacts in the semiconductor community for a final check.

Each application segment has a semiconductor usage profile peculiar to it. For example, EDP is high in memory and microcomponent content, whereas the consumer segment has a high proportion of analog components used in the equipment. In order to estimate semiconductor spend by major product type (memory, microcomponent, logic analog, and so on) these characteristic product profiles were applied to each company's overall spend.

The Results

Our estimates of 1992 semiconductor spend by major user are presented in Tables 11 and 12 (at the end of the report). Table 11 gives our estimate of the top 35 European companies' worldwide semiconductor spends. Table 12 shows estimates of the top 50 worldwide companies' semiconductor spends in Europe.

In the process of compiling estimates of semiconductor spends, we noted a number of structural changes, new ventures and product announcements that may have affected company buying patterns. These company notes are given below to accompany the tables.

Company Notes

AB Electronic: The company's total headcount was reduced by some 1,900 during 1991 and it closed four factories. During the first half of 1991, AB Electronic sold Page Aerospace Limited, which formed the Aerospace and Defence Product Group, to concentrate its resources on core activities.

Acorn: Olivetti Realty NV owns 79.8 percent of Acorn's capital. Acorn plans to strengthen its leading position in the UK education market, of which it already controls 53 percent. The company has announced plans to launch a new notebook computer for use in schools.

AEG: AEG closed its loss-making office automation subsidiary AEG Olympia during 1992.

AEG sold its company AEG Kabel which produces cables to Alcatel, and is also selling AEG Aktiengesellschaft (electric tools) to the Swedish industrial group Atlas Copco.

Aerospatiale: Aerospatiale has formed a joint venture with MBB to develop a European helicopter. Aerospatiale has also created strong partnerships in the satellite field with Alcatel, DASA, Space System/Loral and Alenia.

Alcatel: Alcatel has acquired Fiat's subsidiary Telettra. In the United States, Alcatel bought Rockwell's Network Transmission Systems Division. Alcatel also acquired Canada Wire and Cable from Noranda, along with AEG's cable business.

Apple: In October 1991, Apple established a key alliance with IBM. The alliance is centered on five key technology initiatives:

- Improving Macintosh-to-IBM connectivity
- Developing a powerful RISC-based Macintosh
- Developing a mainstream, easy-to-use open-systems platform
- A joint venture, Kaleida, that will spur multimedia development
- A joint venture, Taligent, that will try to revolutionize the way software is developed

Apple also demonstrated the "Newton," its personal digital organizer, in 1992.

Ascom: In November 1991 Ascom formed a joint venture with LM Ericsson in the field of transmission. This joint venture, Ascom Ericsson Transmission AG, is based in Bern, Switzerland. Ascom has also purchased the American company Timeplex Inc., which is one of the world's leading suppliers of enterprise networks.

Bosch: During 1991, Bosch began to produce electric power tools at Sebnitz in Saxony. Also in Eisenach, in the New States of Germany, Bosch began construction of a factory for automotive equipment with a gross floor space of 42,000 m^2. At the end of 1991 the company completed a plant in Wales, which is now in volume production making alternators.

Bull: Bull has formed a major alliance with IBM on UNIX-based systems and microcomputer technologies. Bull has reduced the number of major manufacturing facilities it has worldwide from 13 to 5, and cut its work force by nearly 20 percent.

Commodore: Commodore has four product groups: Amiga multimedia computers, PC-compatible computers, C64 computers, and CDTV. Commodore began the phased launch of its CDTV player, the first CD-based interactive multimedia product for consumers, during the fourth quarter of 1991.

Compaq: Compaq has been manufacturing equipment in Europe for some time, but this has been built from imported subassemblies. The company began buying large volumes of memory modules in the United Kingdom, though, in 1991.

Dell: Like Compaq, Dell has begun buying memory modules in Europe for its facility in Ireland.

Digital Equipment: In 1991, Digital Equipment Corporation bought the majority of Philips' information systems business.

Electrolux AB: A production survey conducted by Dataquest in 1992 revealed that Electrolux only performs pre-production and design assembly of electronics subsystems. Once the design is complete, the company then subcontracts virtually all its electronics manufacture; it also allows the subcontractors to do all semiconductor procurement. Thus, Electrolux purchases very little semiconductor product itself.

More than 50 percent of Electrolux' revenue comes from its household appliances sector. These household appliances are split between white goods, floor-care products, room air-conditioners, kitchen and bathroom cabinets, and sewing machines. A restructuring program has been set in motion which will lead to the closure of at least 10 plants worldwide. During 1992 the company signed an agreement with Sanyo to develop and manufacture microwave ovens in Europe using fuzzy logic chip sets.

Hitachi: Hitachi is making a special effort to expand production at overseas sites. In 1991, as part of this strategy, it set up a company in Orleans (France) for manufacturing computer products (large magnetic disk storage subsystems), and increased the production capacity of a number of bases in other parts of the world. Hitachi says it plans to begin manufacturing domestic appliances in Europe in the next two years.

Lucas: Lucas acquired Tracor Aviation, a US company specializing in aircraft modification and maintenance services. It opened a new Lucas Hartridge factory in Buckingham, England, designed to produce sophisticated automated assembly and test products for aerospace and automotive markets. Lucas' joint venture with Eaton enhances its truck brakes business by improving their access to the North American market.

Matra: During 1991, Matra took a decisive step forward in the German market by signing agreements with AEG on mobile phones. The accords give Matra Communication a 100 percent stake in the capital of AEG Mobile Communication (of Germany) and AEG Radiocomunicaciones (of Spain).

Mitsubishi Electric: At the end of 1990, Mitsubishi Electric France SA's new factory in Rueil-Malmaison (near Paris) began delivery of cellular telephones to some sectors of the European market. Mitsubishi purchased, in 1990, the PC manufacturing operations of the UK firm Apricot Computers, and has since invested heavily in the factory, increasing its capacity.

Philips: Philips has sold the majority part of its information systems business to Digital Equipment Corporation. Philips also sold its remaining 47 percent interest in Whirlpool International BV to Whirlpool Corporation (mainly white goods appliances plants). Philips formed a consortium in Japan together with Matsushita and Sony for promoting the development of the CD-interactive system, and in particular CD-I software.

In January 1992, Philips sold its remaining 20 percent interest in Hollandse Signaalapparaten BV to the French company Thomson-CSF. In the former East Germany Philips acquired Narva Speziallampen GmbH in Plauen, a manufacturer specializing in the production of automotive lamps and special lighting, and in Bautzen it started the production of digital transmission systems. During 1992, after obtaining broad support from music companies and audio equipment manufacturers, Philips introduced the digital compact cassette (DCC).

Sagem Group: Sagem Group mainly comprises three companies: Sagem, SAT and Silec. As a result of efforts to control costs and monitor general expenses, the work force was reduced in the group's three main companies, by about 1,000 in 1991.

Schlumberger: Schlumberger has launched a new-generation ITS 9000 FX ATE components tester.

Siemens: During 1991, Siemens' investment in the eastern part of the unified Germany included the acquisition and modernization of 11 plants as well as the establishment of a distribution and service network covering the entire region.

Thomson Consumer Electronics: Thomson TCE had a bad 1991, mainly due to the fact that the consumer electronics market decreased, especially in North America and in Europe. Its new-generation VCR product is being made in Singapore.

Toshiba: Toshiba has opened a new copier plant in France. Production of printed circuit boards at the Regensburg laptop PC plant began at the end of 1991. Toshiba Consumer Products (UK) has begun making air-conditioners at its old microwave plant in Plymouth, England. Toshiba has increased its strategic alliances in Europe by cooperating in a joint venture with GEC Alsthom of France to manufacture and market vacuum bottles used in circuit breakers for power plants and substations.

By Jim Eastlake

Table 11
European Companies' Worldwide Semiconductor Consumption in 1992
(Millions of Dollars)

Company	Total Semi.	Total IC	Digital Bipolar	Total MOS	MOS Memory	MOS Micro	MOS Logic	Linear	Discrete	Opto.
AB Electronics	11	9	0	7	2	2	2	3	2	2
Acorn	6	5	1	4	2	1	1	1	0	0
AEG	69	48	3	29	6	11	12	16	17	4
Aerospatiale	19	15	3	8	3	2	3	4	3	1
Alcatel	521	407	22	271	68	110	93	113	75	40
Amstrad	84	70	5	49	21	16	13	15	10	4
Ascom	100	75	5	48	12	20	17	21	17	8
Asea Brown Boveri	78	48	5	28	4	12	12	14	23	6
Bang & Olufsen	20	14	0	6	2	3	1	8	5	1
Bayer	27	26	3	21	10	6	5	2	1	1
Bosch	670	494	18	346	49	126	171	130	133	42
Bosch Siemens	142	97	3	39	13	18	9	55	39	6
British Aerospace	35	28	6	15	5	4	6	7	5	1
Bull	181	170	17	140	67	39	34	13	6	5
Electrolux	50	34	1	14	4	6	3	19	13	2
Ericsson	331	261	18	179	51	68	60	65	47	23
GEC	213	140	21	78	17	29	32	41	57	15
GPT	143	111	6	74	18	30	26	31	20	11
Grundig	287	197	7	87	25	38	24	104	76	13
ICL	124	117	12	97	47	27	23	8	4	3
Italtel	113	88	5	58	15	24	20	24	16	9
Lucas	64	46	3	32	4	11	17	11	14	4
Matra Communication	76	59	3	39	10	16	14	16	11	6
Nokia Group	202	142	6	71	20	31	21	65	48	12
Olivetti	346	324	32	266	127	74	65	26	12	10
Philips	937	643	31	302	89	129	84	310	245	49
Racal Electronics	42	32	3	20	5	7	7	9	8	3
Rank Xerox	44	41	4	34	17	9	8	3	1	1
Sagem	49	40	3	28	9	10	9	9	6	3
Schlumberger	137	99	11	68	22	24	22	21	28	9
Sextant Avionique	10	8	2	4	1	1	2	2	1	0
Siemens	939	672	52	433	89	171	173	187	196	71
Thomson Consumer	331	228	7	94	30	43	21	126	88	15
Thomson-CSF	93	76	15	41	14	10	17	20	14	3
Tulip	17	16	2	13	7	4	3	1	0	0
Total	$6,509	$4,882	$334	$3,046	$885	$1,130	$1,030	$1,502	$1,243	$385

Source: Dataquest (December 1992 Estimates)

Table 12
Worldwide Companies' European Semiconductor Consumption in 1992
(Millions of Dollars)

Company	Total Semi.	Total IC	Digital Bipolar	Total MOS	MOS Memory	MOS Micro	MOS Logic	Linear	Discrete	Opto.
AB Electronics	11	9	0	7	2	2	3	2	2	1
Acorn	5	5	1	4	2	1	1	0	0	0
AEG	53	36	2	20	5	8	7	14	14	3
Aerospatiale	19	15	3	8	3	2	3	4	3	1
Alcatel	423	330	18	220	55	89	76	92	60	33
Amstrad	81	67	5	47	20	15	12	15	10	3
Apple	218	206	21	170	83	47	41	15	6	6
Ascom	94	71	5	47	11	19	16	20	16	7
Asea Brown Boveri	58	36	4	21	3	9	9	11	18	5
Bang & Olufsen	20	14	0	6	2	3	1	8	5	1
Bayer	20	19	2	16	8	4	4	1	1	1
Bosch	500	369	14	258	37	94	127	97	100	31
Bosch Siemens	142	97	3	39	13	18	9	55	39	6
British Aerospace	35	28	6	15	5	4	6	7	5	1
Bull	124	117	12	96	46	27	23	9	4	4
Commodore	83	76	7	61	29	17	15	8	4	2
Compaq	20	20	4	20	20	9	8	3	1	1
Dell	30	28	3	23	11	6	6	2	1	1
Digital Equipment	135	123	12	99	45	29	25	13	7	5
Electrolux	30	21	1	8	3	4	2	12	8	1
Ericsson	302	238	16	163	46	62	55	59	43	21
GEC	180	119	18	67	15	24	27	35	48	13
Goldstar	35	24	1	10	3	4	2	13	9	2
GPT	103	81	4	54	13	22	18	22	15	8
Grundig	214	148	5	65	19	28	18	78	57	10
Hewlett-Packard	209	191	20	155	73	44	38	16	11	7
Hitachi	57	39	1	16	5	7	3	22	15	3
IBM	849	801	81	663	322	182	159	57	24	23
ICL	113	107	11	89	43	24	21	8	3	3
Italtel	113	88	5	58	15	24	20	24	16	9
Lucas	50	36	2	25	3	8	13	9	11	3
Matra Communications	76	59	3	39	10	16	14	16	11	6
Mitsubishi	43	29	1	12	4	5	3	17	12	2
NCR	59	56	6	46	22	13	11	4	2	2
Nokia Group	180	127	6	63	17	27	19	58	43	10
Olivetti	251	235	23	193	92	54	47	19	8	7
Panasonic/Technics	153	109	5	51	18	21	12	53	37	7
Philips	547	370	17	168	46	74	48	185	148	29
Racal Electronics	31	24	3	14	4	5	5	7	6	2
Rank Xerox	44	41	4	34	17	9	8	3	1	1
Sagem	49	40	3	28	9	10	9	9	6	3
Schlumberger	53	39	4	26	9	9	8	8	11	4
Sextant Avionique	10	8	2	4	1	1	2	2	1	0
Siemens	580	417	32	268	56	106	107	116	120	44
Sony	201	137	4	55	18	25	12	78	54	9
Sun Microsystems	51	48	5	40	19	11	10	3	1	1
Thomson Consumer	149	102	3	42	14	19	10	57	40	7
Thomson-CSF	93	76	15	41	14	10	17	20	14	3
Toshiba	48	33	1	15	5	6	3	17	12	2
Tulip	17	16	2	13	7	4	3	1	0	0
Total	$6,962	$5,526	$424	$3,704	$1,340	$1,264	$1,117	$1,404	$1,084	$354

Source: Dataquest (December 1992 Estimates)

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9212 December 11, 1992

In This Issue...

Pricing Analysis

European Pricing Update

Most prices have experienced only nominal changes, with the exception of memory, where the imposition of dumping duties is beginning to affect prices. Demand for standard logic in small-outline packages, and 386 products, is increasing lead times.

By Mike Glennon and Adrian Walker *Page 1*

Market Analysis

State of the Industry

The SIA flash European book-to-bill ratio for October was 1.12, improving on September's 1.11. The 12-month moving-average continues its growth, and is approaching 10 percent increase. The first 9 months' data are now available from WSTS, giving the total product detail, and this shows a strong third-quarter recovery to the market. Most significant is the growth in memory and microcomponents, supporting the Windows-driven recovery to the European market. However, even analog and discrete products show signs of improvement. Growth for the year may exceed 12 percent if the past quarter's trend continues.

By Mike Glennon *Page 3*

European 1991 Microcomponent Market Share Rankings

The microcomponent market grew well above average in 1991, outperforming the semiconductor market in general again. Intel continues to dominate the market, with strong uptake for the 386 and 486 processors. Motorola is holding onto second position, though, well ahead of third-placed NEC. The majority of the growth for the market is from microprocessors, with microperipherals showing the lowest growth. This report analyses the market in 1991, and examines the performance of the top 10 suppliers to this market.

By Mike Glennon *Page 12*

Pricing Analysis

European Pricing Update

General

Prices have been unchanged over the past two weeks, with general uncertainty in the market following the Korean antidumping decision. The exchange rates are also more stable, following the major hiatus seen in October. Table 1 shows European semiconductor booking trends for orders of 1,000 and 10,000 units, and volume orders.

Standard Logic

Small-outline (SO) packaged products remain in short supply, and lead times are still 6 to 12 weeks, but prices have yet to show a rise as a result of the longer lead times. There are conflicting indications of how long the shortage will continue, with some expectations out to the start of the second quarter. Conversely, there are few indications of any additional capacity being added to reduce lead times, and meet demand.

Analog

The market is weak but stable. The consumer market is showing no signs of recovery, and demand from telecoms applications is continuing.

Microcomponents

As before, demand in the microcomponent market varies. New products from Intel and Cyrix, offering lower-voltage operation, are targeted more towards the portable market, and will have little impact on the existing market for a while. Advanced Micro Devices (AMD) and other 386 suppliers are benefiting from Intel's focus on the 486, as demand continues for 386 products. This keeps 386SX20 lead times long, as suppliers struggle to meet the demand. The MIPS processor is falling out of favor in Europe as the major users of this product, Digital

Table 1
European Semiconductor Pricing November 1992
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (%)	1K Adder (%)	Lead Time (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.37	10%	15%	4-12
74F244	PDIP	100K	0.21	10%	15%	4-12
Analog						
78L05	TO92	100K	0.14	10%	20%	4-8
IMSG171D 35-MHz Video DAC		100K	3.05	15%	25%	8-12
Microcomponents						
80386SX-20	PQFP	5K	45.00	0%	5%	10-16
80386DX-40	CPGA	5K	94.00	0%	10%	10-16
80486DX-33	CPGA	5K	350.00	-5%	5%	8-12
68040-25	CPGA	5K	370.00	-5%	10%	4-6
R3000-25	CPGA	5K	80.00	-5%	15%	4-10
DRAM						
1M×1-80 (1M)	SOJ	100K	3.30	5%	15%	2-6
4M×1-80 (4M)	SOJ	100K	10.30	5%	15%	6-8
512K×9-80 (4M)	SOJ	100K	13.25	5%	15%	10-12
256K×16-80 (4M)	SOJ	100K	12.75	5%	15%	10-12
4M×4-70 (16M)	SOJ	10K	92.00	0%	5%	8-14
(4M×1)×2+1M-60	SIMM	50K	26.50	5%	10%	8-10
128×8-80 VRAM	SOJ	100K	6.95	5%	15%	4-6
FLASH						
1M-17 (128K×8)	PDIP	10K	5.85	0%	10%	4-8
2M-17 (256K×8)	PDIP	10K	13.50	0%	30%	12-16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	4.30	10%	20%	8-12
SRAM						
256K-70 (32K×8)	PDIP	50K	3.00	5%	15%	2-4
256K-25 (64K×4)	PDIP	20K	4.50	5%	10%	6-8
1M-70 (128K×8)	PDIP	5K	8.00	-5%	15%	4-6

Source: Dataquest (December 1992 Estimates)

Equipment and Olivetti, switch to Digital's Alpha processor.

Memory

DRAM

The DRAM market is playing a waiting game, with prices firming as a result of the anti-dumping action both in Europe and in the United States. List prices may be higher, but contract prices have yet to reflect a significant increase. Wide-word ×9 and ×16 products are still on long lead times.

Flash

The flash market is dominated by the mobile phone market, with other applications in Europe taking a back seat. The heavy demand from this application and the dominance of the major suppliers combine to keep contract prices stable. The shortage of supply compared with demand is keeping the product on allocation, and inevitably reducing pressure on prices.

EPROM

The EPROM market is unchanged from October. Suppliers have good backlogs, and prices are stable.

SRAM

Prices have remained stable following the removal of duty from SRAM. However, the manufacture of fast SRAM in Europe next year will ensure imported fast SRAM will incur duty again, and give an advantage to local suppliers. In spite of the 40 percent price decline seen in the 1M SRAM in Europe over the past year, the market for SRAM will show the fastest growth after masked ROM this year. Unit demand is therefore very strong.

Current Exchange Rates

1 US dollar =
0.657 UK pounds
1.598 deutsche marks
5.389 French francs
0.811 ECU

By Mike Glennon
Adrian Walker

Market Analysis

State of the Industry

The SIA flash three-month average book-to-bill ratio for the month of October was 1.12, an increase over September's restated ratio of 1.11. October actual billings for Europe were $992.0 million, and three-month average bookings were $1,143.4 million. Figure 1 shows the book-to-bill ratio for the past 13 months, and the three-month average bookings and billings for the semiconductor market in Europe.

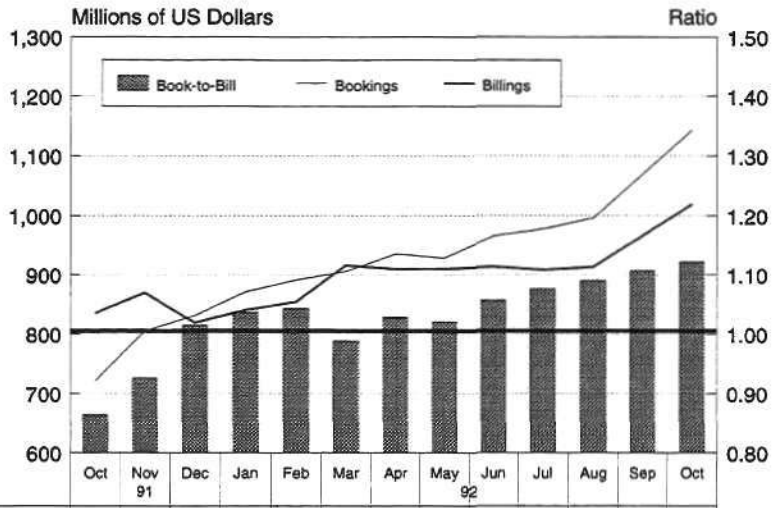
Billings for October normally decline when compared with September's, and this is reflected in the data. The actual billings data for September have been restated downward, but this has had little impact on the growth for the month. The bookings data for September have also been restated downwards, but not to the same extent; this has raised the book-to-bill ratio to 1.11 for September.

October's bookings are again at record levels, exceeding September's revised figures, and continue the inexorable rise, against the norm for this time of year. Bookings have broken the billion dollar mark for the second successive month, and three-month average billings for the first time ever.

The book-to-bill ratio is leaping well ahead, driven by the high level of bookings. Normally the book-to-bill ratio would have bottomed out this month, followed by a rise to the end of the year. The rise in the ratio, against the normal trend, would suggest higher billings levels are achievable.

The continued rise in bookings and billings is a clear sign of semiconductor recovery, and the data are tracking a similar recovery in the United States. As can be seen in Figure 2, the 12-month average growth in billings for the United States and Europe shows that much growth is still possible in the European market. The US market is acting as a leading indicator for Europe, and the recovery which began there in 1991 has continued to rise beyond 15 percent growth. Europe still has considerable room for further growth.

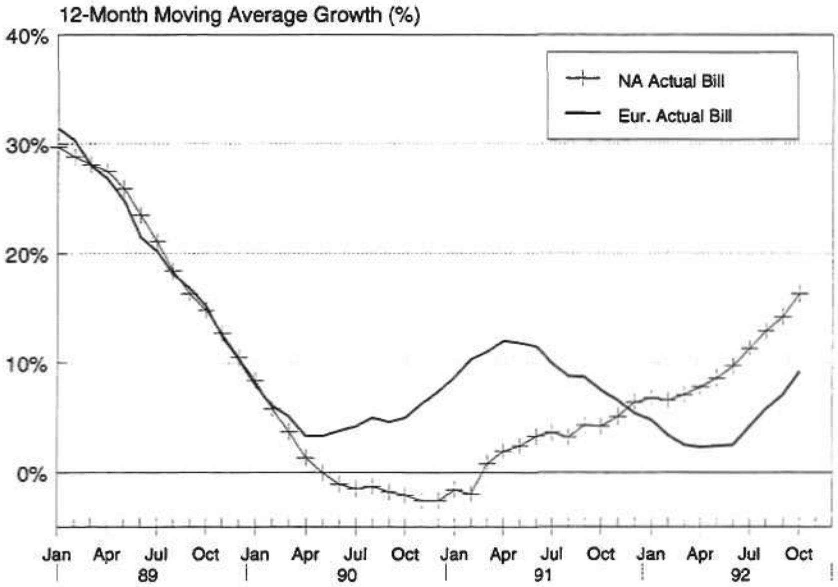
Figure 1
European Total Semiconductor Orders Booked and Sales Billed
(Three-Month Average)



	Oct	Nov 91	Dec	Jan	Feb	Mar	Apr	May	Jun 92	Jul	Aug	Sep	Oct
Book-to-Bill	0.86	0.93	1.02	1.04	1.04	0.99	1.03	1.02	1.06	1.08	1.09	1.11	1.12
Bookings	721	805	831	871	891	905	935	928	966	977	996	1,070	1,143
Billings	835	869	819	841	854	916	910	910	914	908	913	966	1,019

Note: Last two months are preliminary
Source: WSTS, SIA

Figure 2
European and US Total Semiconductor Billings Growth
(12-Month Average)



Source: WSTS, SIA, Dataquest (December 1992)

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trend and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billings and three-month average bookings figures. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

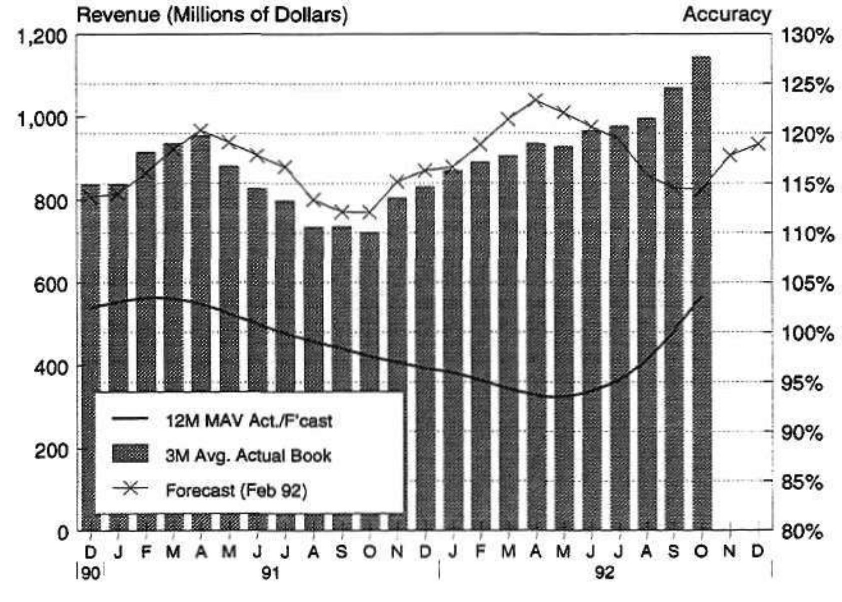
The phenomenal growth in bookings which began to run against the model indications began in June, as can be seen in Figure 3. Since then the high growth has driven the actual data to exceed the forecast data by as much as 38 percent for October. The 12-month moving-average actual over forecast is now above 100 percent, indicating the total year is an above-average year.

The actual billings data, seen in Figure 4, have yet to exceed the 12-month average forecast data for the year, but are getting very close. The actual data are tracking closely with the model, following 12 months of underperformance against the model. The momentum built up from the high level of bookings will ensure billings will exceed the forecast model predictions. The model forecasts a billings growth for the year over last year's actual of 12.8 percent, and this is likely to be exceeded.

WSTS product detail for the third quarter is now available, and it is possible to see how the products are performing when compared with the predictions made by the model for a typical year. The three product areas which have performed best in 1992 are memory, microcomponent, and logic. The comparison of the forecast model data and the actual data for these three product areas, and the growth predicted by the model are shown in Figure 5. The general recovery of the semiconductor market is easy to see from the lines in the graph, with both microcomponent and memories showing an upward trend.

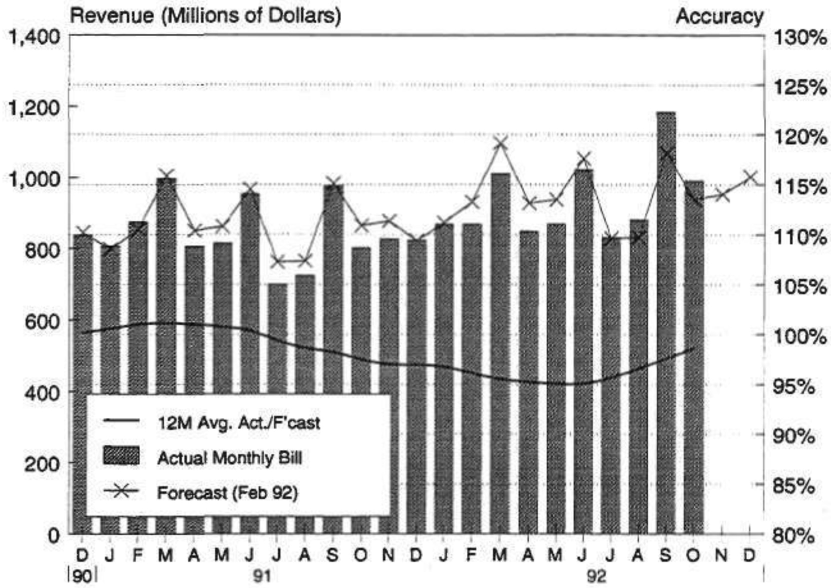
The microcomponent market has been outperforming the model for the past 20 months, and reflects a very healthy market. The model predicted a growth of 12.4 percent for 1992 over 1991's actual data, but this is a reflection of a good 1991, where the actual data exceeded the forecast model. When the growth is calculated

Figure 3
European Total Three-Month Average Bookings



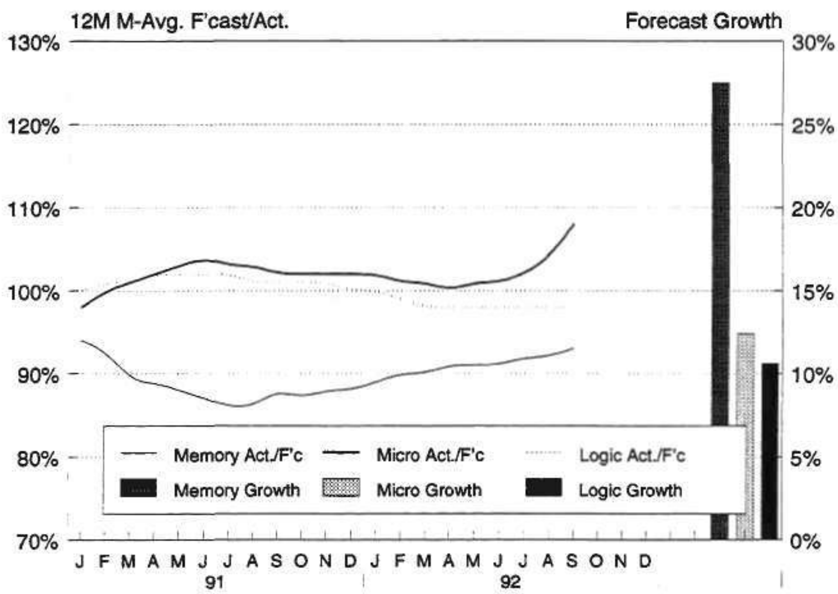
Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (December 1992)

Figure 4
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary
Source: WSTS, SIA, Dataquest (December 1992)

Figure 5
European Semiconductor Forecast Model Accuracy and Growth
Memory, Microcomponent and Logic



Source: WSTS, SIA, Dataquest (December 1992)

using 1991 forecast data, a higher figure of 14.5 percent is seen.

The memory market has also shown signs of a longer-term lifting in revenue, and the actual data are now approaching the forecast data. The model forecast very high growth for 1992 compared with 1991 actual data—a growth of 27.5 percent. This high figure is because of the underperformance of the market compared with the model throughout 1991 and the second half of 1990.

The logic market has matched the forecast model fairly closely, only slightly underperforming compared with the model. The above-average performance of the logic market in 1991 resulted in a lower-than-average growth forecast for 1992, but the weakness of the current year means the actual data are unlikely to reach this growth figure.

To summarize, for the three major product sectors, representing nearly 60 percent of the market: memories, at 94 percent of forecast, has had a below average year; microcomponents, at 110 percent of forecast, is well above average; and logic, at 98 percent of forecast, is slightly below average.

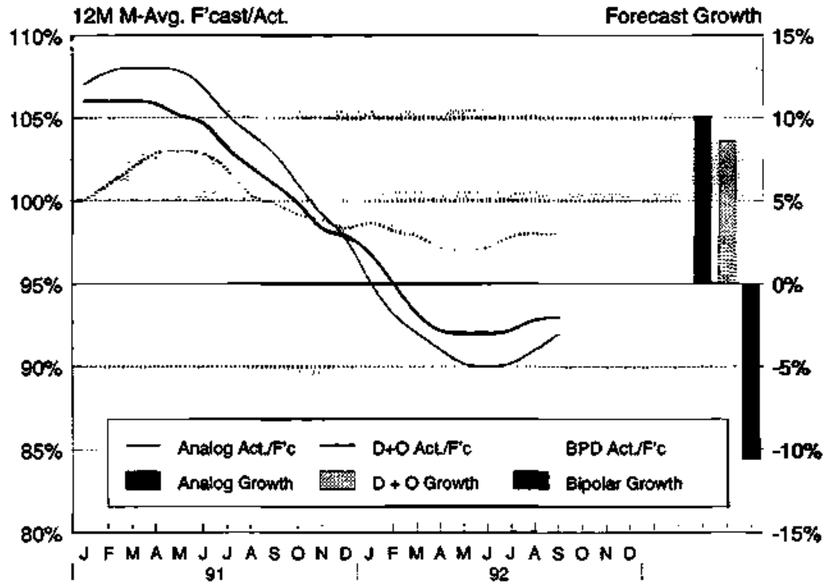
The other product categories of analog, discrete and optoelectronic, and bipolar digital are shown in Figure 6. Analog and discrete have had a well-below-average year, as is apparent from the performance against the model. Both of the products were performing well above average during 1991, resulting in a low growth forecast for 1992. However, the market for these products is so weak that they have failed to achieve even the low forecast suggested by the model. Only bipolar digital has performed anything like expected, and the model forecast a 10.6 percent decline here. The outlook is more optimistic, though, as analog, discrete and optoelectronics are both showing an upturn in the actual versus forecast, suggesting growth is returning to this product area.

Detailed Product Performance—The Year to Date

The year-to-date growth for the products which make up Europe's semiconductor market are shown in Figure 7. Also included in this graph is growth for the first half of the year for the products, and this shows how most of the growth for the year has come in the third quarter.

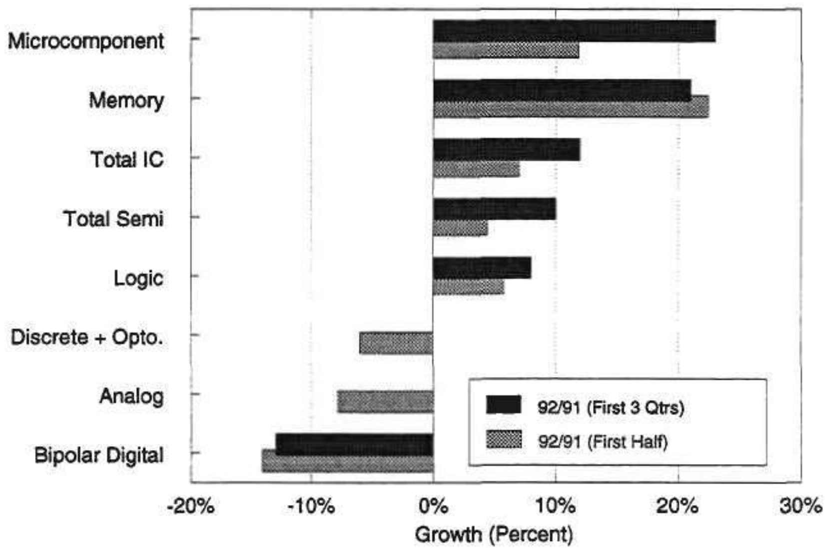
Figure 6

European Semiconductor Forecast Model Accuracy and Growth
Analog, Discrete and Optoelectronic, and Bipolar Digital



Source: WSTS, SIA, Dataquest (December 1992)

Figure 7
European Product Growth, First Half and Year-to-Date



Source: Dataquest (December 1992 Estimates)

Microcomponent

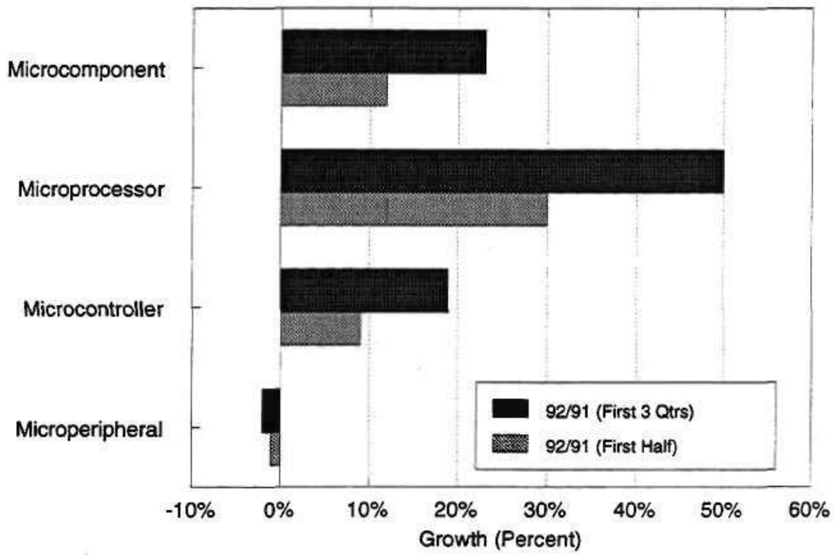
The fastest-growing product segment this year is microcomponents, which is showing an astonishing 25 percent growth for the first three quarters of 1992, compared with a mere 12 percent growth for the first half of the year. Early indications for the remainder of the year suggest the final quarter will be even better than the third quarter.

A closer look at the microcomponent detail shows the microprocessor sector is the dominant contributor to microcomponent growth, and much of this growth has come in the third quarter. Figure 8 gives more detail for microcomponent growth and shows that year-to-date growth for microprocessors is an incredible 50 percent, up from 30 percent for the first half. On a worldwide basis the 32-bit microprocessor segment shows an even more astonishing growth. While worldwide microprocessor growth for the year to date is below that for Europe, at 38 percent, 32-bit worldwide microprocessor revenue has risen by 76 percent over the previous year's first three quarters. There could not be a clearer indicator than this that the revenue growth for Europe in 1992 is driven by the PC.

European microcontroller revenue is also climbing, but not at the same rate as for microprocessors. Microcontroller revenue grew by 19 percent for the first three quarters of the year, compared with the first three quarters of last year. The introduction of emission standards for most new cars sold in Europe, together with the rise in use of anti-lock braking systems and safety features such as air bags, have added to microcontroller growth, doubling growth of 9 percent for the first half, to 19 percent for the first three quarters.

Microperipheral revenue was not able to match this revenue growth, and has actually declined by 1 percent over the same period. Again, this is indicative of a shift in emphasis from 386 processors to higher-value 486 processors for the PC. In addition, considerable PC production in Europe is from imported boards, with the processor and the memory components added locally. The microperipheral components would be added at initial board assembly, outside Europe, and would therefore not be measured in the European revenue figures. The worldwide microperipheral growth is currently 6 percent, suggesting that there is growth in this market, but it is outside Europe.

Figure 8
European Microcomponent Growth
Processors, Controllers and Peripherals



Source: Dataquest (December 1992 Estimates)

Memory

The second highest-growing product sector is memory, but growth in this sector has declined when compared with the first half. While microcomponents have shown a considerable third-quarter boost to growth, the memory sector has not exhibited a similar spurt. Growth has fallen marginally, from 22 percent for the first half, to 21 percent for the first three quarters. Memory components are benefiting from the growth in PC demand, and the additional need for memory for PCs using Windows applications. However, memory devices have undergone price erosion, so the dollar value of the memory market has not risen to the same extent as for microprocessors.

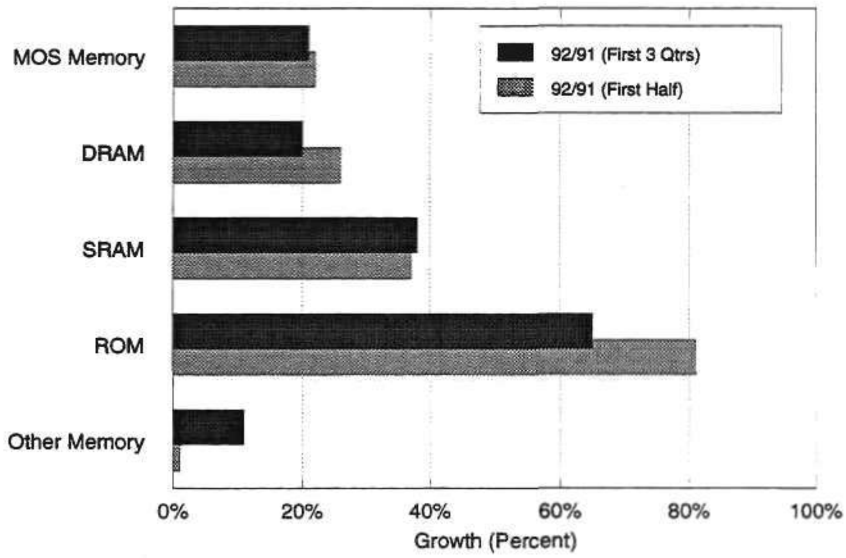
Figure 9 shows more detail for memory growth, and from the graph it can be seen that the memory product showing the highest growth in Europe is MOS ROM; however, this represents only 1 percent of the total memory market. Following this is SRAM, with 38 percent year-to-date growth. SRAM has seen two weak years, with severe competition forcing prices down. But some suppliers have left this market, and this has eased price pressure a little.

DRAM holds the largest share of the memory market in Europe, at 60 percent. The product has not seen growth as high as for SRAM, but year-to-date growth is still a creditable 20 percent. Price declines have lowered the growth of the market, while unit shipments have seen much higher growth. On a worldwide basis Europe is underperforming, with worldwide growth reaching 24 percent year-to-date. This is because of the high pressure on prices in Europe, Europe being the cheapest region in the world for memory products. The rate of decline in prices is likely to be lessened, however, due to the provisional antidumping duties imposed on Korean suppliers for 1M and 4M devices. In the United States the antidumping duties are more severe than the 10 percent imposed in Europe, and this is expected to provide higher growth to the market there than in Europe. Overall, though, the likelihood is that there is still room for growth in the memory market for the foreseeable future.

Logic

The logic market has added to its first-half growth of 6 percent, lifting this to 8 percent. More than 60 percent of the logic market is now ASIC, and this had a weak first quarter.

Figure 9
European Memory Growth
DRAM, SRAM, ROM and Other Memory



Source: Dataquest (December 1992 Estimates)

Much of the growth for this market is related to ASIC design starts, and uncertainty over the future of equipment demand has delayed many equipment projects, resulting in a delay in these ASIC starts. The designs are now either beginning to appear, or have been cancelled, incrementing ASIC growth, and lessening future uncertainty.

General-purpose logic has also suffered from weak demand and the general decline in this market. Application areas such as telecommunications have kept the market alive, and demand is now recovering, mainly because of a shortage of SO package capability. This shortfall is increasing lead times for products, but has yet to increase prices. However, these prices are stabilizing, and this will at least slow the decline in the market. Lead times for some products are now extending into 1993.

Discrete and Optoelectronic

Discrete and optoelectronic products have shown considerable recovery from the first half, with a 5 percent decline for the first half being improved to flat growth for the first three quarters. Discrete applications include consumer and telecoms equipment. The consumer market in Europe has been very weak, but the telecoms sector has shown stable growth. In addition, the growth in consumption of automotive electronics has provided some stimulus to discrete products. While much of automotive growth has been for microcontrollers, driven by the imposition of emission standards for all new cars, antilock brakes and air bags have also grown in use. These applications use discrete products, and this has added to discrete and optoelectronic growth. Discrete products represent 19 percent of the total semiconductor market in Europe, and the turnaround of this product has had a small impact on the total market.

Analog

The consumer market in Europe has been very weak, and continues to remain in this condition. The build-up of inventory of TV sets and video recorders in time for an expected boom resulting from the Olympic Games has left Europe awash with products. The expected demand never really appeared in any significant abundance, and the result is the weak demand for analog components. Other areas have provided some demand for analog, and these include telecoms and automotive. The growth of automotive has added to analog's weak first half growth, reducing a decline of 8 percent for the first-half to zero growth for the first three quarters.

Bipolar Digital

The demand for bipolar products continues much as expected, with a 14 percent first-half decline softened slightly to a 13 percent decline for the year to date. With bipolar digital now representing less than 4 percent of the total market, events in this product area have little impact on the semiconductor market as a whole. Bipolar is still finding applications in the highest-speed products, and the PC boom is adding to bipolar PAL demand, as PC clock speeds move towards 50 MHz. There will always be an inherent demand for the highest-speed products, but the reducing size of the market means less interest from many suppliers. Some suppliers are already leaving this market, and this will reduce competition for sockets. The final result is a reduction in price declines, but unit demand is still weakening, lowering the dollar value of the market further.

Dataquest Perspective

The PC is driving the third quarter growth in Europe. The shift to higher-performance machines is increasing memory and microcomponent demand, as can easily be seen from the preceding data. Automotive applications are also increasing demand for microcomponents, as engine management becomes mandatory to meet the new emission standards. These two factors alone are sufficient to explain the meteoric growth in semiconductor demand for the third quarter of 1992. In addition, memory demand is increasing, and competition is being reduced, albeit artificially, with the imposition of anti-dumping duties.

There is a real spectre of shortages for some components next year, if demand recovers. Already lead times are lengthening for SO general-purpose logic, and while the emphasis is shifting to the 486 for the PC, Intel's departure from 386 supply is increasing lead times for 386 parts as well. Some memory products are on long lead times, but as demand grows lead times for other memory products will also lengthen. The capacity exists to meet the expected demand, but this capacity is not operational yet, as much of it has been put on hold because of the weak demand earlier in the year. Whether this capacity is switched on is up to the individual suppliers. Clearly, higher prices benefit semiconductor manufacturers, but significant supply-and-demand mismatches represent a lost opportunity, and make longer-term forecasting of demand much more difficult. This encourages the incorrect phasing of supply and demand, and promotes the well-known boom-and-bust cycle for the semiconductor market.

Finally, we present an outlook for the year-end. The rolling 12-month growth is currently 9.2 percent. If November and December show zero growth, the year will close 9.1 percent up on 1991, but if the last two months reflect more closely the third quarter, they will show growth nearer to 20 percent. Should this be the case, the year will close 12.4 percent up on 1991—a healthy growth in a supposedly poor year.

By Mike Glennon

European 1991 Microcomponent Market Share Rankings

The microcomponent market in Europe grew by an estimated 15.5 percent in 1991, compared with a growth of 5.8 percent for the total semiconductor market. The microcomponent market has consistently outperformed the semiconductor market, growing from a share of 2.9 percent in 1977, to 18.9 percent in 1991. Much of this growth can be attributed to the dominance of personal computers, with microperipherals following the lead set by microprocessors, but microcontrollers have also enjoyed growth comparable with microprocessors and microcontrollers.

The top suppliers in this market are both North American, with Intel and Motorola retaining the leading positions in the market share ranking. Intel consolidated its first position with a 25.6 percent growth over 1990, and the company's microcomponent revenue is now larger than the combined revenues of the next four companies.

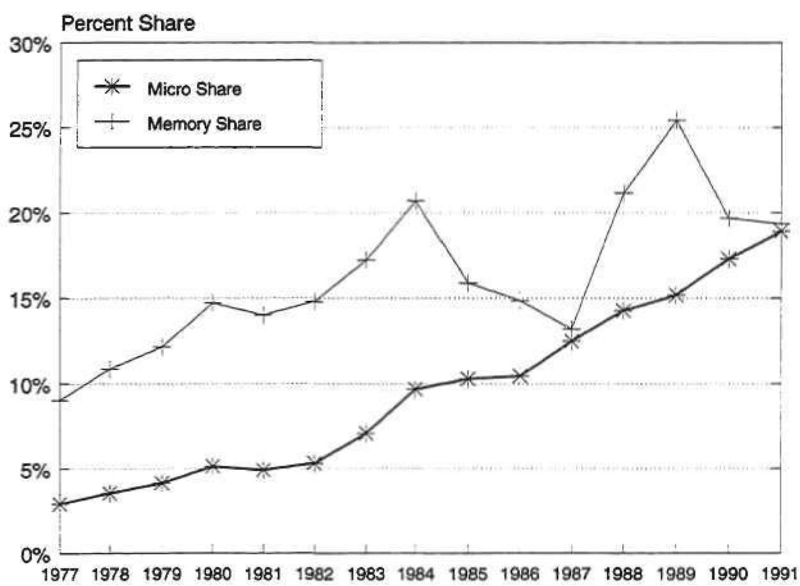
This report examines the performance of the top 10 microcomponent suppliers, and analyses the performance of the product segments that comprise the microcomponent market.

Microcomponents

The microcomponent market grew by an estimated 15.5 percent in 1991, adding to its 25.0 percent growth the previous year. Microcomponent growth has consistently outperformed the total semiconductor market in Europe, and consequently grown its share of the market. This is graphically illustrated in Figure 10, which shows microcomponents' share of the semiconductor market growing from a mere 2.9 percent in 1977 to nearly 19 percent in 1991. The share of the market taken by memory products is also shown on the graph, and while memory has a comparable share of the total market, its growth has been from a larger initial share. The microcomponent market has also exhibited more stable growth, when compared with the cycles seen in the memory market.

Microcomponent growth in 1991 slowed compared with 1990, but this is partly because of the slowness of the total semiconductor market, and partly because of the magnitude of the previous year's growth.

Figure 10
European Microcomponent and Memory Revenue
(Percent of Total Semiconductor)



Source: Dataquest (December 1992 Estimates)

Intel is by far the largest supplier of microcomponents, and has revenue exceeding that of the following four suppliers added together. Table 2 shows the top 10 microcomponent suppliers, and there are few changes since last year. SGS-Thomson (ST) and Philips have changed places, Philips having overtaken ST; and AMD displaces Toshiba at eighth position, with Toshiba falling out of the top 10 suppliers.

Intel has continued its success with its microprocessor family, mainly through sales to PC manufacturers. The 386 has become the entry-level product for most PCs and the company is now competing with other suppliers of this type of product. To defend its position as number-one supplier of microprocessors to the PC industry, Intel is moving the demand for processors to the 486, and is protecting this product through product enhancements and litigation. By moving the entry-level processor for PCs to the 486, Intel is making a space for high-performance systems to use its next-generation processor, the P5, which is due for production release in early 1993.

Motorola has continued in the development of embedded controllers, and is achieving considerable success with the 68ECxxx family. The workstation market has moved towards RISC processors, previously the domain of Motorola's 68xxx processors, but a large percentage of laser printers still use the 68xxx as the core controller.

Table 2

Top 10 Microcomponent Suppliers in Europe, 1991

Rank '90	Rank '91	Company	Revenue ($M)	AGR (%)
1	1	Intel	663	25.6
2	2	Motorola	264	13.3
3	3	NEC	150	8.7
5	4	Philips Semiconductor	115	2.7
4	5	SGS-Thomson	108	-14.3
6	6	Texas Instruments	107	8.1
7	7	Siemens	87	4.8
8	8	Hitachi	75	8.7
11	9	Advanced Micro Devices	65	38.3
10	10	National Semiconductor	58	18.4
		Others	390	22.6
		Total All Companies	2,082	15.5

Source: Dataquest (December 1992 Estimates)

Motorola generates the majority of its revenue in the microcontroller market (55 percent), but this market grew less than the microprocessor market in 1991, resulting in Motorola growing below the market average. Motorola's microcomponent revenue is nearly twice that of its nearest competitor, though, allowing a considerable decline in the company's share before it loses its second place.

NEC, like Motorola, has the majority of its microcomponent revenue (73 percent) in microcontrollers, and consequentially its microcomponent share has also grown less than the average. NEC's microcontroller performance has also been slightly below average, mainly due to the state of the consumer market. Much of NEC's controllers fit into consumer applications, and the sale and manufacture of consumer goods through much of 1991 was weak. The company also had considerable sales in microperipherals, which was the weakest of the three product markets. NEC's sales in this market declined.

Philips Semiconductor also grew below average, mainly because of the decline in microperipheral sales. The company's microcontroller sales grew above average, a significant achievement considering Philips' focus on consumer products. The company improved its position in the market share ranking, mainly due to the decline in SGS-Thomson's revenue, rather than above-average growth from Philips.

SGS-Thomson dropped one position in the market share tables, as its revenue declined in all three product segments. Nearly half of the company's revenue is in microcontrollers, and is focused in consumer and industrial applications. SGS-Thomson has access to Intel's products through its acquisition of Mostek. Mostek had a license agreement with Intel, allowing the company to manufacture Intel's products; this license passed to SGS-Thomson when the company bought Mostek. However, ST has so far failed to use this agreement to enter the lucrative Intel-compatible processor market.

Texas Instruments (TI) retained its position, although with below-average growth. The majority of TI's revenue is in microcontrollers and microperipherals. The company's position in programmable digital signal processors (DSP) is good, with much of this market using TI's TMS320 series of devices; DSP devices are included in the microcontroller category of microcomponents. In addition, TI has a range of graphics and local area network (LAN) products, which have also added to the company's revenue growth.

However, while TI grew its revenue above average in microperipherals, this market only grew by 4.0 percent. In microcontrollers, where growth was higher, at 15.8 percent, TI only grew by 5.8 percent. As microcontrollers represent over half of the company's microcomponent revenue, the overall performance was below average when compared with the microcomponent market as a whole. The introduction of TI's 80386 processor in 1992 should boost its microprocessor revenue considerably; Texas Instruments has the design for the 80386 developed by Cyrix, and has an agreement with Intel which allows it to supply the processor.

Siemens grew below average due to a decline in both microprocessor and microperipheral revenues. The R3000 RISC processor, which promised significant revenue for Siemens, has not been as successful as was first anticipated. The major workstation user for the processor, Digital Equipment, fared poorly in the workstation market, resulting in low sales of the MIPS architecture processor by all manufacturers in Europe.

The outlook for 1992 is not much better, because of the breaking-up of the ACE consortium, which would have promised large sales for the R3xxx product family. Digital also introduced its own Alpha RISC microprocessor, and announced the defection of the company to the new processor. Olivetti, another subscriber to the MIPS architecture camp, has also agreed to use the Alpha processor in its products, replacing the R3000.

Siemens was more successful with its microcontrollers, which focus more on industrial and automotive applications. Automotive in particular grew well in 1991, driven by an increase in use of engine management systems.

Hitachi, as with most of the top 10, grew below average. Over half of the microcomponent revenue (65 percent) is from microcontrollers, which also grew below average. This is due to the poor performance of the consumer market, one of Hitachi's main application areas for its controllers.

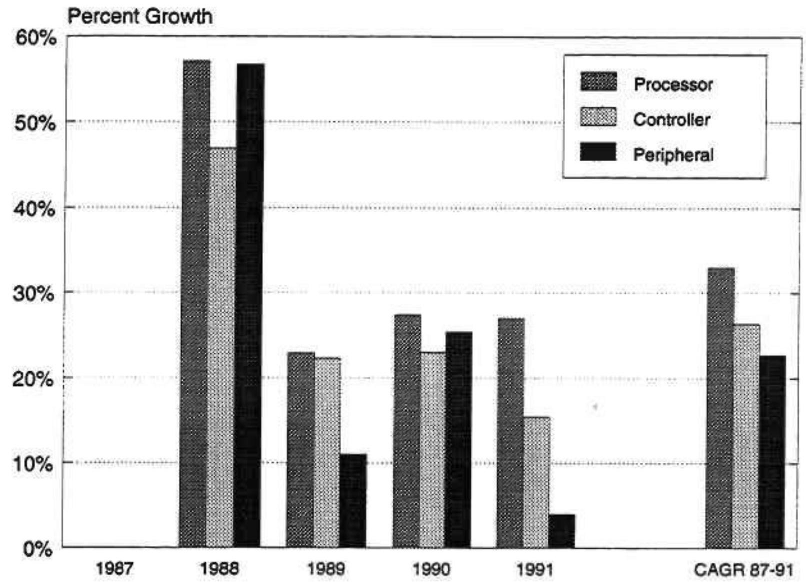
Advanced Micro Devices was the star performer of the top 10, growing by nearly 40 percent. All of this growth is from the rise in microprocessor sales, which compensated for a decline in revenue from microcontroller and microperipherals. The introduction of AMD's Am386 product family generated the growth in microprocessor revenue, and provided the only competition to Intel's i386 products. AMD is now attempting to capitalize on this revenue growth, and aims to introduce a 486 copy to penetrate Intel's sales of this product also. Intel recently won a legal case forbidding AMD from using Intel's microcode, and this has delayed the introduction of AMD's 486 products. AMD's high growth allowed it to leap two places in the rankings, and enter the top 10 at ninth position. While much of the credit for AMD's growth can be attributed to its 386 products, shipments of the 29000 family of RISC processors also contributed to revenue growth, finding major success in applications such as laser printers.

National Semiconductor was one of only three companies in the top 10 to grow above average. Most of the company's growth is from gains in processor and controller revenue. Embedded control is one of the main areas of focus for the company now, with the NS32032 family of processors finding considerable success in laser printer applications. National is also strong in LAN products, and has recently reached an agreement with IBM over the supply of devices for IBM's Token-Ring network.

Product Performance

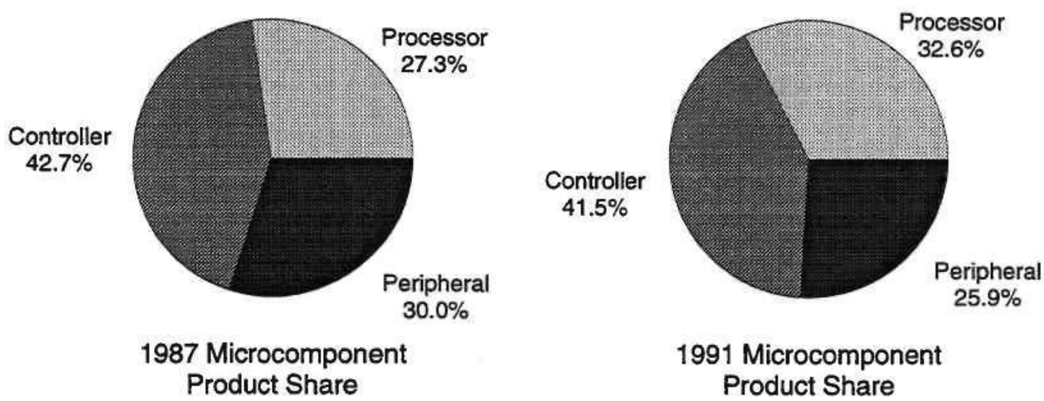
The microcomponent market is composed of microprocessors, microcontrollers and microperipherals, with DSP products included in microcontrollers. The three product segments have had differing growth rates during 1991, compared with similar rates in the previous year. Figure 11 shows the growth rates for the product categories, and it can be seen from this that the greatest growth came from microprocessors, with microperipherals showing the lowest growth. The relative sizes of the categories are shown in Figure 12, with microcontroller taking the largest share of the microcomponent market. Microcontrollers have slowly lost share of this market since 1977—the earliest date for which Dataquest has separate data for the three product categories—as has microperipherals.

Figure 11
European Microprocessor, Microcontroller and Microperipheral Market Growth



Source: Dataquest (December 1992 Estimates)

Figure 12
European Microprocessor, Microcontroller and Microperipheral Product Share of Microcomponents (Percent)



Source: Dataquest (December 1992 Estimates)

Microprocessors

The high growth seen in microprocessor can mainly be attributed to Intel's success with its 80386 and 80486 products. Nearly half of the growth in this product sector is from Intel. The company's position as sole supplier of 386 processors has lessened competitive pressure that would force the company to reduce its prices. The benefit to the company has been in high margins on the product, allowing higher levels of investment in product development and manufacturing.

Table 3 shows the top 10 microprocessor suppliers to Europe, and their growth rates for 1991. Intel has unsurprisingly retained its position at the top of the table, with Motorola also retaining its position. AMD moved up two positions, pushing down SGS-Thomson and Siemens. NEC slipped a little, from joint ninth position to tenth.

Microcontrollers

The microcontroller market is the largest of the three product segments, both in units and revenue. This market fared less well than the microprocessor market, though, growing by a little over 15 percent, largely because of the range of applications for controllers. Much of the demand for microcontrollers is in consumer applications, but the market was weak in 1991 because of the weak demand for consumer goods. Demand from telecoms and automotive applications was stronger, however; with controllers being used in telephone handsets, engine management units and body electronics, this lifted the total microcontroller market in Europe by 15.4 percent.

Table 4 shows the top 10 microcontroller suppliers in Europe, and there is very little change in company rankings when compared with 1990. The major change is Siemens taking over the lead from SGS-Thomson. Siemens recently introduced a new 16-bit controller family for telecoms and automotive applications, and this contributed to the company's growth. The relatively poor performance of SGS-Thomson was because of its greater focus on consumer markets, which contributed to the exchange of positions at the top. The remaining suppliers retained their positions in the rankings.

Microperipherals

This market segment grew the least of the three segments, with only 4.0 percent growth in 1991. The top 10 suppliers are listed in Table 5, which shows that the microperipheral market is the one with the greatest change in the positions of the companies.

Table 3
Top 10 Microcoprocessor Suppliers in Europe, 1991

Rank '90	Rank '91	Company	Revenue ($M)	AGR (%)
1	1	Intel	420	32.5
2	2	Motorola	74	10.4
5	3	Advanced Micro Devices	35	169.2
3	4	SGS-Thomson	27	-25.0
4	5	Siemens	19	-5.0
6	6	National Semiconductor	16	33.3
7	7	Toshiba	13	18.2
8	8	Hitachi	11	10.0
9	8	Harris	9	50.0
10	10	NEC	7	16.7
		Others	47	30.6
		Total All Companies	678	27.0

Source: Dataquest (December 1992 Estimates)

Table 4
Top 10 Microcontroller Suppliers in Europe, 1991

Rank '90	Rank '91	Company	Revenue ($M)	AGR (%)
1	1	Motorola	145	14.2
2	2	NEC	110	13.4
3	3	Intel	108	13.7
4	4	Philips Semiconductor	89	25.4
5	5	Texas Instruments	55	5.8
7	6	Siemens	52	15.6
6	7	SGS-Thomson	49	-2.0
8	8	Hitachi	39	11.4
9	8	Toshiba	36	5.9
10	10	Matra MHS	29	20.8
		Others	152	
		Total All Companies	864	15.4

Source: Dataquest (December 1992 Estimates)

Table 5
Top 10 Microperipheral Suppliers in Europe, 1991

Rank '90	Rank '91	Company	Revenue ($M)	AGR (%)
1	1	Intel	135	16.4
2	2	Texas Instruments	47	9.3
4	3	Motorola	45	15.4
10	4	Western Digital	38	111.1
6	5	NEC	33	-5.7
3	6	SGS-Thomson	32	-20.0
7	7	VLSI Technology	30	11.1
8	8	Advanced Micro Devices	25	-3.8
9	8	Hitachi	25	4.2
5	10	Philips Semiconductor	22	-42.1
		Others	108	-4.4
		Total All Companies	540	4.0

Source: Dataquest (December 1992 Estimates)

Most of the microperipheral market consists of coprocessors, network products, PC chip sets, and graphics controllers. There is relatively little manufacture of graphics cards in Europe, but those which are manufactured have enjoyed reasonable growth. The demand for PC graphics cards is clearly related to PC demand, but much EDP consumption now comes from upgrades of existing machines. Therefore, while PC demand has been reasonable, demand for microprocessors and memory has been greater, as PC users upgrade their PCs to give higher performance and larger memory.

Coprocessors have seen major price reductions, with Intel responding to competition from suppliers such as Cyrix and IIT, which have offered compatible products but at a much lower price. In addition, the 486DX processor includes a floating-point unit, obviating the need for an additional coprocessor.

The PC chip set market was very aggressive in 1991, and price declines have been severe. Profitability for those companies which participated in this market has been weak.

The LAN market has shown high growth, although manufacture of network cards in Europe is low. Most of the cards are imported. In spite of this, though, there is a rise in manufacturers coming to Europe to build products, and the number of companies which manufacture here will continue to rise.

In the market share rankings, Motorola moved up one place, to third place, but the greatest improvement in position is from Western Digital, leaping from tenth place in 1990 to fourth in 1991. This is due to increased sales of network products to manufacturers in the region, and reinforces the high growth for these products. Disk drive products also contributed to Western Digital's growth.

Regional Suppliers

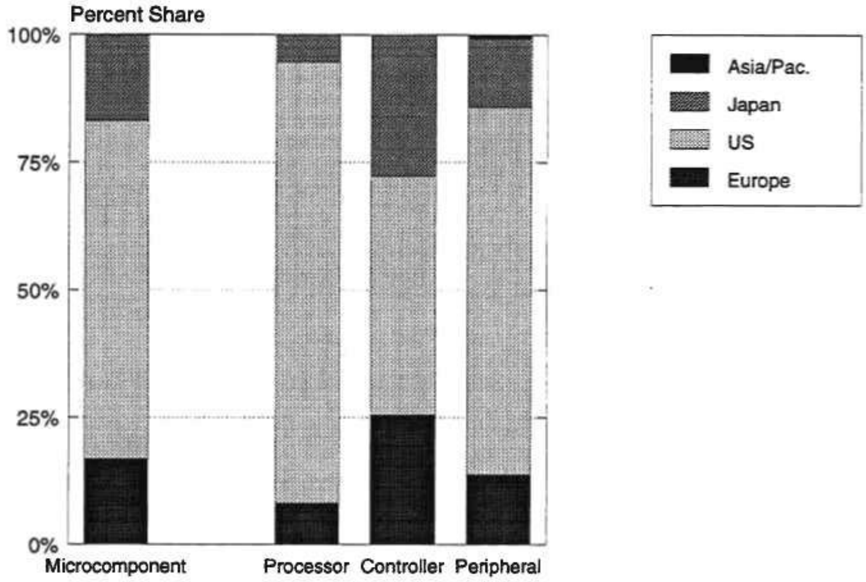
The microcomponent market is dominated by North American–based suppliers, as is shown in Figure 13. Two-thirds of the microcomponent market is served by these suppliers. An examination of the product categories reveals the microprocessor segment is almost exclusively served by US-based suppliers, which have over 85 percent of the market. This dominance is growing. In 1988, 60 percent of the microcomponent market was served by US companies, and the greatest loss has been to Japanese suppliers, whose share has fallen from nearly 21 percent in 1988, to just under 17 percent by 1991.

The strength of North American suppliers in the microcomponent market had appeared to be under threat, since the introduction of RISC processors allowed European and Japanese companies to gain licenses for the products. As RISC processors were initially expected to replace CISC processors, the hold of the processor market by US-based companies appeared to have been relaxed. However, RISC processors have not achieved their initial expectations, ensuring the US strength in the microcomponent market remains.

In microcontrollers the share by supplier base is more balanced. Applications for microcontrollers cover most of the categories, and consumer and telecoms products in particular are major users of microcontrollers. It is in these applications that European and Japanese suppliers have greater expertise, developed in their home markets, and this is where these companies are able to use this expertise to provide products more suited to the microcontroller market.

The microperipheral market is again dominated by North American suppliers, closely matching

Figure 13
Regional Share of Product Markets by Supplier Base Region



Source: Dataquest (December 1992 Estimates)

the microprocessor market. The link between the two is obvious, as peripheral products will find their biggest demand in the PC, until recently manufactured mainly in the United States, by US companies.

Dataquest Perspective

Intel's position at the top of the microcomponent market appears unassailable. This one company alone has nearly one-third of this market, leaving the remaining two-thirds to be divided between the more than 30 others. Intel's strength comes from its focus on microcomponents as its main source of revenue. Most of the other suppliers have a wider range of products other than microcomponents, and inevitably place less emphasis on the market.

There has been a period of consolidation in the market, with the effective rebuffing of threats to the established processor architecture. In Europe at least, the RISC processor has enjoyed less success than its CISC counterpart. RISC has found its place in the microcomponent market, but not as the leading architecture—this place goes to CISC.

The introduction of other suppliers of Intel-based architecture has finally provided some competition for the company. The near tripling of AMD's microprocessor revenue shows what can be gained when even a small part of the PC market is won. Intel is responding well, though, and is shifting the entry-level PC to a 486 base. The company has already shown its ability to move the market to 386.

The PC chip set market is still very competitive. Time to market is the major issue with these parts, and they have a typical product life of only 18 months. It is no surprise, therefore, to see ASIC companies such as VLSI Technology high in the microperipheral market share rankings, as these ASIC companies have a wealth of experience serving fast-moving markets, where time to market can be crucial. However, the profitability of these chip sets is low, and poor timing can cost the companies dearly. The weakness of the microperipheral market relative to the microprocessor market is related to the high level of competition between chip set suppliers.

Among the other microperipherals, the coprocessor saw strong competition for the first time. Suppliers such as AMD and Weitek had been making coprocessors for some time, and were happy to follow Intel's lead on pricing. The entry to the market of other suppliers such as Cyrix and IIT, prepared to undercut the established pricing strategy to gain market share, reset the high price band these coprocessors fell into, resulting in significant price reductions from Intel. This also pushed the microperipheral market value down.

In the network market, the outlook is for strong growth. The agreement between National Semiconductor and IBM over IBM's Token-Ring system should open up the network market more. National has enjoyed considerable success in the network market anyway, and this should add to its fortunes.

Microcontrollers have suffered mixed fortunes. The weakness of the consumer market, following a small boom over the fourth quarter of 1990 and the first quarter of 1991, reduced demand for 4-bit and 8-bit controllers, but this was compensated for by the rise in demand for telecoms and automotive applications, giving moderate growth to microcontrollers.

The outlook for microcomponents is mixed. Data processing remains the major application. The introduction of Windows from Microsoft has stimulated demand for higher-performance processors, which is continuing through 1992 and into 1993. The development of video compression techniques, and the establishing of standard algorithms for this compression, should stimulate the demand of computer-based products such as multimedia players and videotelephones. The weakness of the consumer market will delay the demand for these products, though, consequentially delaying demand-led growth for the microcomponents. The success of the PC will ensure that established levels of growth continue, and semiconductor suppliers to this market do not suffer in the meantime.

By Mike Glennon

In Future Issues

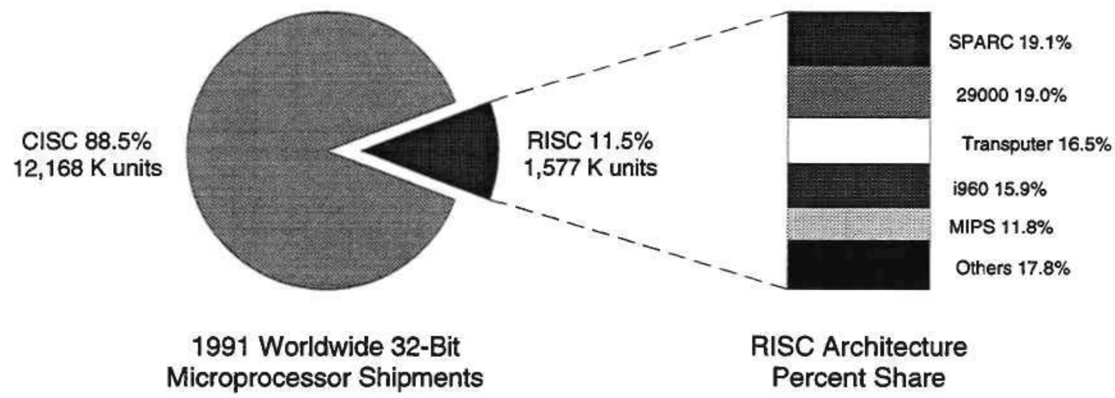
The next issue of *Dataquest Perspective* will include the following:

- Major users
- Memory rankings
- Capital and expenditure of European companies

Correction

With reference to *Dataquest Perspective* SCEU-SVC-DP-9210, August 28, 1992, please note we have revised Figure 9 on page 15 of that issue, which showed worldwide 32-bit unit shipments for 1991. The revised figure is shown below.

Worldwide 32-bit Unit Shipments, 1991



Source: Dataquest (December 1992 Estimates)

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9211 November 6, 1992

In This Issue...

Pricing Analysis

European Pricing Update

This issue, Dataquest is tracking a new set of parts, including flash memory, to maintain currency of the price tracking and give a representative measure of prices. Some microcomponents are in short supply, thus firming prices, and change is expected in DRAM resulting from US and EC antidumping action against Korean manufacturers.

By Mike Glennon and Jim Eastlake *Page 1*

Market Analysis

State of the Industry

The European book-to-bill ratio is maintaining its high level at 1.10. This is due mainly to very high booking levels, although billings are also growing well. The major driver for this is PC demand, with exchange rates adding to the growth.

By Mike Glennon *Page 4*

Antidumping Duties Levied on Korean DRAMs in Europe and North America

A provisional antidumping duty of 10.1 percent has been imposed on the European Commission by three Korean suppliers, Goldstar, Hyundai and Samsung, effective September 18. The US Department of Commerce has also imposed varying duties on the same three vendors, effective October 28.

By Jim Eastlake and Mark Giudici *Page 8*

IBM/Siemens/Toshiba 256M DRAM Venture Breaks New Ground in Industry Cooperative Undertaking

The $1 billion joint venture to develop the 256M DRAM and accompanying 0.25 µm process breaks new ground in collective technical efforts and poses new challenges to industry competitors.

By Lane Mason *Page 11*

Pricing Analysis

European Pricing Update

This is the first input for price tracking for a new set of parts. The standard logic section has been reduced, with representative octal parts for FAST and AC product families. The analog section follows a representative voltage regulator, and the IMS171D is a high-performance triple digital-to-analog converter (DAC), used to track higher-integration analog components.

The microcomponent section has been updated with the higher-performance Intel and Motorola products, and has retained the MIPS RISC processor. The memory section has been updated to follow faster and higher-density products. Flash memory is also being followed for the first time, replacing some of the UV EPROM products.

These modifications should ensure the currency of the price tracking, and also give a representative measure of most prices in the European semiconductor market.

Table 1 shows European Semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Standard Logic

Demand for SO parts is slowing, as capacity and demand align themselves. Nevertheless, lead times are still at 6 to 12 weeks, and prices remain firm. PDIP parts are on shorter lead times, but prices are still strong. Business in Europe is reasonable, with the German market still supporting much of the region.

Analog

The overall market is reasonably stable, with a weak consumer segment compensated by the stronger telecoms sector. Lead times suggest this condition is likely to continue. EDP demand is strong, as lead times for the triple video DAC are typically at 8 to 12 weeks.

Table 1
European Semiconductor Pricing November 1992
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (%)	1K Adder (%)	Lead Time (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.37	10%	15%	4-12
74F244	PDIP	100K	0.21	10%	15%	4-12
Analog						
78L05	TO92	100K	0.14	10%	20%	4-8
IMSG171D 35MHz Video DAC		100K	3.05	15%	25%	8-12
Microcomponents						
80386SX-20	PQFP	5K	45.00	0%	5%	10-16
80386DX-40	CPGA	5K	94.00	0%	10%	10-16
80486DX-33	CPGA	5K	350.00	-5%	5%	8-12
68040-25	CPGA	5K	370.00	-5%	5%	4-6
R3000-25	CPGA	5K	80.00	5%	15%	4-10
DRAM						
1M×1-80 (1M)	SOJ	100K	3.30	5%	15%	2-6
4M×1-80 (4M)	SOJ	100K	10.30	5%	15%	6-8
512K×9-80 (4M)	SIMM	100K	13.25	5%	15%	10-12
256K×16-80 (4M)	SOJ	100K	12.75	5%	15%	10-12
4M×4-70 (16M)	SOJ	10K	92.00	5%	5%	8-14
(4M×1)×2+1M-60	SOJ	50K	26.50	5%	10%	8-10
128×8-80 VRAM	SOJ	100K	6.95	5%	15%	4-6
Flash						
1M-17 (128K×8)	PDIP	10K	5.85	5%	10%	4-8
2M-17 (256K×8)	PDIP	10K	13.50	10%	30%	12-16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	4.30	10%	20%	8-12
SRAM						
256K-70 (32K×8)	PDIP	50K	3.00	5%	15%	2-4
256K-25 (64K×4)	PDIP	20K	4.50	5%	10%	6-8
1M-70 (128K×8)	PDIP	5K	8.00	5%	15%	4-6

Source: Dataquest (November 1992 Estimates)

Microcomponents

The state of the microcomponent market depends on the product. The 486SX20 parts are shipped off the shelf, but 486SX25 parts are typically on a 13-week lead time, and 486DX33 parts are also on longer lead times, as demand improves. Lead times for 386SX and 386DX have increased dramatically, as Intel moves on to the 486. Demand is still there, but the supply is reducing.

Memory

DRAM

The general atmosphere in DRAM is one of impending change. The change has been brought about by the US and EC antidumping action taken against Korean manufacturers, particularly the US action (see separate article). Vendors all feel they can begin to justify price increases. However, the major OEMs that Dataquest talked to in the process of compiling this update are still playing it cool.

Virtually all vendors and buyers acknowledge that the ×9 DRAM module is showing a price inflection now. There are bullish vendors quoting prices in the mid-$30 range, but for most a price of around $26 to $27 is more real. All agree that the price in the United States is substantially higher than in Europe.

It is the 4M DRAM that seems next in line for an upward price inflection. Lead times have moved out over the past few weeks. Again, though, the larger computer customers feel that any hiatus in availability, caused by Korean attempts to rethink their global allocation strategy, will be resolved certainly by the new year.

There does seem to be a true availability problem on the "wide-word" DRAMs. Dataquest has noted a significant extension of lead times on the ×9 and ×16 organizations. This is being followed by an inevitable price firming.

Quite the opposite seems to be happening on VRAMs. For so long the "speciality" DRAM that has been on extended lead time, it is now becoming readily available.

Flash

Conditions in the flash market are being determined at the moment by the limited number of suppliers. This limited availability is having a particular impact on the 2M part, which is very popular for use in mobile phones. Currently, vendors indicate that demand from Nokia Mobira, Ericsson Radio and Motorola in Europe is sufficient alone to eat up their European product allocation through February 1993, so lead times are extending rapidly and spot market prices are increasing. Dataquest has heard pricing as high as $18 in volume. While there is little price differential between package options, it is important to note that the "mobile" manufacturers are preferring PLCC and TSOP options to PDIP.

EPROM

Following Intel's departure from the EPROM business there was a battle among the leading vendors to take over the company's vacant share. This has now largely been settled and at least two of the protagonists are now fully booked for the next three months. However, prices for the 2M-170 still remain static at about $4.30 for orders of 50,000 units.

SRAM

Perhaps it would be a pun to say that prices are static in the SRAM market, but this seems to be the case. There seems to be no particular availability problem with the parts we track, and SRAM demand has been healthy in Europe this year. We expect the market to grow by more than 35 percent. The prime factor seems to be cache usage in PCs. European PC assemblers have "stuffed" their boards with SRAM in Europe this year as they have found products cheaper here. As a footnote, several vendors commented that they have seen increased quoting activity from Korean suppliers in the past few weeks. It seems likely that the three suppliers feel under pressure right now to broaden their portfolios away from DRAM.

Current Exchange Rates

1 US dollar =
- 0.653 UK pounds
- 1.569 deutsche marks
- 5.317 French francs
- 0.799 ECU

By Mike Glennon
Jim Eastlake

Market Analysis

State of the Industry

The SIA flash three-month average book-to-bill ratio for the month of September was 1.10, another surprise increase over August's ratio of 1.09 and July's higher than expected 1.08. Figure 1 shows the book-to-bill ratio for the past 13 months, and the three-month average bookings and billings for the semiconductor market in Europe. The billings value for Europe was $1,235.0 million, and the bookings value was $1,080.7 million.

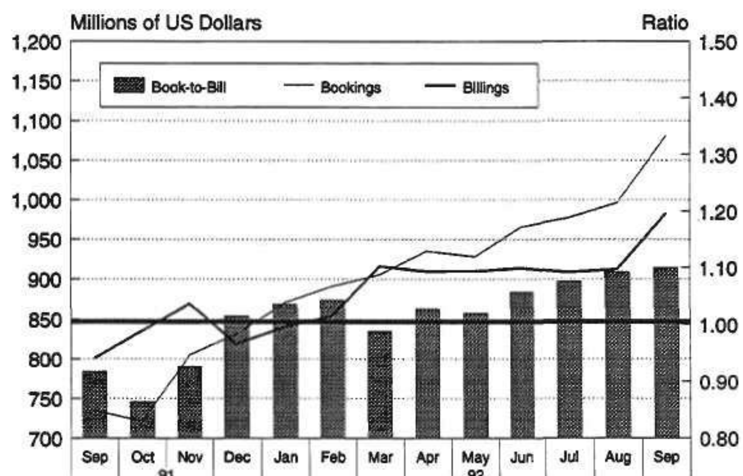
September's billings are normally high, but this month represents a 26 percent growth over the same month the previous year. This is untypical, and the last time growth of this size was seen was in 1988, when growth for the year was 31 percent over the previous year. That annual growth figure is unlikely to be repeated in 1992, though. When the bookings data are examined, the growth is even higher. September's three-month average growth is an astonishing 47 percent higher than the same month the previous year. The high bookings value has pushed the book-to-bill ratio up at a time in the year when it typically declines to below unity.

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trend and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billing and three-month average booking figures. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

The minor adjustments made in the provisional bookings and billings data for August have had no effect on the book-to-bill ratio for the month, and it is still heading in the opposite direction to that indicated by the forecast model. Bookings are still well ahead of the expected level, and are continuing their upward trend, when typically they should be declining on a monthly basis (Figure 2). Billings are reasonably close to expectations, with the exception of September (Figure 3). Figure 4 shows the three-month average book-to-bill ratio.

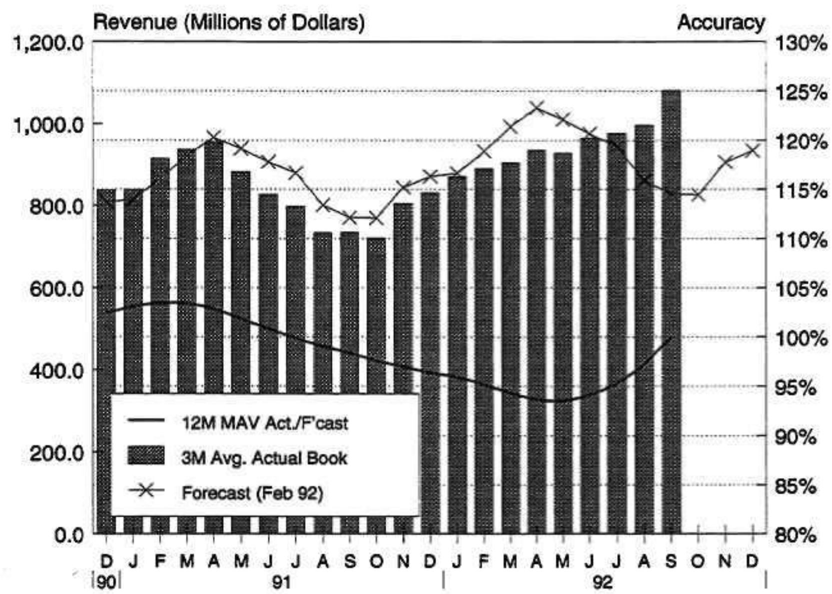
Figure 1
European Total Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Sep	Oct 91	Nov	Dec	Jan	Feb	Mar	Apr	May 92	Jun	Jul	Aug	Sep
Book-to-Bill	0.92	0.86	0.93	1.02	1.04	1.04	0.99	1.03	1.02	1.06	1.08	1.09	1.10
Bookings	735	721	805	831	871	891	905	935	928	966	977	996	1,081
Billings	801	835	869	819	841	854	916	910	910	914	908	912	983

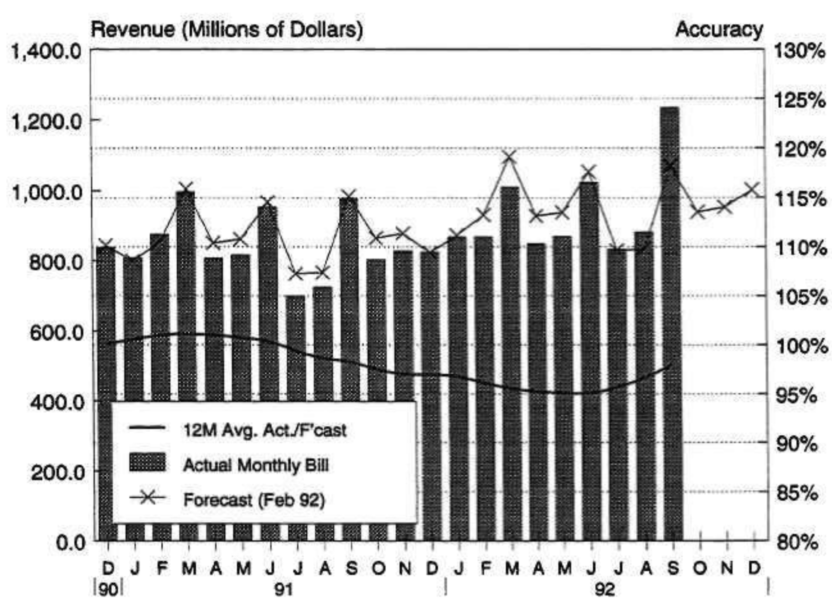
Note: Last two months are preliminary.
Source: WSTS/SIA

Figure 2
European Total Semiconductor Three-Month Average Bookings



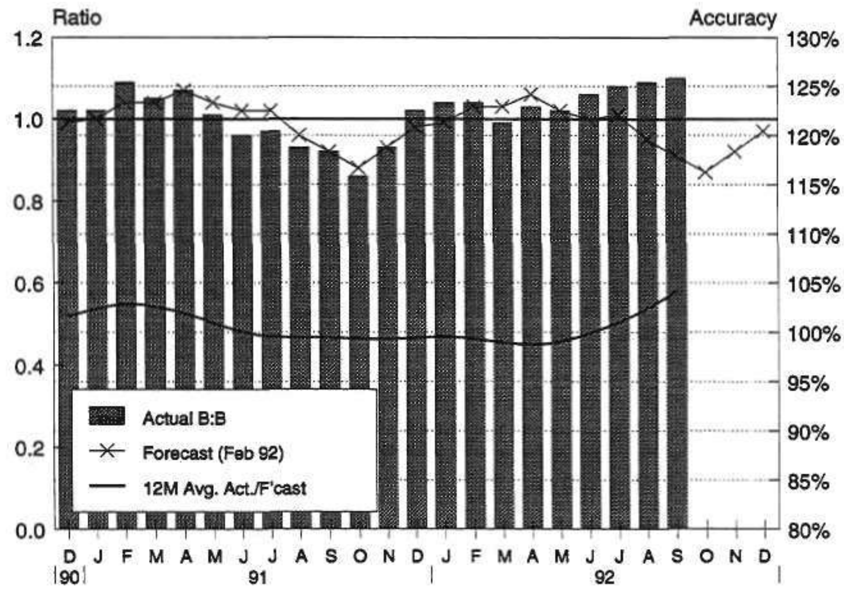
Note: Last two months are preliminary.
Source: WSTS/SIA, Dataquest (November 1992)

Figure 3
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary.
Source: WSTS/SIA, Dataquest (November 1992)

Figure 4
European Total Semiconductor Book-to-Bill Ratio
(Three-Month Average)



Note: Last two months are preliminary.
Source: WSTS/SIA, Dataquest (November 1992)

The rise in billings is not unexpected, however, given the three-month rise in bookings. With a typical two- to three-month delay before bookings become billings, the inherent demand built up in the bookings data will ensure billings data maintain healthy growth.

There is still the spectre of double ordering, driving the high bookings figures. However, the billings data suggest at least some of this high level of booking is turning to real orders, offsetting the fear of double orders.

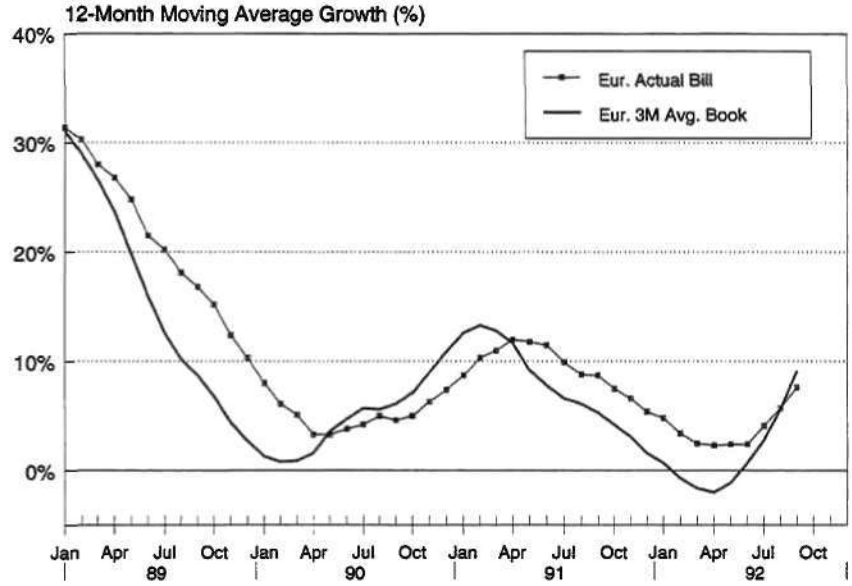
Dataquest Perspective

Bookings and billings are clearly enjoying very healthy growth, as is easily apparent from the 12-month average growth shown in Figure 5. The sudden rise in reported revenue mirrors the high growth reported for the US semiconductor market. There is some hearsay evidence of double ordering, but the general feeling in the market is that demand is true. Early indications of October bookings suggest that month may overshadow September's high growth.

The puzzling factor is what is driving this big increase in demand. The economies of the countries in Europe are not in a good enough condition to drive a major increase in demand. The growth must therefore be related to supply. For some time there has been the hint of a shortage in memory products, but the available capacity, albeit not necessarily utilized, should offset this worry. Other short-term issues include the raising of Korean memory prices, and the shortage of SO packaged general-purpose logic components.

Inventories have been reducing for some time, and the general level at the beginning of the year was low. However, this reduction only serves to transmit changes in the market back to the suppliers faster, as equipment manufacturers are not able to smooth the swings in demand through rises and falls in inventory. The rise in demand could be related to greater business confidence, producing a rise in inventories, but other business indicators do not support this.

Figure 5
European Total Semiconductor Bookings and Billings Growth
(12-Month Average)



Source: WSTS/SIA

Another clue to the rise in demand is the recovery of business though distribution. As major semiconductor suppliers introduce or extend their key account programs, many of these companies' lesser accounts are passed to distributors. This has stimulated distribution business, but it also hides an underlying increase in demand through distribution. The smaller accounts are increasing their business, and this is spread across all applications.

The product level detail gives the greatest hint of where demand is coming from. The fastest-growing products are memories and microcomponents. The demands of Windows on memory are severe, and many memory products have been shipped as upgrade cards direct to the end users. The performance of newly purchased PCs is rising, with the 486-based PC gradually displacing the 386 PC as the preferred machine. This increases the dollar value of the processor, and has a subsequent effect of increasing the memory demands of the machine. These two factors have combined to increase component demand considerably.

One of the more established methods of building PCs in Europe is to import preassembled boards, without memory or microprocessor, and place these on the board after purchasing them locally. This effectively increases demand for these products, while not having the same increase in demand for the other components on the board, and has a positive effect on semiconductor consumption in Europe.

Demand is also rising in general-purpose logic, but this is driven by a shortage of SO parts, creating an artificial demand for these components, and it is here that some double ordering is appearing. Lead times for these products are stretching to 18 to 20 weeks for some components, forcing purchasing managers to place orders for parts which they may not need. Ultimately the situation will stabilize, but it could be disastrous for these purchasers if they have overordered by any significant amount.

The final factor driving up demand is the exchange rate. While unit demand is increasing in many areas, the exchange rate is shifting to the extent that the growth in the dollar value of the market is much greater than the growth when measured in local currency.

All of these factors have combined to give a sharp rise in the market. The underlying demand is increasing, as seen by, for example, the shift to higher-performance PCs. Other areas are also showing some signs of recovery. The transportation sector is growing, as the legislation introduced for exhaust emissions for new cars encourages the use of microprocessor-controlled engine management units. This rise in the semiconductor content is thus compensating for the relatively weak new car sales. The telecoms sector is stable, and remains the backbone for semiconductor demand in Europe.

The high growth witnessed is therefore on top of the underlying upward trend, and is distorting the data. The immediate outlook could be for a continued rise in demand, or an apparent fall-off of this demand as overordering is compensated for, and prices soften again. The outlook for the year-end, though, is for a reasonable growth in the dollar figure, perhaps as high as 10 percent, but at least 7 percent without a doubt.

By Mike Glennon

Antidumping Duties Levied on Korean DRAMS in Europe and North America

Europe

In the *Official Journal* of the European Communities L272, volume 35, dated September 17, 1992 the European Commission (EC) announced the imposition of a provisional antidumping duty on imports of DRAMs originating from the Republic of Korea (Commission regulation No. 2686/92 of September 16, 1992).

In March 1991, the Commission announced the initiation of antidumping proceedings on DRAMs originating in South Korea. This followed a written complaint received from the European Electronic Components Manufacturers Association (EECA). The period of investigation was from January 1, 1990 to December 31, 1990 and the EC's investigations involved:

- Community producers—Motorola and Siemens
- Producers in Korea—Goldstar, Hyundai and Samsung
- Exporters of Korean origin parts to the European Community—Texas Instruments

Products Investigated

The products investigated cover DRAMs of all types including:

- Densities—256K, 1M, 4M, 16M
- Process technologies—NMOS, CMOS
- Configurations—×1, ×4, ×8
- Packages—PDIP, PSOJ, PZIP, etc.
- Access times—100ns, 80ns, 70ns, 60ns, etc.
- DRAM wafers and die, multi-combination forms of DRAMs such as DRAM modules, and SIPs/SIMMs referred to by the EC as stack DRAMs
- Variations of finished DRAMs such as VRAMs and pseudo SRAMs

Dumping Margins

In deciding whether dumping had occurred, constructed normal values were determined for each producer on the basis of their individual costs of production. This took into account sales, general and administrative costs (SG&A) together with a reasonable profit margin. The cost calculation and the calculation of "reasonable profit margin" took into account current and future R&D costs, the financing of the very large capital expenditure necessary for fab construction, the short innovation cycles associated with DRAMs, and the "generally risky nature of the cyclical business."

The weighted-average dumping margins provisionally established for each producer and expressed as a percentage of the total cif Community-frontier value of imports are as follows:

- Goldstar, 122.4 percent
- Hyundai, 57.3 percent
- Samsung, 18.1 percent

The evaluation revealed that for all three Koreans substantial price undercutting existed in the European market. Indeed a substantial proportion of the sales to the Community were made below cost. The Commission identified three DRAM manufacturers in Europe: Motorola, Siemens and NEC. Two of these companies supported the complaint, while NEC did not participate. A study of the two revealed that injury had been caused to both parties. Motorola had planned to increase its production capacity in 1990 based on the outcome of the EC's investigation into Japanese-produced DRAMs. Subsequently, these extension plans had to be cancelled due to substantial price erosion on the Community market. In the 1989 to 1990 period Siemens had to delay and finally alter its plans for a new 4M DRAM fab, after a major price decline occurred.

European Commission Action

A provisional antidumping duty has been imposed on imports of all types of DRAM as indicated above, including modules. The rate is 10.1 percent expressed as a percentage of the net free-at-Community-frontier price before duty. The regulation came into effect on September 18, 1992.

North America

Shortly after the imposition of duties in Europe, the US Department of Commerce announced preliminary antidumping duties levied against the same Korean DRAM suppliers: Samsung, Hyundai, and Goldstar. The tariffs will become effective upon publication in the *Federal Register*, which should be on October 28, 1992. The duties imposed were the result of an antidumping petition made by Micron Technology to the International Trade Commission this summer. Separate duties per company have been set because of the investigation method and findings. The duties are as set out in Table 2.

The tariffs include all affected devices (wafers, unsorted or sorted die, all packaged devices and memory modules) manufactured in Korea and shipped into the United States directly from the manufacturer or indirectly via subcontractors. This also includes offshore purchasing offices and affects all shipments made into the United States on or after the *Federal Register* publication date. DRAM devices that are "materially transformed" into electrical equipment (that is, computer motherboards or a finished system) and shipped into the United States are not included in the preliminary determination.

Dataquest Perspective

Both European and US antidumping duties are provisional, while a solution is sought. The form of this solution is yet to be decided, but two alternatives are: Korean companies subscribing to a reference price agreement; or Korean companies subscribing to a data collection scheme to ensure future fair play.

Table 2
US Duties on Korean Suppliers

Company	Duty	US DRAM Market Share
Samsung	87.40%	14.3%
Goldstar	52.41%	5.7%
Hyundai	5.99%	4.5%
Other Korean Suppliers	61.88%	

Source: European Commission

In Europe, the imposition of the dumping duties is already having an impact on the price of DRAMs. Most memory suppliers have seen an easing of price pressure for the affected parts, and can justify price rises. Some of the drive for this appears to come from the high prices seen in the United States, though. Korean companies have a significant inventory of products already in Europe, and appear to be supporting their major customers through the provisional period from this inventory. This may change as the inventory is used, and new products have to be shipped into Europe.

In the United States, the antidumping duties levied against the Korean suppliers will have a dramatic impact on overall pricing of the affected devices (1M, 4M, 16M and above DRAMs, VRAMs, and modules). Dataquest estimates that the three companies shipped 24.5 percent of all DRAMs consumed in the United States in 1991, and it is estimated that the overall price for the DRAM market in the United States could be increased by 10 to 15 percent above current expectations for price declines.

The Korean suppliers have been unable to build a similar inventory in the United States to the one in Europe, and although current DRAM availability in North America remains good, with lead times ranging between six and eight weeks for most devices, most likely this decision will change the relative stability of the market for the next four to six weeks. Prior to this decision there was concern from purchasing managers that the potential of a supply constraint in 1993 could occur, based on system demand and known semiconductor capacity levels. This concern has now been compounded with antidumping duties.

Similar to the timing of the last antidumping duty decision made in September 1986, prices then and now for many DRAM parts had been stabilizing, if not rising. These duties are expected to quickly raise the average price floor of the affected parts and result in destabilized pricing on both the spot and contract markets until specific user–supplier adjustments have been made.

The inclusion of all DRAM products in the United States (from wafers to SIMMs, including VRAMs) appears to be an effort to close the SIMM market loophole raised in the 1986 fair market value (FMV) decision. With the final determination on dumping duties to be set in March 1993, users of Korean DRAM and VRAM most likely will be avidly petitioning the Department of Commerce about the overall impact of this decision on electronics products.

According to the US Department of Commerce, all interested parties have an opportunity to comment on earlier requests made by different companies that wanted to exclude certain devices from this ruling. Comments should be submitted in at least 10 copies to the Assistant Secretary for Import Administration no later than November 19, 1992.

The increase in component costs is less likely to affect equipment prices in Europe than in North America, as the price increase is relatively small compared with North America. Following the imposition of duties on LCDs, US equipment manufacturers responded by exporting manufacture out of the United States to Europe and Asia. This is likely to occur again with board-level products. The announcement excluded boards assembled outside the United States with Korean DRAMs and imported into the country. While Europe benefited from the LCD dumping duties, it is less likely to benefit from this DRAM decision, as duties have been imposed here also.

The biggest effect in Europe will be on multinational companies. These companies are worldwide purchasers of components, and if a supplier is unavailable in one world region it is likely to be removed as a preferred supplier in the other regions. The reduction of the number of memory suppliers available to the major memory users can only exacerbate a potential shortfall in memory supply, pushing up prices and lengthening lead times.

By Jim Eastlake
Mark Giudici

IBM/Siemens/Toshiba 256M DRAM Venture Breaks New Ground in Industry Cooperative Undertaking

The joint venture among IBM, Siemens, and Toshiba announced in July is another step in the industry's trend toward massive cooperative ventures to lower the cost and risks associated with advanced process development. In one stroke, it cuts the private cost of process development for the 0.25 µm process by two-thirds or more and poses a significant economic challenge to companies that fancied going at it alone.

This article discusses the particulars of this most recent megaventure, along with its significant implications for the development of the industry for the remainder of the 1990s.

Basic Tenets of the Agreement

The basic agreement calls for Toshiba, Siemens, and IBM to collectively develop a 256M DRAM design and the 0.25 µm process on which it can be manufactured. The limit stops at the end of the development stage and at present has no provision for manufacturing (which might run into a host of antitrust objections). The group estimated that the program would entail aggregate expenditure of more than $1 billion to develop the 256M DRAM and qualify it for production late in the decade.

IBM's Advanced Semiconductor Technology Center in East Fishkill, New York State, will be the principal initial focus of development activity, with supporting projects being undertaken independently by Toshiba and Siemens. The program is expected to employ more than 200 researchers from the three members at its peak.

According to IBM, each participant will also be allowed to resell the technical fruits of the joint venture, making it possible that any of these companies could reduce its net financial commitment significantly by achieving a royalty stream to compensate for the immense development costs. In addition, though the process will initially be developed for the 256M DRAM, each party is free to enhance and modify the common process and apply it to other products, including logic devices.

Earlier Agreements

At present, IBM has an agreement to produce 16M DRAMs in France with Siemens. These devices are now in production at the existing IBM facility at Corbeil-Essonnes, and are being marketed by Siemens. IBM and Siemens also have a 64M development program in place. Apparently seeking to dispel notions that Siemens was re-evaluating its positioning in DRAMs or semiconductors, Siemens President and CEO Karlheinz Kaske commented that the joint venture "contributes to future applications in telecommunications, and assures our customers of our engagement in microelectronics."

Toshiba and Siemens have a relationship that began with the 1M DRAM in 1985, which transferred the Toshiba 1M design and process to Siemens in exchange for a fee and continuing technical support.

Also, IBM and Toshiba within the past few months have negotiated a technology agreement to develop solid-state files (SSFs) using Toshiba's NAND flash technology and IBM's advanced controllers and interface technology.

Clearly, the prior arrangement between Siemens and IBM and the addition of a 256M agreement will make it easier to keep the process and product program on a steady path.

Financial Risk and Cost—The Prime Mover for Alliances

All other reasons aside, the prime mover for this agreement is cost and risk. The calculus of return on investment on deep process development is horrendous. One has only to look at IBM's massive investments in X-ray lithography to see the difficulty of the problem: year after year, tens or hundreds of millions of dollars were invested to try to catch a receding goal. It is small solace to IBM to be the X-ray leader. It has cost close to a billion dollars, without appreciable return.

Development of a 256M technology is a similar program, requiring significant years of investment in advance of any return, fraught with timing uncertainties of market development and pushing into the unknowns of technology development. In sheer magnitude, it is on the same scale, and no one, not even IBM, is rich or smart enough to go it alone. The risks are too great and the costs are too large, so the semiconductor industry is grouping together to create advanced process knowledge and to share costs.

Global Technology

While this present agreement has a partner in each of the world's markets, in fact the global element of this venture is weak compared with the finance and risk elements. Still, IBM cements its position as a "European" electronics company and lends a hand to Europe's leading supplier of commodity memory chips and arguably its leading semiconductor technology house. Because there are no manufacturing or marketing plans as a part of the compact, however, most of the trade issues are sidestepped or avoided and knowledge will flow freely through the porous borders of the United States, Japan, and Europe.

Perhaps the more important global aspects of this venture may be any difficulties that arise from conducting research in three widely separated locations. Although research tasks can be well defined and divided up, there is certainly a high value in the incessant communication taking place among the research staff. Whether we like it or not, geographic separation has its high overhead costs and inefficiencies.

Increased Pressure on Other DRAM Makers to Do Likewise

Another likely outcome of this announced venture among Toshiba, Siemens, and IBM will be forcing other aspirants to the 0.25 μm or 256M DRAM realm to find similar means of remaining cost-competitive later in the decade. No independent, go-it-alone DRAM producer can hope to be competitive in future generations while spending three times as much as other participants to develop the process. To date, we have seen three 64M/0.35 μm deals (NEC/ATT, IBM/Siemens, and Hitachi/Texas Instruments). Already the 256M development costs are getting steep enough that they need to be shared. NEC announced earlier in the year that it would spend $150 million for development of the 256M DRAM in 1992.

Who Is Driving the Industry?

Such a transnational arrangement serves to refocus the industry's attention on the fact that, despite virtually universal government participation in the semiconductor industry, the prime movers are still private companies pursuing what they perceive as their own best interests. The US government's subsidy of Sematech, at $200 million per year, is about 5 percent of the US industry's R&D budget, and is comparable to this single program. JESSI is of similar scope and magnitude. This undertaking will be financed, at least superficially, by the industry participants themselves.

There are probably lessons here, as well, for managing multiparty development undertakings that require substantial investment and provide returns to each participating party. Deciding the quid pro quo and the research program among disparate parties with similar interests is a formidable problem. How can one be sure that the benefits derived by each party are commensurate with its contribution? There is every incentive to minimize financial and human resource inputs and maximize technology outcomes.

Common Process—Core and Differentiators

The formidable costs faced by companies for development in the subquarter-micron range have been rather cleanly divided into a "common process pool" that has appeared to pose the most significant barrier to 21st-century industry development, and "other," which includes manufacturing costs, marketing, non-DRAM product definition, and specialty process development costs. Process development costs are where the biggest dollars are spent, but they do not provide proportionate profits or added value in today's marketplace.

From another view, just as Texas Instruments tries to feed as much revenue as possible off a common set of process tools, equipment, and recipes (both independently and with the Hitachi joint ventures), these three companies seek the same broad amortization across a massive range of products: not only their own product lines (which in 1992 were about $10 billion), but also to others through resale of the technology allowed under the terms of the agreement.

By dramatically reducing the costs of forward process development, "process" pushed back the hierarchy of differentiating capabilities, because these three companies, and likely others later, can build off the same core capabilities. Many observers of the industry have criticized the intense focus of the industry on manufacturing and money, on "process," and on the fine-line capabilities best exemplified by Japanese progress in MOS memories during the 1980s, instead of on looking at where the performance-enhancing opportunities are in silicon-consuming systems.

Today, "process" appears to be becoming an enabling capability, necessary but not sufficient for semiconductor companies' profitability. Value to the customer and sustainable market advantage are increasingly given by proprietary architectures, products well-defined to fit applications, and software. One can read in this agreement then that, provided this 0.25 µm capability is made available to parties outside the three principals, a tilt toward design-intensive US companies and away from market domination through process excellence will result. It reduces, though hardly eliminates, the advantages achievable through sheer financial resource.

Dataquest Perspective: A New World Order?

This megaventure quite likely is the largest and most recent fixture in the emerging semiconductor industry structure. In this view, basic technologies will be developed in common, widely shared, and differentiated by each individual practitioner. Fully 20 separate 0.8 and 0.7 µm processes were developed for the 4M DRAM generation. For future generations and the 0.25 µm level, as a result of this common development pact, we may see just four to five basic processes offered by groups of collaborators, reducing redundancy and unnecessary process development and freeing industry resources to concentrate on the highest value-added (and, for the maker, profitable) chip design issues.

Process development may be even further separated from production and design in the future, just as the equipment industry, formerly a part of the semiconductor industry, has evolved into a separate standalone industry offering standard products to all device manufacturers.

By Lane Mason

In Future Issues

Along with the regular features, "European Pricing Update" and "State of the Industry," the next issue of *Dataquest Perspective* will cover:

- European microcomponent market share

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Dataquest Index

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Semiconductors *Europe*

January - December 1992 | December 31, 1992

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Semiconductors *Europe*

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In This Issue...

Pricing Analysis

European Pricing Update

There are minor changes in prices, as the summer slowdown is taking its effect. Demand is increasing for SRAM products, and this has helped to maintain prices. Prices tend to fall into two bands, with those unaffected by reference price agreements able to reach lower levels than those forced to abide by the agreements.

By Mike Glennon *Page 2*

Market Analysis

State of the Industry

The SIA flash European book-to-bill ratio for July was 1.10, improving on June's 1.06. The 12-month moving-average growth is still improving, and has risen for three months in a row. The apparent rise in the market is more related to beneficial movements in exchange rates, though, as when the market is measured in ECU, a 14 percent growth in dollars falls to a 4 percent decline in ECU, when compared with last year. To complement this, unit demand is increasing for some products, and microcomponent demand is still high. EDP seems to be the main driving factor behind the current upswing in demand.

By Mike Glennon *Page 4*

Exploding the RISC Myth in Europe

Reduced-instruction-set computing (RISC) promised lower costs and higher performance for a wide range of computer applications. Its success in Europe has been muted, though, and the equipment which is most suited to RISC processors is only manufactured at a few locations in the region. CISC has held its position in the market well, and the outlook is this position is unlikely to change. This report examines the expectations for RISC, and whether reality has met with the expectations. The report also looks to where the future lies for RISC processors.

By Mike Glennon *Page 8*

End-User Analysis

1992 European Vendor of the Year

The European semiconductor vendor of the year, as voted by the semiconductor purchasing community, is Motorola. Texas Instruments, LSI Logic and European Silicon Structures won awards in the responsiveness, medium-size, and niche vendor categories. The awards were presented at Dataquest's annual European Semiconductor Conference, held this year at Jury's Hotel, Dublin.

By Sarah Jacob and Jim Eastlake *Page 19*

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Pricing Analysis

European Pricing Update

Table 1 shows European semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Standard Logic

Small-outline parts are still in demand, and this is stabilizing prices, so there are no price changes to report. The level of business is good, but some of this is related to positive currency movements increasing the dollar value of the market.

Analog

The mono operational amplifier arena in Europe is fairly stable, with no price changes.

Microcomponents

Microcomponent prices have seen little change, but lead times are reducing. This is due to improvements in logistics on the part of the suppliers rather than to any increase in demand. Demand for the 486 is increasing, and 386 demand is fairly stable.

Memory

DRAM

The decline in exchange rates has come as a bonus for US importers of DRAMs, with their prices having the greatest flexibility—constant dollar prices are reflected as declining local currency prices. However, the reference price mechanism has provided stability to those who subscribe to it.

The 256K part is approaching phaseout, with some suppliers reducing their emphasis and support for the part, perhaps considering dropping it in the longer term. There are split prices, with Korean suppliers who are not yet party to the reference price agreement being able to offer the lowest prices. Prices as low as $1.00 have been seen on the spot market.

Split prices also operate on the 1M parts, with generally little spread in prices across volumes. the 70ns parts command no premium, but 60ns parts are priced a little higher, typically 5 to 10 percent more.

Nominal movements have occurred in 4M parts, mainly related to the negotiating skills of the vendors and purchasers. Spot prices have fallen below $10 on occasions for this part; 70ns parts command no premium, but 60ns parts are around 5 to 10 percent up on their slower counterparts.

SIMM modules are split between the three-chip and nine-chip configurations, with the three-chip option taking the larger share of the market. The nine-chip solution is currently discounted by around $2 to $4 over the three-chip version. Suppliers are still reaping the benefits of no duty on these parts, and the Korean suppliers are offering the lowest prices.

The 16M DRAM is unchanged since the last price survey, and is still priced a little above the estimated reference price. Demand for the part is still fairly low, due to its high price relative to other parts such as the 4M.

The average contract price per Mbit is as follows: 256K $6.00; 1M $3.00; 4M $2.68; 1Mx9 $2.83; 16M $8.13.

EPROM

Competition is still high in the EPROM market, and the pressure on prices remains. Nevertheless, prices have undergone only minor adjustment, and this is mainly in their spread, rather than for average and contract prices. The average contract price per Mbit is as follows: 1M $2.70; 2M $2.15; 4M $2.60.

SRAM

SRAM prices are unchanged, but business is improving. Some suppliers have seen a big and unexpected increase in demand. Supply has so far kept pace with this sudden increase, so prices have not risen. The average contract price per Mbit is as follows:
64K $25.00; 256K $13.00; 1M $9.25.

Current Exchange Rates

1 US dollar =
- 0.503 UK pounds
- 1.407 deutsche marks
- 4.795 french francs
- 0.696 ECU

By Mike Glennon

Table 1
European Semiconductor Pricing August 1992
All Prices in US Dollars (including import duty where relevant)

Device Family	Product	Package	Mean 1K Price	Mean 10K Price	25K+ Contract Price	Lead Time in Weeks
Standard Logic	74F00	PDIP	0.12	0.10	0.10	4-12
Fast TTL	74F74	PDIP	0.14	0.12	0.12	4-12
	74F138	PDIP	0.18	0.16	0.14	4-12
	74F244	PDIP	0.25	0.23	0.21	4-12
Standard Logic	74AC00	PDIP	0.19	0.17	0.15	12-24
Advanced CMOS	74AC74	PDIP	0.24	0.20	0.18	12-24
	74AC138	PDIP	0.32	0.28	0.24	12-24
	74AC244	PDIP	0.49	0.41	0.37	12-24
Analog	741 Op. Amp.	TO92	0.17	0.12	0.11	4-6
	CODEC/Filter 1	[1]	2.90	2.65	2.50	6-10
	CODEC/Filter 2	[2]	5.75	5.45	5.00	6-10
Microcomponents	80386SX-16	PQFP	47.00	46.00	45.00	2-4
	80386DX-25	CPGA	101.00	97.00	94.00	2-4
	80286-16	PLCC	11.70	11.00	10.00	2-4
	68020-16	PQFP	31.00	27.30	26.00	6-8
	R3000-25	CPGA	90.00	85.00	80.00	4-10
Memory						
DRAM	256K-8 (256K×1)	PDIP	1.70	1.55	1.50	2-8
	1M-8 (1M×1)	SOJ	3.39	3.15	3.00	4-6
	1M-8 (256K×4)	SOJ	3.39	3.15	3.00	4-6
	4M-8 (4M×1)	SOJ	11.80	11.10	10.70	4-6
	9M-8 (1M×9)	SIMM	27.50	26.50	25.50	1-2
	1M-7 (1M×1)	SOJ	3.39	3.15	3.00	2-6
	1M-6 (1M×1)	SOJ	3.53	3.28	3.00	2-6
	4M-7 (4M×1)	SOJ	11.80	11.10	10.70	4-16
	4M-6 (4M×1)	SOJ	12.50	11.80	11.10	4-16
	16M-8(4M×4)	SOJ	135.00	135.00	130.00	8-14
UV EPROM	1M-17 (128K×8)	CDIP	3.25	2.90	2.70	4-8
	2M-17 (256K×8)	CDIP	5.20	4.75	4.30	4-8
	4M-17 (512K×8)	CDIP	14.00	11.40	10.40	8-16
SRAM	64K-85 (8K×8)	PDIP	2.00	1.65	1.55	4-6
	256K-85 (32K×8)	PDIP	3.55	3.35	3.20	4-8
	1M-85 (128K×8)	PDIP	10.50	9.65	9.25	2-10

[1] Group 1: Commercial temp, serial, PDIP, A/μ law
[2] Group 2: Commercial temp, serial, PLCC, A/μ law, programmable
NA = Not Applicable
Source: Dataquest (August 1992 Estimates)

Market Analysis

State of the Industry

The SIA flash three-month average book-to-bill ratio for the month of July was 1.10, an increase over June's 1.06. Figure 1 shows the book-to-bill ratio for the past 13 months, and the three-month average bookings and three-month average billings for the semiconductor market in Europe.

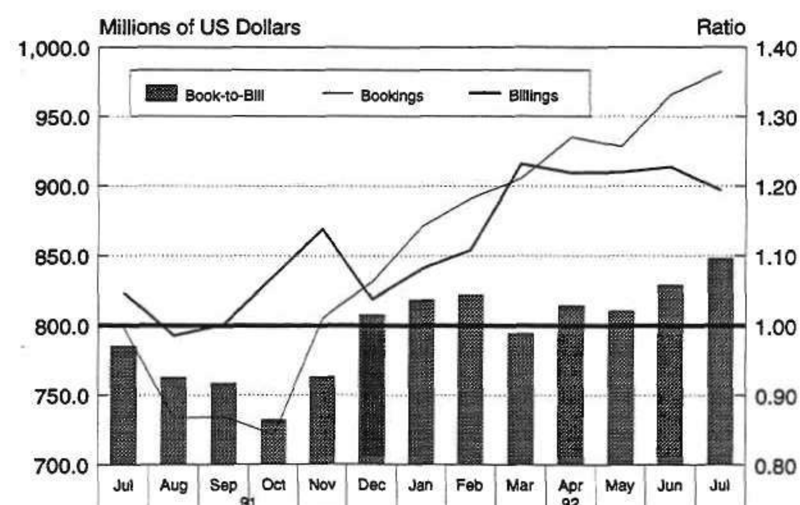
Three-month average bookings grew by 1.7 percent over June's revised data of $965.8 million, to $982.3 million, an astonishing 23 percent increase over the same month the previous year. This represents a significant recovery in bookings, and has lifted the rolling 12-month average growth to 2.9 percent. Actual monthly billings have undergone a similar, but less dramatic rise, growing 14 percent over the same month the previous year, to $798.7 million. July's actual monthly billings have declined by nearly 22 percent over June's, but this is to be expected as June is the last month of a quarter, and is normally much higher than July.

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trend and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billings and three-month average bookings. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

The bookings and billings data for June have been restated downwards slightly, but the book-to-bill ratio is unaffected by the adjustments. The July bookings value has risen over June's at a time when this revenue would be expected to decline, as can be seen from Figure 2. This, coupled with the very high growth seen in bookings, suggests the data will be restated downwards next month. The billings amount is less likely to be restated, though, as it is consistent with what would be expected, as can be seen in Figure 3.

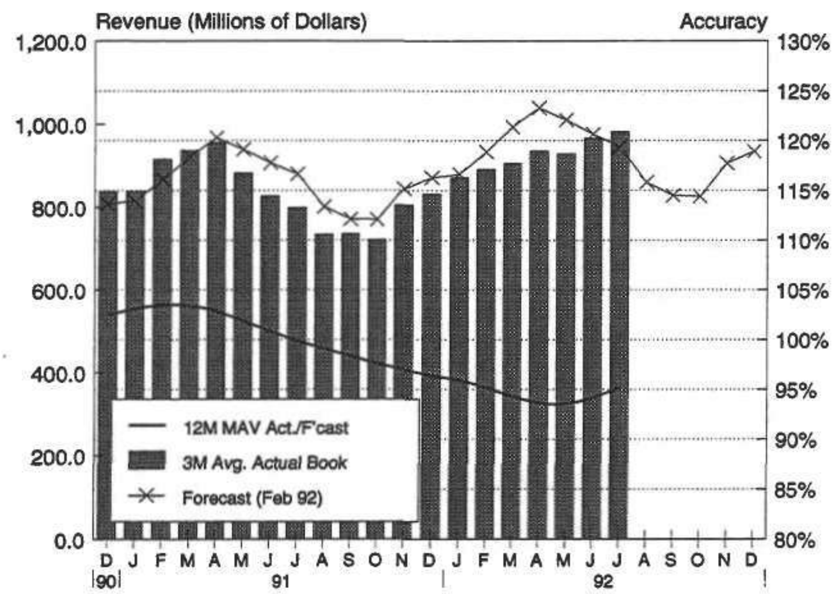
Figure 1
European Total Semiconductor Orders Booked and Sales Billed
(Three-Month Average)



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Book-to-Bill	0.97	0.93	0.92	0.86	0.93	1.02	1.04	1.04	0.99	1.03	1.02	1.06	1.10
Bookings	798.3	733.5	734.6	721.4	805.1	831.0	871.0	891.0	905.4	935.1	928.2	965.8	982.3
Billings	823.0	792.7	800.8	835.2	869.4	818.7	840.5	854.0	915.9	909.5	909.8	913.7	896.9

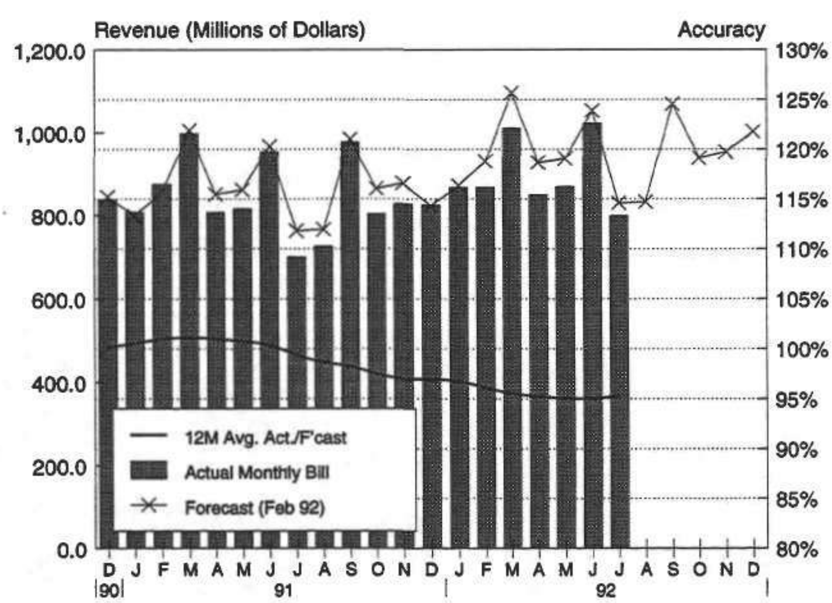
Note: Last two months are preliminary.
Source: WSTS, SIA

Figure 2
European Total Semiconductor Three-Month Average Bookings



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (August 1992)

Figure 3
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (August 1992)

The European data are indicating bookings and billings to have reached rock bottom, and recovery is beginning. In the United States bookings are still exceeding the forecast model indications, and 12-month average growth is still increasing. Rolling 12-month average growth in bookings is now at 13.2 percent, and is still rising, while billings growth is at 11 percent. If the US market is to remain consistent it should maintain its position as a leading indicator for the European market. Figure 4 shows the US and European rolling 12-month average billings growth, which shows this is a valid assumption to make.

Dataquest Perspective

Recovery is within sight, or so it would appear. There is sufficient data to suggest the above-expected growth forecast is not just a single anomalous data point, but is part of a consistent longer-term trend. The difficult factor to reconcile, though, is what is driving this recovery. Clearly, it is not consumer consumption, as Europe is awash with consumer products inventory, and consumer manufacturers are cutting back on production.

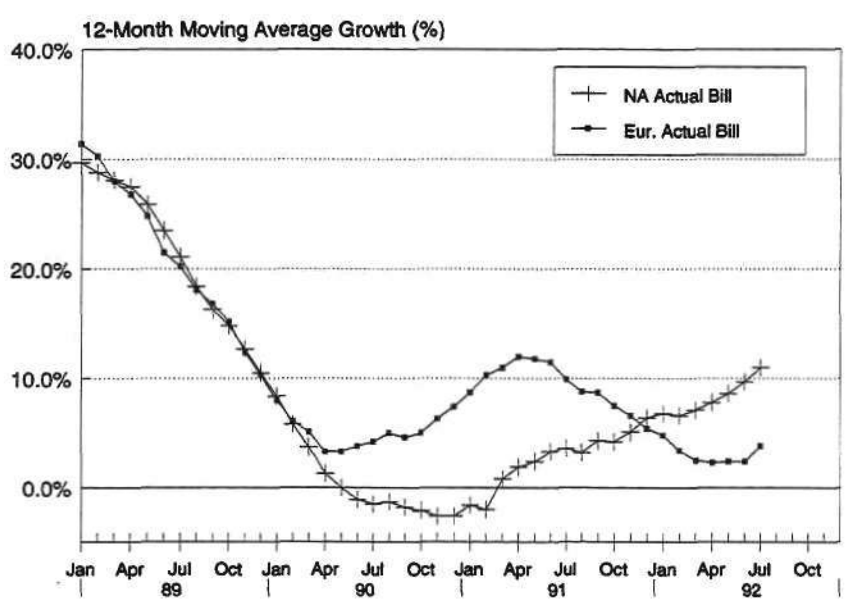
While new car registrations in Europe declined by 3.3 percent in the seven months to August 1992, the semiconductor content of cars is rising. However, automotive demand is unlikely to constitute the driving force behind the semiconductor market's growth, because the market represents only a small percentage of total semiconductor consumption, and any recovery in this market is likely to be small when compared with other markets such as EDP.

The military market is not in a healthy condition, despite aggression in the Balkans, and possibly also in the Middle East. The European Fighter Aircraft is still in doubt, and this was to provide a boost to Europe's military semiconductor consumption.

Industrial applications are ticking over at best, with the decline in small industrial companies' consumption being offset by the growth in some larger industrial concerns.

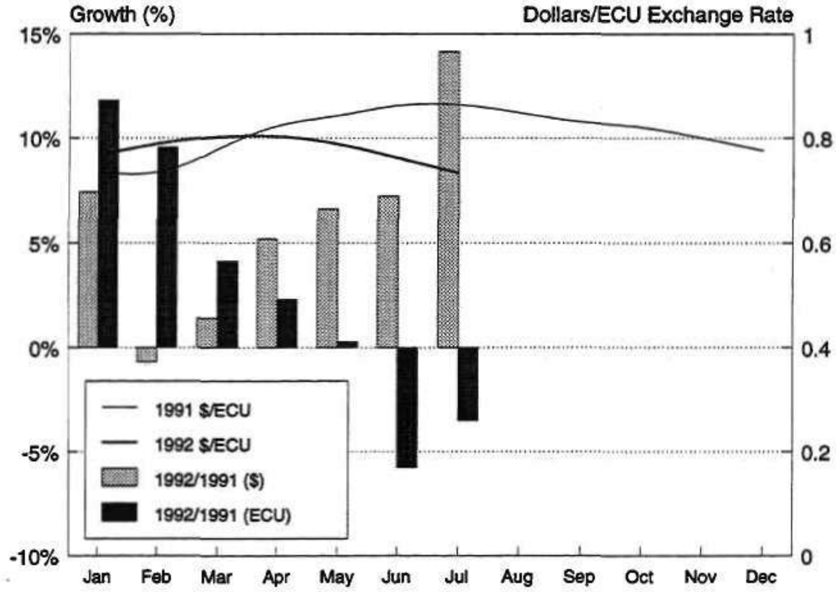
This leaves telecommunications—Europe's traditional area of expertise—and EDP as the only sources of growth in semiconductor demand. EDP is showing significant growth, as memory demand has grown by an average of 22 percent in 1992 over the first six months of 1991; and microcomponent demand has grown by an average 12 percent over the same period. The main factor is related to the success of Windows from Microsoft. This places large demands on

Figure 4
US and European Total Semiconductor 12-Month Average Growth



Source: WSTS, SIA

Figure 5
European Total Semiconductor Monthly Billings Growth and Dollar/ECU Exchange Rate (Month Compared with Same Month Previous Year)



Source: Dataquest (August 1992 Estimates)

memory space and processor performance, so sales of Intel's 486 processor and memory module upgrades are improving. The delay in the introduction of the P5 from Intel can only help improve 486 sales.

Telecoms markets are still benefiting from the infrastructure rebuilding in Eastern Europe, and show great longer-term potential in areas such as GSM and digital cordless telephony. Exports of exchanges outside Europe are also progressing well, and this adds to the apparent growth in the European semiconductor market.

However, the market growth in dollars is not matched by an equivalent growth in local currency. The dollar has declined by 5 percent since the beginning of the year, and 9 percent since its peak, just four months ago. When the monthly growth in dollars and ECU is compared, as can be seen in Figure 5, it is apparent that the recovery in the market is largely accounted for by the exchange rate, not by any significant growth in semiconductor consumption.

By Mike Glennon

Exploding the RISC Myth in Europe

The introduction of reduced-instruction-set computing (RISC) heralded a major improvement in performance for microprocessors. The technique was developed to ease the design and implementation of these microprocessors, and was built around the removal of little-used and complex instructions. The aim was to implement an architecture that would execute instructions in a single clock cycle, compared with the multiple-cycle execution normally used for most complex-instruction-set computing (CISC) processors. This eased the execution and improved the speed of operation of the remaining instructions. The expectation was that ultimately all microprocessors would be RISC.

The reality of the situation is somewhat different. While the growth for the market has been high, it is a long way from dominating microprocessor unit shipments. This report looks at the expectations of the RISC market, clarifying what has happened in this market, and what the expectations are for the future, for:

- Higher performance
- Lower cost
- Market growth

RISC Architectures

There are several RISC architectures, and these are summarized in Table 2. Although some of these RISC architectures have powerful backing—such as from IBM and Hewlett-Packard—only a few of them have had significant success. A more detailed analysis of the architectures, and the companies which supply them is given in the Appendix to this report (see page 17).

Table 2
RISC Microprocessor Architectures and Suppliers

Architectures	Suppliers
SPARC	LSI Logic Fujitsu Cypress BIT
MIPS	Performance Semiconductor IDT LSI Logic NEC Siemens BIT Sony Toshiba
Transputer	SGS-Thomson (Inmos)
ARM	VLSI Technology GEC-Plessey Semiconductor
Clipper	Intergraph APD
88000	Motorola
80860	Intel
29000	AMD
Precision Architecture	Hewlett-Packard Hitachi Samsung Winbond
Power	IBM
Alpha	Digital Equipment Corp.

Source: Dataquest (August 1992)

Applications

Workstations

The main application for RISC processors is in workstations. This market in the United States is large, but there are very few workstation manufacturers in Europe, and their output is relatively small. Table 3 summarizes the European workstation market. This table includes: the consumption of workstations; the production of workstations, including those which are assembled from pre-manufactured boards imported into the region; the effective production, where the semiconductors are purchased locally; the effective production of workstations including RISC processors; and the RISC effective production as a percentage of the total number of workstations consumed in the region.

The data are reproduced and updated from Dataquest's European Semiconductor Application Markets service report on workstation production, published in December 1991. To put the workstation market into context, the effective PC production forecast for the region is included. Clearly effective PC manufacture far exceeds effective workstation manufacture. For every workstation manufactured in Europe

Table 3
European Effective Workstation and PC Production
(Thousands of Units)

	1990	1991	1992	1995
Workstation Consumption	117	154	208	606
Workstation Production	78	141	230	638
Effective Workstation Production	37	83	158	462
RISC-Based Workstation, Effective Production	11	62	135	392
RISC Effective Production, Percent of Consumption	9.4%	40.3%	64.9%	64.7%
PC Effective Production	3,778	4,234	4,850	6,512

Source: Dataquest (August 1992 Estimates)

in 1995, 24 PCs will be made using locally procured semiconductors.

Most of these workstations are used in engineering design, or as small department computers, with additional applications as disk servers in computer networks. Much of the performance required in these applications is for high-speed integer operations, with only engineering and simulation requiring floating-point operations.

X-Terminals

RISC processors also find applications in X-terminals, where the computational needs are high and cost constraints are severe. This is one of the few applications that require high-performance floating-point operations, and RISC processors offer this capability. X-terminals serve a similar market to workstations, and share some of the technical and market requirements of workstations. The pricing criteria of X-terminals are lower than those of workstations, though, and price expectations of X-terminal buyers are falling daily as suppliers battle for business.

Currently, there are very few X-terminal manufacturers in Europe, and the market is under pressure from the lowering of prices for workstations and the increasing performance of PCs. Table 4 shows the X-terminal market in Europe, and the major suppliers of X-terminals. None of the suppliers in 1991 used RISC processors in their products, but Hewlett-Packard has since introduced a RISC-based X-terminal, using Intel's i960 RISC microcontroller. Digital also has a RISC-based X-terminal, and this is likely to be MIPS-based, although future Digital products are more likely to use low-cost versions of the Alpha chip.

Laser Printers

One of the other major applications for RISC processors is in laser printers, a market originally dominated by Motorola with its 68000 32-bit processor. This is still the dominant processor in use in laser printer controllers, but RISC processors are slowly displacing the Motorola processor as the preferred option. The most popular RISC processors are:

- Weitek 8200
- AMD 29000
- Intel i960

Table 4
European X-Terminal Consumption
(Thousands of Units)

Supplier/Processor	1991
NCD, 68020	8.5
Hewlett-Packard, 80186	8.0
Digital, 34010	5.8
IBM, 80186	2.0
Tektronix, 68030	1.4
Visual, 68020	1.0
Others, Various	2.4
Total 1991 Units	29.1
1990	18.0
1992	68.0
1993	310.0

Source: Dataquest (August 1992 Estimates)

The majority of the market for laser printers is in the 1 to 10 page-per-minute (ppm) category, as can bee seen from Table 5, which represents over 90 percent of the units to be consumed out to 1996. In this category the only laser printer manufacturer currently using a RISC processor and manufacturing in Europe is Dataproducts, as can be seen from Table 6.

The dominant supplier in the laser printer market is Hewlett-Packard (HP), and the company does not manufacture laser printers in Europe, although it does have a plant in Italy manufacturing controller boards. This plant has been opened recently, and Dataquest estimates Hewlett-Packard will make between 150,000 and 250,000 controller boards at this site during 1992. HP uses Motorola processors in the 1- to 10-ppm printers it supplies, and uses a RISC processor (AMD 29000) in the only higher-performance LaserJet IIISi, rated at 17 ppm. The overall result, therefore, is that the laser printer market for RISC processors in Europe is small.

The outlook for this market is more optimistic, though, as the share of the market taken by PostScript printers increases. The throughput of a laser printer is controlled by both the printer engine and the controller card. When simple text or bit-map graphics are transmitted to the laser printer, the rate of output is limited by the speed of the printer engine, but using complex page description languages (PDLs) such as PostScript, the printer speed is more likely to be limited by the controller.

To reap the benefits of faster engines, manufacturers are turning to RISC processors to speed the formatting of the page, when it is transmitted in a page description language. This is particularly relevant when color laser printers are introduced. The page throughput may not increase out of the 1- to 10-ppm range for these printers, but color takes much more processing. However, the effective production of laser printers in Europe is still small.

Embedded Control

The small size of the workstation market, when compared with other markets such as the market for PCs, has induced European offices of semiconductor companies supplying RISC processors to search for alternative applications. However, embedded control applications that need the performance of a 32-bit microprocessor are limited.

Applications which are likely to need this performance include group 4 fax machines, digital color photocopiers, and some telecoms applications such as exchanges, but unit volumes are low in these areas. For example, Dataquest anticipates that about 5,000 exchanges a year will be manufactured in Europe over the period 1991 to 1996. In addition, embedded control applications normally do not require floating-point operations, so the floating point units in RISC processors would not be needed. In fact the laser printer is one application of embedded control, and is one of the few

Table 5
European Laser Printer Consumption, 1991 to 1996

Printer Speed (ppm)	Shipments 1991	Units (K) 1996	Market Share (%) 1996
1-6	739	1,966	66%
7-10	658	816	27%
11+	93	205	7%
Total	1,490	2,987	

Source: Dataquest (August 1992 Estimates)

Table 6
Europe-Based Laser Printer Manufacturers
1-10 ppm Category

Manufacturer	RISC-Based Printer
Agfa	No
Bull	No
Canon	No
Dataproducts	Yes (Weitek 8220)
Facit	No
IBM	No
Kyocera	No
Océ	No
Olivetti	No
Rank Xerox	No
Siemens	No
Wenger	No

Source: Dataquest (August 1992)

applications where high computational performance is needed in a control application; other applications which need this are few in number.

The most successful architecture in embedded control is the Transputer, although this is under threat from SPARC. The Transputer's strength in this market comes from its early introduction, being the first commercially available RISC processor. The workstation market was dominated by Motorola 68000 processors at the time of the introduction of the Transputer, leaving embedded control as the main market for this processor.

The embedded market had little need for high-performance processors at the time, and the Transputer found success in a wide variety of niche applications, where volumes were low but performance demands were high. Typically, these included applications ranging from global positioning to laser printers.

SPARC is emerging in embedded control through shipments of VME-based boards. The base of software which supports SPARC is large, and is one of the main factors in the success of SPARC in control applications.

Performance

Measurement of performance is a very subjective issue. The favored method until recently was to use millions of instructions per second (Mips), but this gave an unclear picture of performance, and caused some confusion with, for example, floating-point performance. Other methods, such as the use of SPECmark ratings, give a clearer picture. SPECmark ratings are produced by running a series of programs through a configured system which includes the processor. These programs are divided into integer and floating-point exercises for the device, and two resultant values are given for the processor: SPECint, for integer operations; and SPECfp for floating-point operations. SPECmark ratings measure *system* performance, though, and reflect, but do not measure directly, processor performance. Other factors which are variables in the measurement include compiler performance and system configuration.

The architecture and compiler development of processors, together with the system configuration, can be adjusted to give an unrepresentative indication of performance even when using these SPECmarks. New SPEC programs were introduced at the beginning of 1992 to give a more representative measure, and the new SPECmark rating is what is used to compare performance, where this is available. These performance figures have "92" after the processor name in the Figures 6 and 7 (see below), to differentiate them from the older 1989-based SPEC ratings.

With the introduction of multiple instruction execution (superscalar) architectures, the Mips rating has increased dramatically for these processors as they are able to execute several instructions for each clock cycle. Some manufacturers may be returning to Mips as a rating of performance, to benefit from this perceived improvement.

System performance is a better reflection of processor design, as all processors must be used in a system: they cannot be operated alone. Coupled with the system performance is the aspect of ease of design. Some processors are easy to design with, allowing cache memory to be added easily, to improve performance. Other systems require complex cache design, and this can take considerable time to design and implement effectively. As cache memory size is one of the major influences of performance this is an important issue.

Clock speed is another factor to be considered. Devices which need to be clocked at high rates make board-level design difficult. In addition, high clock speeds increase the performance demands of external chips, such as cache memory. It may be possible to clock a device at 100 MHz, but the cache might be unable to keep up with this performance, and the result would be a degradation of performance as cache misses occur.

Superscalar architectures give some benefits from bigger bus widths. The strain placed on system buses as they are required to operate at over 50 MHz can cause problems with data throughput to the processor, and possibly RF emission problems. Superscalar and 64-bit architectures allow the fetching of more than one instruction in a single cycle, across the wider bus. This allows the bus to operate at a slower clock rate, and eases system design. Clocking the internal logic at two to four times the rate of the external clock also improves performance without placing additional strain on required board performance.

Figure 6 shows the current integer performance rating of the existing processors. The performance of the CISC processors from Motorola and Intel have been included in this figure, and this puts the performance of the RISC processors in perspective. The majority of applications for RISC processors only require integer operation, so the SPECint rating is the most appropriate value to use to compare performance, especially in embedded control.

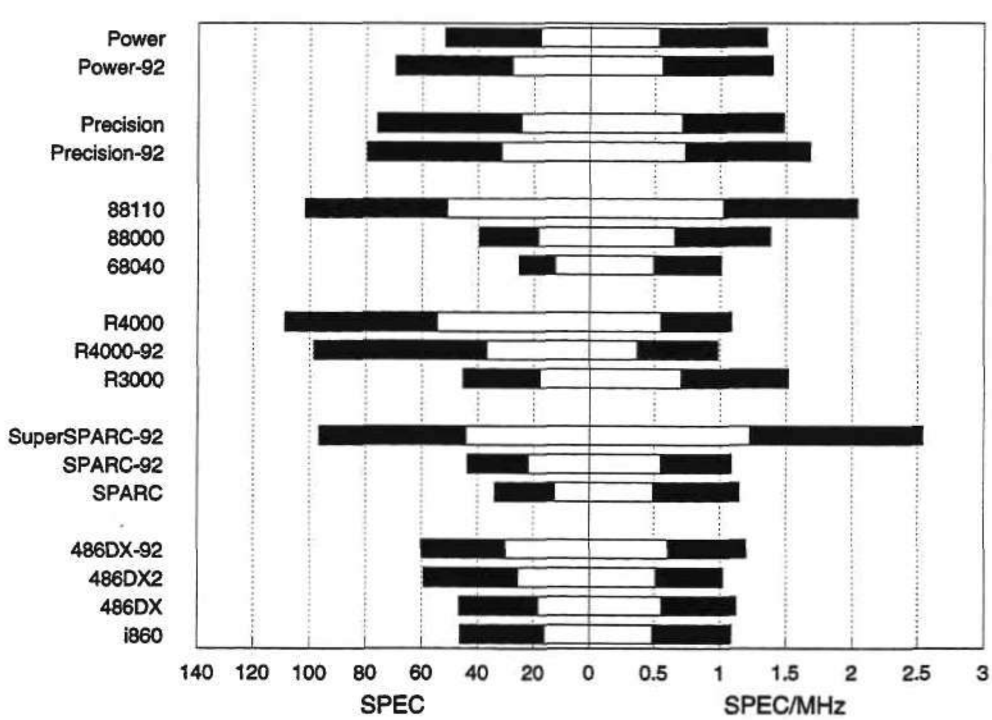
The figure includes a range of SPECint ratings for the processors, and includes processors operating at several clock speeds and system configurations. The highest and lowest SPECint ratings are therefore given.

More recently introduced processors have been manufactured with a smaller dimension process, and as a result are able to be clocked at a faster rate. As this clock speed enables the SPEC software to execute faster, the SPECint rating has been divided by the clock speed, to give a figure for SPECint/MHz. This should give a more representative measure of the processor architecture.

Analysis of this performance rating reveals some interesting results. The most recently introduced processors should benefit not only from an improvement in performance due to becoming available on faster processes, but improvements in architecture and implementation should also increase the performance of the processor, irrespective of the clock speed.

In general this is the case, with the most recently introduced processor, the SuperSPARC, showing the greatest performance when measured in SPECint/MHz, with IBM's Power architecture and Hewlett-Packard's Precision Architecture also showing good performance. As would be expected, Intel's 486 architecture, being among the oldest, is one with the lowest performance when measured in SPECint/MHz. However, its disadvantage is slight, and when it is placed against with the more recently introduced MIPS R4000 its performance is comparable. In terms of absolute performance,

Figure 6
RISC Processor Integer Performance



Source: Dataquest (August 1992 Estimates)

though, the R4000 can be clocked at 100 MHz internally, while the 486DX's top internal speed is only 66 MHz.

The "next-generation" RISC processors which have been announced give a major improvement in performance. These include the SuperSPARC, for which the higher performance can easily be seen in Figure 6. To counter this advantage, Intel is expected to release its latest-generation CISC processor, currently coded the P5, and this is expected to have performance comparable with that of the R4000. The floating-point performance in particular is rumored to have been improved. If this is the case, the best that can be gained through the use of a RISC architecture is time—typically 12 to 24 months.

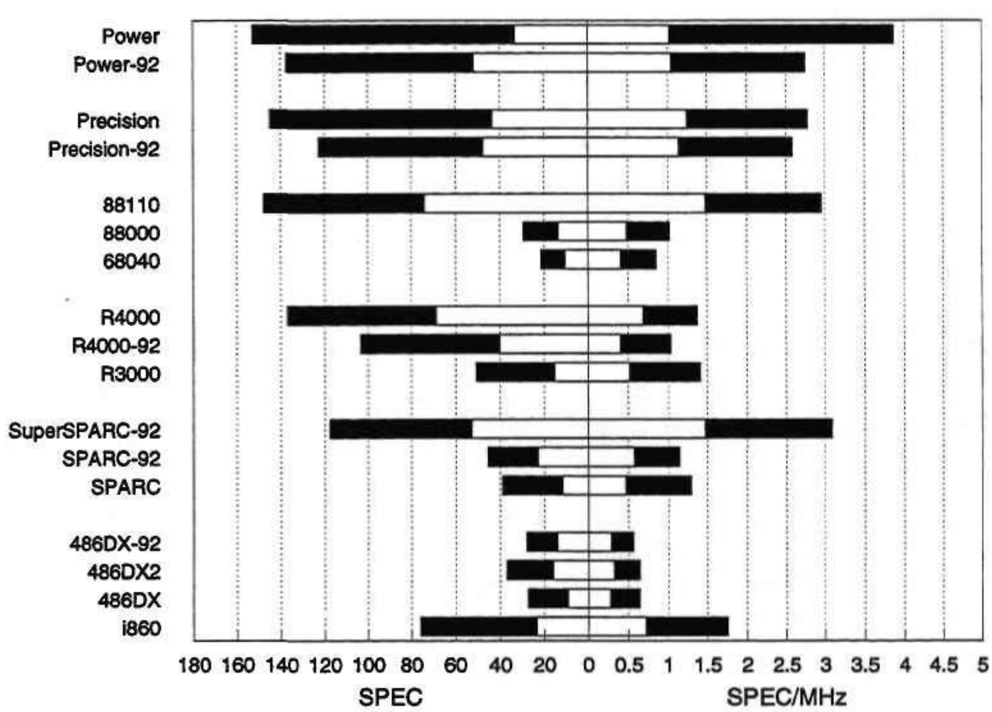
Some applications require floating-point performance, and these applications include translation of page description languages into bit maps for laser printers, and in engineering simulation. While the engineering simulation market is relatively small, the market for PDL laser printers will be much larger.

RISC processors have an advantage in performance here over CISC processors, as can be seen from Figure 7. However, some caution should be exercised when examining this figure, as some of the very high SPECfp ratings are achieved from improvements in compiler performance and favorable configurations, in particular to run the Matrix 300 SPEC program. The aim with the compiler is to reduce the number of bus cycles needed to load data into the cache of the processor. The 1992 SPECfp software suite does not include the Matrix 300 program, because of its distortion of perceived performance improvements.

Cost (Price)

The market for RISC processors is lower in unit terms than that for CISC processors. The development cost will therefore be spread across fewer units, and will be a much higher proportion of the end resale price. However, RISC die sizes should be smaller, as they will benefit from not having the overhead of compatibility

Figure 7
RISC Processor Floating-Point Performance



Source: Dataquest (August 1992 Estimates)

with previous generations. Realistically, though, cost is not the driving factor in the price of processors, as can be seen from the difference in price between CISC microprocessors and their embedded controller equivalents.

Figure 8 shows the forecast and historical price trends for a range of RISC and CISC processors, and the difference in price is dramatic. Whereas the RISC processors are priced close together, comparable CISC processors are priced significantly higher. The embedded control version of the 68040 is also forecast on this figure, and this reinforces the point that RISC processors compete in the embedded control market. The premise that RISC processors offer more dollars per Mip is thus correct, bearing in mind that Figures 6 and 7 show the RISC performance is comparable with that of CISC processors.

As with performance, the cost of the individual processors is not the whole picture. The processors in a RISC system may be lower-cost, but some will demand expensive high-speed cache memory, and cache controllers. The high clock speeds needed in the system to achieve the expected performance can add significantly to the board cost, resulting in higher system costs than were first anticipated. However, these additional costs are also incurred for higher-speed CISC processors, where their external clock speeds are pushed over 50 MHz.

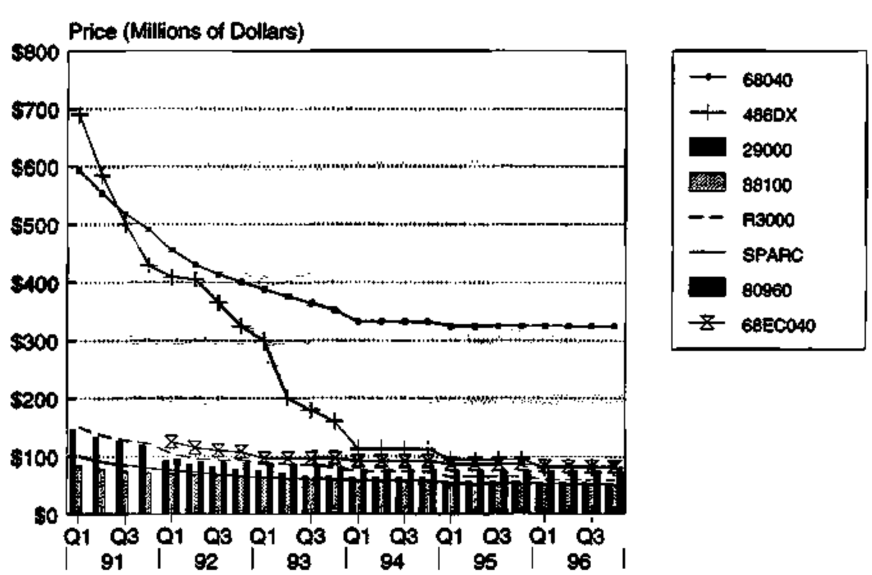
The RISC Market

The original expectations for the RISC market were that the processors would account for up to half of the total market for microprocessors, but, the range of applications so far for the products has been very limited. The processors have achieved the greatest success in workstations, with few, if any, workstations being based on a CISC processor. In this respect RISC processors have been particularly successful.

Figure 9 shows worldwide RISC unit shipments, and the share by architecture of the RISC market. The most successful architectures are SPARC, MIPS and the Transputer. Workstation applications account for over 60 percent of the RISC market worldwide. However, most workstations are manufactured outside of Europe, so the consumption of RISC processors in the region has been small in comparison with the consumption of CISC processors.

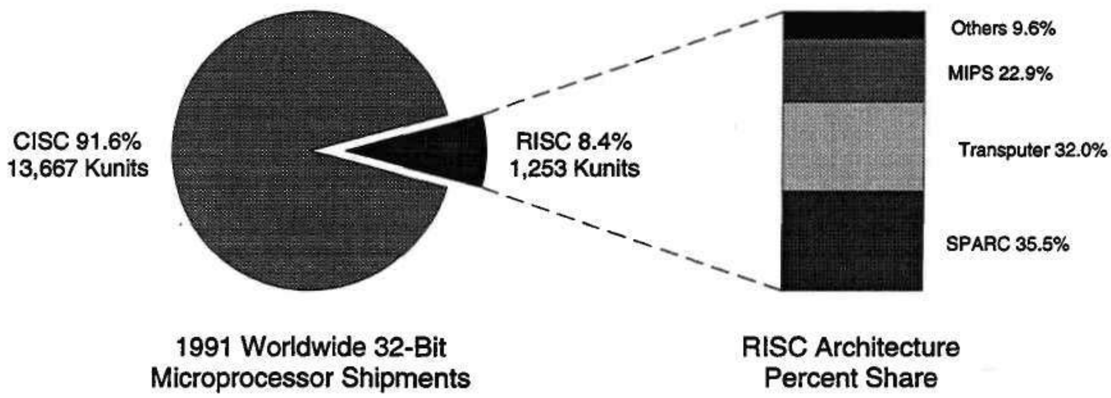
The number of workstations consumed (not manufactured) in Europe in 1991 is estimated at

Figure 8
RISC and CISC Processor Price Trends
North American Bookings Prices (US Dollars)



Source: Dataquest (August 1992 Estimates)

Figure 9
Worldwide 32-bit Unit Shipments, 1991



Source: Dataquest (August 1992 Estimates)

154,000 units. Compare this with the consumption of PCs, which is estimated at 8 million, and the relative sizes of the market can easily be seen; the PC market in Europe is nearly 50 times bigger. The manufacture of workstations presents an even worse figure—whereas over half of the PCs consumed in Europe are locally made, less than half of the workstations consumed are manufactured in the region.

Dataquest Perspective

The development of RISC enabled microprocessor suppliers to change to a more modern architecture while still retaining backwards compatibility with an installed based of software. However, the established CISC architecture is too well entrenched, and could not be shaken from its stranglehold on most applications.

RISC's home market is workstations, but workstations are not enjoying the high volumes of unit shipments achieved by PCs. The PC market is already encroaching on the workstation market anyway, and the expected performance of the P5 suggests it will be used to target the workstation market with a P5-based PC. Developments in operating systems support the view that factors which differentiate the workstation from the PC are disappearing. Multiple-user and multiple-application execution were previously the domain of workstations, but these features are now becoming available on PCs.

To date the PC has been based on Intel processors, but the development of PC operating systems is opening this market. Windows NT, the latest operating system from Microsoft, has the capability to be run on a variety of processors, including RISC. This will enable RISC to expand into the PC market, but the factor that will most govern acceptance will be the availability and ease of use of applications software. Many PCs for business use are networked, and if this network were to include PCs with different processors, two copies of the applications software would be needed for both types of machine. This may be the biggest barrier to the acceptance of RISC as a processor in the PC market. The decision lies with MIS managers.

An important point to consider is the share of RISC shipments which go to a "captive" customer. Over half of RISC shipments go to workstation or computer suppliers. The main market for Precision is in Hewlett-Packard products; IBM is the major user for Power; Digital and Olivetti are the main potential users of Alpha; Sun is the main buyer for SPARC; MIPS is the main buyer of MIPS; Intergraph is the major buyer for Clipper.

Of the remaining RISC architectures, the Advanced RISC Machine (ARM) has major sales away from its parent; AMD enjoys significant sales from a range of customers; Intel and Motorola's will see sales that are not exclusively from the parent. However, Figure 9 shows that these companies represent less than 10 percent of the market. The Transputer is the only architecture which has a significant share of the market, and is not tied directly to a workstation supplier. Since its introduction, though, the Transputer has lost share.

Unit shipments of RISC processors are low when compared with CISC, but they could rise significantly if the architecture can displace CISC in just one volume application. Laser printers hold the greatest potential, as the low cost requirements and high performance needs match well with RISC processors. This is the area where the RISC processor is most likely to succeed—but RISC has offered great potential for some time, and failed to fulfil this potential.

RISC was adopted and sponsored by workstation manufacturers to gain a competitive edge. Its success elsewhere has been limited, especially where the consumer of the product has had a choice. Most RISC architectures are optimized for workstations, so if the product is not a workstation RISC is not optimum. In this case, general-purpose processors will enjoy more success in a wider market.

RISC offers cost and performance benefits, but the major potential market is now in embedded control. Prices for CISC processors in this market are low anyway, and performance needs are not spectacular. Overall cost is the overriding issue in this market, and this covers not just the processor cost, but the cost of developing the complete system.

The performance advantage is apparent, but this only buys time. CISC processors will offer comparable performance, albeit 12 to 24 months later. Time is worth money in many markets, so the adoption of RISC could be worth the investment. However, recent history indicates most equipment manufacturers have decided the risk of choosing the RISC route outweighs the time-to-market benefits.

To return to the original premise:

- **Performance:** Integer performance is similar between RISC and CISC architectures. RISC tends to achieve higher levels of performance before CISC architectures. Floating-point performance for RISC is easily ahead of CISC (for the moment), but performance is much influenced by factors other than the processor, so this is likely to be a secondary issue in the RISC or CISC decision.
- **Cost:** RISC processors are cheaper than their CISC equivalent, but when RISC is compared to embedded controllers, which should be their competition in most applications outside workstations, RISC and CISC prices are comparable.
- **The Market:** The number of applications which specifically need a 32-bit RISC processor are limited. Much of the market can be serviced by CISC controllers, and these are more firmly established. Key applications which benefit from the use of RISC are either low-volume, or much of the manufacture takes place outside Europe. The market is therefore much smaller than originally expected.

By Mike Glennon

Appendix: Profiles of RISC Architectures

SPARC

The SPARC architecture is to date the most successful. It was developed by Sun Microsystems for use in its workstations, and represented a departure for the company from its reliance on Motorola 68xxx processors. Sun does not manufacture the processor itself, but licenses the architecture to several silicon manufacturers. The majority of SPARC shipments are to Sun, which is the major user; Sun workstations use SPARC processors only. There is also a market for controller boards, in particular VME boards based on the SPARC processor, for use in industrial control and instrumentation applications.

SPARC processors have continually improved in performance, with the latest versions announced from Texas Instruments and Cypress. These new "SuperSPARC" processors offer a big improvement in performance over the existing generation. The processors provide superscalar execution of instructions, through the use of parallel integer arithmetic logic units (ALUs), which allow the execution of more than one instruction at once. In addition, the new processors allow the execution of floating-point operations at the same time, although there are constraints on which instructions can be executed together.

MIPS

MIPS, also a workstation company, has developed its own architecture, which is supplied by several silicon manufacturers. While the SPARC architecture is licensed to the silicon manufacturers, allowing these manufacturers to decide on the implementation themselves, the MIPS implementation is defined by MIPS, and the silicon manufacturers then make the silicon to this implementation.

The MIPS processor was one of two processors chosen by the ACE consortium, a group of companies whose aim was to establish an alternative architecture to the Intel 80x86 CISC architecture. The ACE group intended to develop both PC-type and workstation-type products around a common platform. At first the consortium aroused much interest, but there have been some defections from the ACE camp, and it is now seen as being less powerful than was first anticipated.

As with SPARC, the processor has been evolving, and the R4000—the latest implementation of the processor—has superscalar techniques to improve performance.

Transputer

The Transputer was the first commercially available RISC processor, and was originally targeted at parallel processing applications only. The inclusion of several high-speed serial links on the silicon ensured that the interprocessor communications capability of the Transputer was second to none. Because of its parallel processing abilities, the Transputer is regularly selected for parallel processing computer initiatives in this area.

Inmos designed and manufactured the Transputer. Initially a UK government-funded semiconductor supplier, the company has changed ownership several times, and now falls under the umbrella of SGS-Thomson, which acquired the company from Thorn EMI. The Transputer is now aimed at more mainstream applications, and is used in a wide range of control functions. It is one of the few RISC processors which does not have workstation products as its mainstream application, although it was previously used as the processor in Racal-Redac's engineering workstation.

ARM

The ARM (Advanced RISC Machine) is a processor architecture developed by Acorn Computers, now majority-owned by Olivetti. Its main application has been in home computers developed for the educational market, accounting for almost all of the shipments. The processor development division of Acorn Computers was spun off into a separate venture, also called ARM, and this is funded by Acorn, VLSI Technology and Apple Computer.

The ARM processor is unique in that the ultimate performance has not been the goal in the use of RISC to design the processor. As with most of the other RISC products, computing has been the main application. In this case, however, the computers are not workstations, but home computers. ARM's most recent success was to be selected by Apple for use in its new personal digital assistant, the Newton. This could be the new face of computing, and if successful possibly represent millions of units for ARM.

In common with most of the other RISC architectures, ARM is not manufactured by the company which designs the architecture, but by VLSI Technology, one of the shareholders. GEC Plessey Semiconductors has also taken a license to manufacture the processor. These two companies license the architecture and the design of the processor.

Clipper

The Clipper architecture was developed as part of Fairchild Semiconductor's Advanced Processor Division (APD). When Fairchild was purchased by National Semiconductor, the APD was sold to Intergraph. Intergraph was the major customer for Clipper, and had built a range of workstations around the product. National Semiconductor already had its own range of microprocessors, and was unwilling to support two, hence the sale of the processor division to Intergraph. Again, the major application for the processor was in workstations. Intergraph has chosen not to sell the architecture or the processors outside the company, resulting in low overall sales for the processor.

Precision

The Precision architecture was developed by Hewlett-Packard as the next generation after the 9000 series. This is primarily used in the company's workstations, and HP has licensed the architecture to Samsung, Hitachi, and most recently Winbond. Hewlett-Packard purchased Apollo several years ago to strengthen its position in the workstation market, and displaced Motorola as the supplier of the processor for these workstations.

Power

The Power architecture was introduced by IBM, again for use in its workstations. Since the development of this multichip architecture, IBM has reached agreements with Motorola and Apple to develop a single-chip version, for use in lower-cost workstations and personal computers.

88000

The 88000 architecture is one of the few which has not been sponsored by a workstation supplier. Motorola has enjoyed less success with this architecture than have some suppliers of other architectures, but some computer manufacturers, such as Data General, have adopted this processor for use in their workstations. The lack of a guaranteed customer means the architecture has found more success in embedded control.

Motorola has pioneered the development of portable software based around the architecture, and there is an organization, 88Open, whose sole function is to promote the 88000 architecture and police the conformance of software to the required standard. While it is in Motorola's interest to maintain this organization, it is actually independent of the company.

Alpha

This is the most recently introduced RISC architecture, developed by Digital Equipment Corporation. The processor has very high performance, and is targeted initially as a VAX replacement. The processor is clocked at 200 MHz, and dissipates 30W, so its use will be reserved initially for mainframe-type applications. Processor architecture has been Digital's strong point in the past, and the company has enjoyed major successes with PDP-8, PDP-11, and VAX architectures. Before the introduction of the Alpha architecture Digital used the MIPS processor in its workstations, but has since defected from MIPS and ACE.

While the processor is very power-hungry, it has a guaranteed market from its parent, and Digital intends to develop other processor offshoots to target the broader computer market. Digital also intends to offer the architecture and the processors to other companies, and has already signed an agreement with Olivetti where Olivetti will use the Alpha chip in its products; Digital has taken a 10 percent stake in Olivetti, as part of the same agreement.

End-User Analysis

1992 European Vendor of the Year

The first Dataquest European Semiconductor Vendor of the Year Awards were presented at the European Semiconductor Conference, held in June at Jurys Hotel, Dublin, before an audience of more than 150 people. Four awards were made:

- The European vendor of the year was Motorola.
- Texas Instruments received an award for customer responsiveness.
- Vendor of the year in the medium-size vendor category was LSI Logic.
- The niche vendor of the year was European Silicon Structures (ES2).

Methodology

The selection of the European Vendor of the Year Awards 1991/1992 was based on a customer opinion poll conducted between November 1991 and January 1992, as part of Dataquest Europe's annual procurement survey. Each year Dataquest surveys buyers in order to understand purchasing trends, reviewing areas including major procurement issues and trends in semiconductor spending. The survey is conducted among approximately 60 companies across Europe.

This year, as part of the survey, respondents were asked to nominate and rank their top three semiconductor vendors, in first, second and third positions, based on the criteria of delivery, quality, responsiveness, technical support, and overall performance. Of the 60 companies surveyed 40 felt able to give an input on their preferred vendors. The spending power of these companies amounted to 42 percent of the total European semiconductor market—a very significant sample size.

The Categories

The categories, as mentioned above, refer to the following attributes:

- **Delivery** refers to a vendor's ability to meet the schedules it committed to its customer. Only a vendor that can be trusted to meet its commitments will find itself participating in "preferred vendor" or "vendor of choice" programs with its important customers. "Time to market" is becoming more and more critical in all the electronic systems markets, from PCs to central office exchanges, so customers must be able to rely on the commitments its suppliers make.
- **Quality** refers to the quality of semiconductor products shipped to a customer. The customer requires assurance that every product conforms to the data sheet specification. If a vendor fails to deliver reliable products then, as with delivery, the customer will feel unable to trust its business to that supplier.
- A vendor's **Responsiveness** is harder to quantify than delivery or quality. Responsiveness encompasses many aspects of the vendor–customer relationship. It is best summed up by asking the question: How easy is it to do business with vendor A or B? A vendor may deliver products with zero defect, and always meet schedules, but if it takes weeks to get a price and leadtime commitment on a simple 74LS00, then doing business with that vendor becomes very frustrating.
- The standard of **Technical Support** that a customer receives from its supplier has become a key differentiator between vendors, as ICs become more complex. Semiconductor manufacturers are packing high levels of systems knowledge into silicon these days. A designer can only get a limited knowledge about a VLSI device from reading a data sheet. A clear applications note combined with access to the support of a qualified applications engineer are key to allowing a customer to use, for example, an advanced graphics chip.
- **Overall Performance** is the expression of a vendor's total performance to customer requirements. The vendor must measure up well to all the above criteria; if it does, then it will provide an excellence of service that will give the customer the competitive edge needed to succeed in its markets.

Summarizing the Results

Respondents ranked their suppliers in each of the five categories, first, second and third. The results from the survey were then aggregated on the basis of 10 points awarded for a first rank, 6 points for a second rank and 3 points for a third rank.

A summary of the overall results revealed that Motorola ranked highest in delivery, quality, technical support and overall performance (see Figure 10). However, in the subcategory of responsiveness, Texas Instruments received most votes displacing Motorola into second place. Thus, two awards were decided: vendor of the year for 1991/92 would be Motorola, while Texas Instruments was recognized for the responsiveness of service it provides (see Figure 11).

Dataquest defined two further important categories, for medium-size and niche vendor of the year, in recognition of the contribution that more specialized semiconductor vendors make to the industry. These categories were defined as:

- Medium-size vendor: annual revenue between $50 million and $499 million
- Niche vendor: annual revenue of less than $50 million

Large, broad-based suppliers like Motorola and Texas Instruments supply products to many customers. As they supply everything from transistors to advanced microprocessors, their customer base is much wider than that of specialized vendors which focus on particular markets. However, niche vendors make no less strenuous efforts to provide their customers with excellent service. In the final reckoning it was LSI Logic that customers recognized as the outstanding vendor in the medium-size category (see Figure 12). In the niche category European Silicon Structures came top—the only European semiconductor vendor to excel (see Figure 13).

Dataquest Perspective

The first point to note is that the response to the survey was outstanding. Over 40 percent by value of Europe's purchasing muscle gave us their input. With this in mind, what is the overall picture the survey paints of the service vendors provide to their customers in Europe?

Quite clearly the US-based vendors are ahead of the pack. Motorola in particular has picked up two awards from Dataquest this year, having first won the worldwide vendor of the year award, and now the European award. It is also interesting to note that Japanese-based vendors as a group generally fared poorly, particularly in delivery, technical support and responsiveness. These are aspects of service that perhaps reflect more on their local European infrastructure than on other factors.

In the medium-size and niche categories, two ASIC vendors were recognized as providing best service. Nowhere can the aspects of customer service be put to the test more than when tailoring a piece of silicon to one customer's specification. LSI Logic and European Silicon Structures were both pioneers of ASICs. As the large multinationals entered the business, LSI Logic and ES2 both faced fierce competition. Clearly, their recipe for survival has been to stress the service aspects of their businesses.

The success of these companies in responding to their company needs can be measured not only in winning these awards, but also in their ability to gain market share. A quick look at the market shares of the four winners over the past three years shows market share gains for three of the four. Motorola's share of the total semiconductor market has grown from 6.9 percent in 1989, to 7.1 percent in 1991. LSI Logic's share has grown from 0.8 percent of the market in 1989, to 0.9 percent in 1991. European Silicon Structures' share has grown from 0.18 percent to 0.25 percent. Only Texas Instruments lost share over this period. This is mainly due to the DRAM market, which declined by nearly 22 percent over two years. More than 20 percent of Texas Instruments' revenue comes from DRAM, so it is no surprise to see the company lose market share over this period.

Success with customers can be translated into market share gains. The attention paid to customers has clearly paid off for these four companies, and their customers appreciate this. So, congratulations to Motorola, Texas Instruments, LSI Logic and European Silicon Structures. Their customers acknowledged them as providing good service.

By Sarah Jacob
Jim Eastlake

Figure 10

Barry Waite, senior vice president and general manager of the European Semiconductor Group was delighted to receive the European Vendor of the Year Award on behalf of Motorola. He is seen here with Bríd O'Connor and Bipin Parmar of Dataquest's European Semiconductor Group.

Figure 11

Marc Vodovar, central marketing manager of Texas Instruments, received an award for Customer Responsiveness.

Figure 12

LSI Logic was voted the best Medium-Size Vendor of the Year. Horst Sandfort, president of the company's European operations, received the award.

Figure 13

European Silicon Structures came top of the Niche category awards. Werner Kopf, chairman and CEO, is seen here making a brief acknowledgement speech to delegates at the conference.

In Future Issues

Forthcoming issues of *Dataquest Perspective* will report on:

- Microcomponent market share
- IBM/Siemens/Toshiba 256M DRAM venture

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9209 July 31, 1992

In This Issue...

Pricing Analysis

European Pricing Update

The European Commission is thought to be preparing provisional antidumping duty legislation against South Korean DRAM manufacturers, and this is expected to be published in September. In the meantime, a shortage of supply for SO package standard logic products is pushing lead times out to 30 weeks in some cases. Prices have yet to show an increase, though, and price erosion continues for many memory products.

By Byron Harding and Mike Glennon *Page 2*

Market Analysis

State of the Industry

The SIA flash European book-to-bill ratio for June was 1.06, improving on May's 1.02. The 12-month moving-average growth is improving, and has risen for the second consecutive month. However, the forecast model data suggests the billing data is a little high, and may be restated downward next month. The signs are that the market has hit rock bottom, and is now climbing out of the depths to which it had sunk. Some suppliers are experiencing very large and unexpected orders in July, and lead times are extending. Recovery may well be on the horizon.

By Byron Harding and Mike Glennon *Page 5*

European Semiconductor Market Forecast: 1990-1996

Dataquest forecasts the European market to grow by 7.2 percent in 1992, and by a compound rate of 10 percent per year out to 1996. Long-term growth will come from consumer, telecoms and EDP applications, but there may well be a fundamental change in the way the majority of the computational power will be delivered to the user. Overcapacity is likely to affect short-term prices, but delays in the opening of new fabrication plants will ensure the oversupply issue will not be exacerbated. MOS memory is the star product over the next five years, followed by microcomponent. This reflects the strength of EDP applications in Europe.

By Mike Glennon *Page 10*

Final 1991 European Semiconductor Market Share Rankings

The European market grew by just 5.8 percent in 1991. Much of this growth was serviced by non-European companies. The share of the European market held by European companies continued its long-term decline, falling to 37.6 percent of the market in 1991. Philips remained the number-one company, despite only growing by 1.4 percent. The star performer was Intel, growing its revenue by 23 percent.

By Byron Harding *Page 18*

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File inside the *Dataquest Perspective* binder labeled **Semiconductors** *Europe*

Pricing Analysis

European Pricing Update

Industry Events

The European Commission is thought to be preparing provisional antidumping duty legislation against South Korean DRAM manufacturers. This is expected to be published in the *Official Journal* in September. It is not yet clear whether any voluntary undertakings have been accepted by the Commission from the Korean companies. It is through such undertakings that the antidumping duties can be suspended.

In the previous DRAM antidumping case against Japanese companies, voluntary undertakings in the form of reference prices were accepted by the EC in return for suspending the 60 percent antidumping duty. It is believed that the Commission may instead accept undertakings from the Koreans in the form of a data-collection program for manufacturing costs. This is similar to the system employed in the current US–Japan trade arrangement, whereby cost data can be made available at short notice to official bodies investigating fresh allegations of dumping.

This so-called "fast track" investigation would enable a decision to be made quickly, and action to be taken before irreversible damage is inflicted upon domestic industries. The current Korean investigation is more than two years old now. End users of semiconductors in Europe would prefer the data-collection undertaking for manufacturing costs to be accepted by the Commission because it would probably affect market prices less than a reference price undertaking. This is important, as Korean supply of the DRAM market in Europe in significant: 80 percent of 256K, 30 percent of 1M, 20 percent of 4M, and 15 percent of 16M.

If the cost data-collection undertaking gives participants greater freedom to compete, then Japanese reference price participants may want a similar arrangement. However, now that some Japanese companies have committed to manufacturing DRAMs in Europe, views are split. Those participants with European fabs (NEC, Hitachi, Fujitsu, Texas Instruments, and soon Mitsubishi) regard the reference price system as protection against Japanese competitors without a European fab (Toshiba, NMB, Oki, Sanyo, Sharp, and Matsushita). The former are understood to prefer the reference price system, while the latter prefer the cost data-collection system. Watch this space for updates.

Table 1 shows European semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Standard Logic

Demand is exceeding supply for small outline (SO) parts, resulting in a significant shortage, which has a consequential effect on PDIP parts. This high demand is keeping prices level, and lead times have lengthened. Prices have yet to rise in general at OEM buyers, but distributors are lifting their prices. The distribution prices were artificially low anyway, as the weak business levels had forced them to cut margins to stimulate demand. This rise in distribution is therefore a return to normal pricing practices.

Much of the demand is across the board, but some PC suppliers are showing an increase above other applications. However, some of the major PC manufacturers are still suffering from very poor demand. The disproportionate rise in demand over supply for SO in particular is related to some manufacturers cutting back their standard logic capacity. Other suppliers saw the potential rise in demand and kept their capacity levels high. These suppliers are now benefiting from their greater ability to supply their customers; they are now servicing their major customers, and those standard logic users who are not considered "key" are having to wait as long as 30 weeks for products in some cases.

Analog

The mono operational amplifier arena in Europe is fairly stable, with no price changes.

Microcomponents

Business is improving, with much of the demand coming from manufacturers new to PC manufacture. These companies are stimulating sales of microprocessors and memory modules, but little else. They are importing general-purpose PC boards, and adding the processor and memory in response to market demand. The sales of the remaining components for these boards is taking place in the Far East, where the boards are assembled. The market for RISC processsors in Europe is small, and focused on compute-intensive applications only. All shipments tend to be on contract negotiation only, and so variations in price reflect the negotiating skills of the buyers, rather than market trends. However, design wins still appear in Europe, and volume contracts are pushing down the price as other CISC architecture processors compete for the design socket.

Memory

DRAM

Prices for 256K DRAMs have dropped a little recently. The short-term outlook is for relatively stable pricing with lead times remaining quite short. Samsung is the leading supplier, with an estimated 55 percent market share.

Price erosion has occurred in the 1M market, although prices from South Korean suppliers appear to have risen recently. This may be due to their increased focus on 4M DRAM production.

A substantial drop in 4M DRAM prices has been seen. Competition has accelerated in the ×1 and ×4, but the real action is in ×8 and ×16 organized versions, or byte-wide and word-wide options. Demand has suddenly picked up from computer and laser printer manufacturers in Europe. There are particular benefits to be gained from wide-organized 4M DRAMs, such as better matching to bus-widths in printers and less power consumption in notebook computers. Parity-check versions, such as 512K×9 and 256K×18 are also proving very popular. These have a premium over ×1, ×4, ×8, and ×16 versions according to the extra capacity, namely 12.5 percent at least. Lead times have thus extended for wide-organized 4M, but only such that capacity has just been overtaken by demand. Capacity should catch up quite quickly, but in the meantime, expect some lead times out as far as 16 weeks.

The 16M part is hovering at around reference price levels, estimated at $130. Demand is still small. The 1M×9 DRAM SIMM is still in two-tier pricing. The nine-chip solution, which is very quickly losing popularity, is at around $29.50, while the three-chip solution is now close to $25. Products are still widely available and South Korean sources provide the best prices, as a result of this country benefiting from a duty-free arrangement with the EC.

Higher-density DRAM SIMMs are also available at attractive prices. It is cheaper to buy DRAMs already mounted on a SIMM than to buy them as loose chips. This negative premium on SIMMs should continue for at least the next quarter, or until demand can catch up with supply. The 1M video RAM continues to be in short supply, with extended lead times expected through the next six months.

The average contract price per Mbit is as follows: 256K $6.00; 1M $3.20; 4M $2.70; 1M×9 $2.83; 16M $8.13.

EPROM

Prices for EPROM remain under pressure, with more erosion at most densities. European and North American competition is the cause. Price erosion will persist despite a relatively slow take-up of higher-density parts. The 4M part has seen some gradual erosion; strong demand from games machines manufacturers in the Far East has caused some restriction in supply to Europe, resulting in extended lead times and only limited price erosion. The average contract price per Mbit is as follows: 1M $2.60; 2M $2.28; 4M $2.60.

SRAM

Prices of 64K slow SRAM are flat in Europe. The main source of supply is now South Korea. Supply and demand are both declining. Slow 256K parts are stable in pricing, although there have been some very low prices from Asia/Pacific while Japanese prices seem to have gone in the opposite direction. The 1M part has stabilized temporarily, and European prices are still lower than in other parts of the world; some users, though, are asking even lower prices. Duty suspension on all speeds of 1M SRAM continues; this may be changed at the end of the year when local supply of certain speeds becomes available. The average contract price per Mbit is as follows: 64K $25.00; 256K $13.00; 1M $9.25.

Current Exchange Rates

1 US dollar =
- 0.526 UK pounds
- 1.500 deutsche marks
- 5.063 French francs
- 0.736 ECU

By Byron Harding
Mike Glennon

Table 1
European Semiconductor Pricing July 1992
All Prices in US Dollars (including import duty where relevant)

Device Family	Product	Package	Mean 1K Price	Mean 10K Price	25K+ Contract Price	Lead Time in Weeks
Standard Logic	74F00	PDIP	0.12	0.10	0.10	4-12
Fast TTL	74F74	PDIP	0.14	0.12	0.12	4-12
	74F138	PDIP	0.18	0.16	0.14	4-12
	74F244	PDIP	0.25	0.23	0.21	4-12
Standard Logic	74AC00	PDIP	0.19	0.17	0.15	12-24
Advanced CMOS	74AC74	PDIP	0.24	0.20	0.18	12-24
	74AC138	PDIP	0.32	0.28	0.24	12-24
	74AC244	PDIP	0.49	0.41	0.37	12-24
Analog	741 Op. Amp.	TO92	0.17	0.12	0.11	4-6
	CODEC/Filter 1	[1]	2.90	2.65	2.50	6-10
	CODEC/Filter 2	[2]	5.75	5.45	5.00	6-10
Microcomponents	80386SX-16	PQFP	47.00	46.00	45.00	4-6
	80386DX-25	CPGA	101.00	97.00	94.00	4-6
	80286-16	PLCC	11.70	11.00	10.00	4-6
	68020-16	PQFP	31.00	27.30	26.00	6-8
	R3000-25	CPGA	90.00	85.00	80.00	4-10
Memory						
DRAM	256K-8 (256K×1)	PDIP	1.75	1.55	1.50	2-8
	1M-8 (1M×1)	SOJ	3.50	3.35	3.20	2-6
	1M-8 (256K×4)	SOJ	3.50	3.35	3.20	2-6
	4M-8 (4M×1)	SOJ	11.60	111.20	10.80	2-8
	9M-8 (1M×9)	SIMM	27.50	26.50	25.50	1-2
	1M-7 (1M×1)	SOJ	3.50	3.35	3.20	2-8
	1M-6 (1M×1)	SOJ	3.64	3.48	3.20	4-10
	4M-7 (4M×1)	SOJ	11.60	11.20	10.80	4-8
	4M-6 (4M×1)	SOJ	12.30	11.90	11.20	6-10
	16M-8(4M×4)	SOJ	135.00	135.00	130.00	8-14
UV EPROM	1M-17 (128K×8)	CDIP	3.25	2.95	2.60	2-6
	2M-17 (256K×8)	CDIP	6.10	4.90	4.55	2-8
	4M-17 (512K×8)	CDIP	14.00	11.40	10.40	8-16
SRAM	64K-85 (8K×8)	PDIP	2.00	1.65	1.55	4-10
	256K-85 (32K×8)	PDIP	3.55	3.35	3.20	4-8
	1M-85 (128K×8)	PDIP	10.50	9.65	9.25	2-10

[1] Group 1: Commercial temp, serial, PDIP, A/μ law
[2] Group 2: Commercial temp, serial, PLCC, A/μ law, programmable
NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Market Analysis

State of the Industry

The SIA flash three-month average book-to-bill ratio for the month of June was 1.06. This is based upon average bookings of $990.6 million and average billings of $935.6 million, both of which are preliminary figures. The bookings figure represents a 6.7 percent increase over the previous month, while the billings figure represents a 2.3 percent increase. Figure 1 shows the three-month average bookings and billings for the past 13 months, and the book-to-bill ratio over the same period. The June ratio provides some optimism for business recovery, although the third quarter is traditionally a slow period because of factory shutdowns and vacations. The real recovery in bookings may not show up until November, while a billings recovery may not show up until September to reflect strong growth in bookings for the first half of the year.

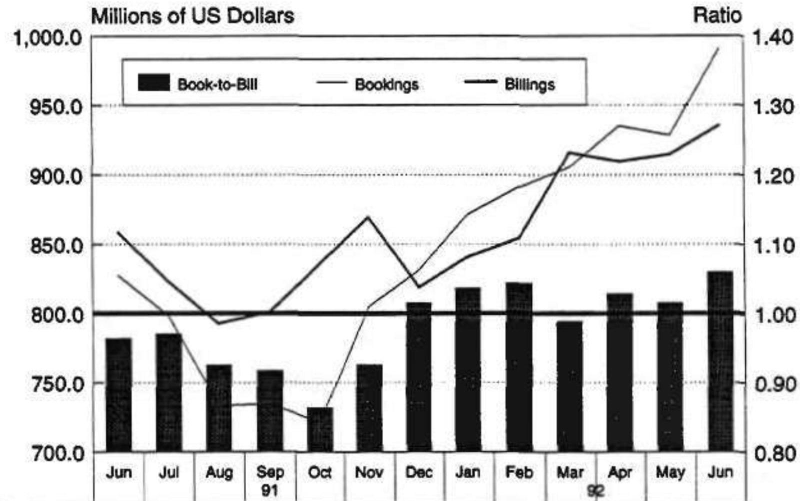
Preliminary average bookings for the month of May have been revised slightly upwards, from $923.1 million to $928.4 million. This change is in the area of ICs, while discretes remain almost unchanged. Preliminary average billings for the same month have also been revised upwards slightly, from $907.9 million to $914.6 million, this time with the change in the area of discretes, while ICs remain almost unchanged. The net result is no change in the ratio for the month of May.

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trend and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billing and three-month average booking figures. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

Figures 2, 3 and 4 show the forecast and actual three-month average bookings, actual monthly billings, and book-to-bill ratio from the Dataquest forecast model.

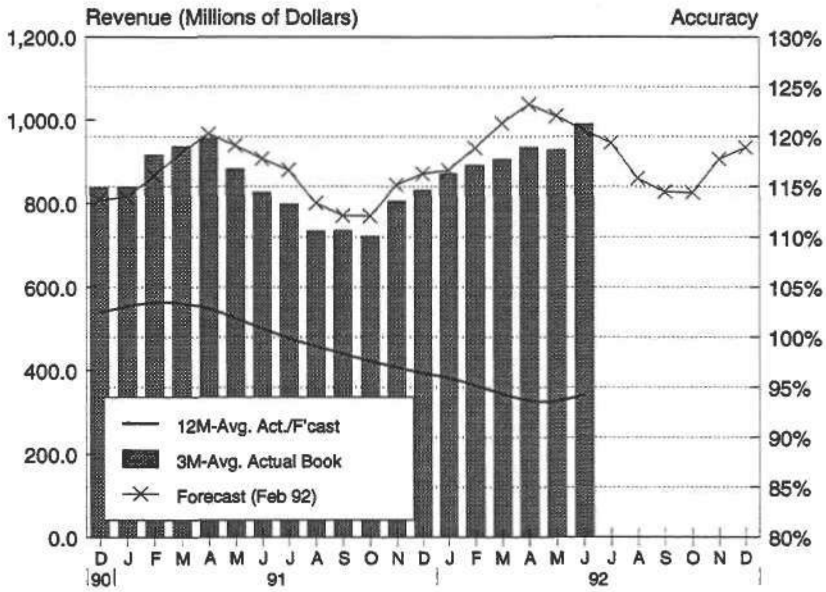
Figure 1
European Total Semiconductor Orders Booked and Sales Billed
(Three-Month Average)



	Jun	Jul	Aug	Sep 91	Oct	Nov	Dec	Jan	Feb	Mar 92	Apr	May	Jun
Book-to-Bill	0.96	0.97	0.93	0.92	0.86	0.93	1.02	1.04	1.04	0.99	1.03	1.02	1.06
Bookings	827.3	798.3	733.5	734.6	721.4	805.1	831.0	871.0	891.0	905.4	935.1	928.4	990.6
Billings	858.7	823.0	792.7	800.8	835.2	869.4	818.7	840.5	854.0	915.9	909.5	914.6	935.6

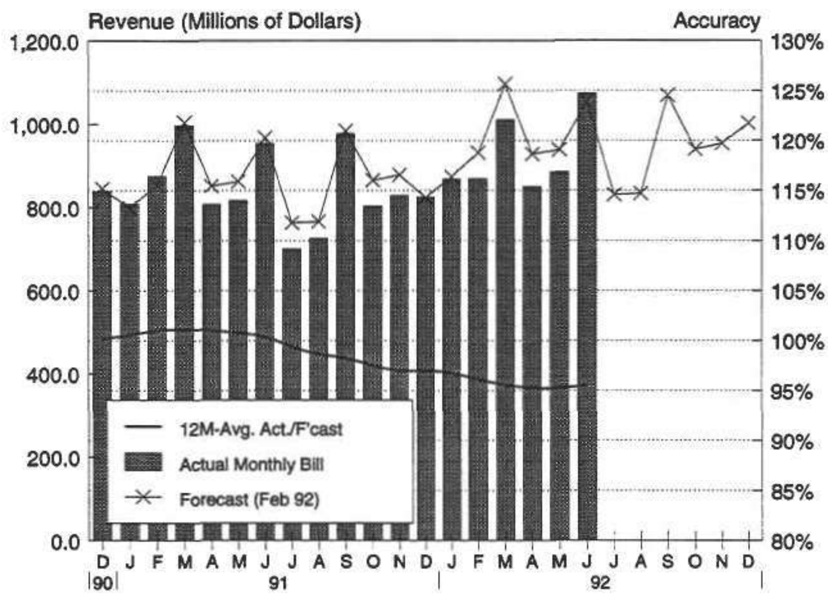
Note: Last two months are preliminary.
Source: WSTS, SIA

Figure 2
European Total Three-Month Average Bookings



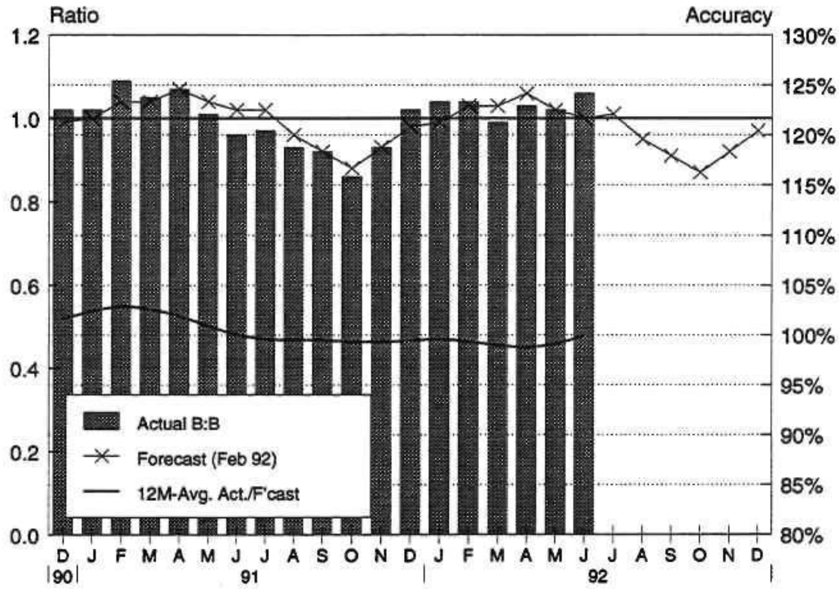
Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (July 1992)

Figure 3
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (July 1992)

Figure 4
European Total Semiconductor Book-to-Bill Ratio



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (July 1992)

The bookings and billings data for April have been restated slightly, as is usually the case. However, the minor adjustment has had no noticeable effect on the forecast versus actual graphs. The moving-average accuracy has levelled at roughly 95 percent, but this is partly due to the high bookings and billings data. Plotting the actual data on the forecast graphs shows the data points are slightly higher than would have been expected, and the billings value for June in particular is not consistent with the trend. This figure is therefore likely to be restated downwards. There are indications that European business is picking up, but this is related more to July revenue rather than June.

The 12-month moving-average billings growth, shown in Figure 5, is continuing the upturn it began last month, supporting the premise that the worst is behind us. If the June billings data is restated downward, it is unlikely that the restated figure will reduce the average growth so much that it will decline again.

Dataquest Perspective

The first half of 1992 has turned out a total semiconductor billings figure of $5,554 million for the European market, according to the SIA flash report. This compares with $5,256 million for the same period last year, and translates into a 5.7 percent growth for the first half of 1992 over the first half of 1991. The growth rates in previous years have been 10.6 percent in 1991, 2.6 percent in 1990, 15.6 percent in 1989, and 33.1 percent in 1988. Therefore, in this context, the first half of 1992 has seen below-average billings growth. However, Dataquest is forecasting annual growth of 7.2 percent for 1992 on 1991, with the assumption that the second half of the year will experience a 10.8 percent growth over the second half of 1991.

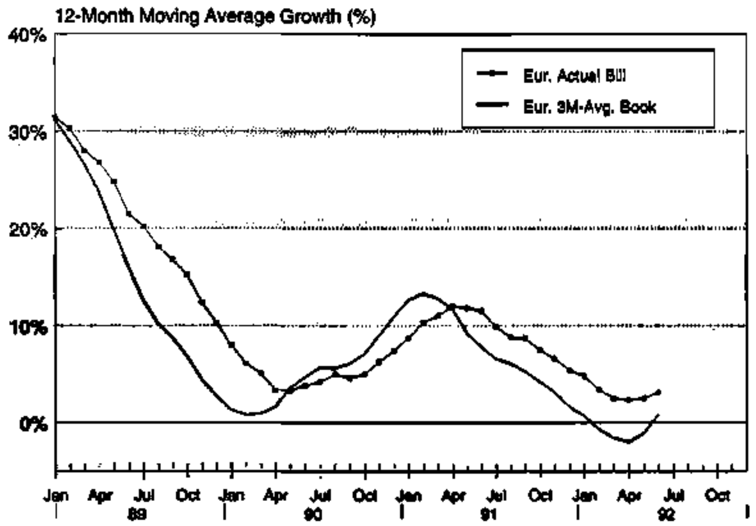
Demand

Demand issues which are expected to drive growth in the second half are outlined below.

PC Production

Although unit production has not increased substantially, the type of PC in production has moved upmarket. This has meant that the processor core has a higher clock speed and/or more peripheral integration on chip, and therefore a higher average selling price (ASP). Examples are the move from 80386 to 80486, SX to DX, and 25 MHz to 33 MHz. Recent price adjustments have affected price/

Figure 5
US and European Total Semiconductor 12-Month Average Growth



Source: WSTS, SIA

performance comparisons. Coupled with the advancement in processor core is the need for greater minimum motherboard memory, typically changing from 2MB to 4MB. However, the add-on DRAM module market is strong, as many shell and applications software require 6MB or 8MB to run efficiently. There is very strong price erosion in the European DRAM module market, and memory modules from South Korea are now priced lower than the total cost of the chips used to build them.

Telecommunications Production
Demand from the telecommunications segment is healthy, particularly in Germany, where equipment production of private and public switches is strong. This is linked to the liberalization of the PTT in that country. In other countries, there is steady demand, as major contracts have already been awarded and monthly/quarterly contract negotiations simply adjust and confirm order volumes and schedules. Telephone handset production is flat, partly because it is being moved out of Europe to lower-cost countries such as China and Taiwan.

Automotive Production
Coming from a relatively small base, there is strong demand in the automotive segment. Again, Germany appears to be the strongest region in Europe. This is partly a result of the higher-end positioning of the German automotive industry. European automotive manufacturers in general are increasingly adopting electronic ABS, electronic power steering, driver information display, engine control, and peripheral equipment such as car audio systems and voice/data communications.

Consumer Equipment Production
Audio and video electronic equipment production in Europe has gone very quiet, as inventory remains high. The only area of entertainment electronics where demand appears to be strong is in the area of satellite receivers/decoders. Possibly this has benefited from promised coverage of the Barcelona Olympics by satellite TV broadcast networks. Another area of consumer equipment with strong growth is white goods. These are generally kitchen-based equipment such as washing machines, refrigerators, freezers, microwave ovens, dishwashers, spin-dryers, and food processors.

Industrial Production
Small to medium-size industrial electronic equipment manufacturers have been placing large quantities of orders recently, particularly

in the United Kingdom. The main demand is for 8-bit microcontrollers, although 16-bit is beginning to pick up. This demand signals the start of a recovery in the semiconductor industry for the second half of 1992, more than any other end-user segment, as the industrial electronics segment is the foundation for a broad range of other industries.

Military Production

This segment has seen very little growth in the first half and is not expected to suffer from the German withdrawal from the European Fighter Aircraft (EFA) project.

Supply

A number of supply issues are expected to modulate growth in the second half of the year:

- Prices for Intel 80386 and 80486 microprocessors have been slashed. This should attract computer manufacturers upmarket.
- Antidumping legislation against South Korean suppliers is expected to be published by the European Commission. This is expected to raise market prices for memory modules and certain generations of DRAM. Dataquest also predicts much reactive lobbying from end users and South Korean suppliers.
- SGS-Thomson aims to have commercial samples available of high-speed SRAMs in the third quarter. Motorola should also produce high-speed 1M SRAMs in Scotland by the first quarter of 1993. The full duty suspension currently affecting all speeds of the 1M SRAM will be revised to cover only slow speeds as a result. This legislative amendment should be made sometime in the fourth quarter, with the reinstatement of the 14 percent import duty on high-speed 1M SRAM.
- Siemens and IBM anticipate having commercial samples available of 18M DRAM (2M×9) in October 1992. This is effectively a 16M DRAM with on-chip parity check. A 2M×8 version should be available towards the end of the year, and wider-organized versions will also become available later. Although the European price of the 16M DRAM is about 10 times the price of the 4M DRAM today, a certain number of users of high-density memory modules are likely to take advantage of the 16M/18M from Siemens and IBM to reduce SIMM size and power consumption.
- Lead times for EPROM in Europe could become extended if demand from Far Eastern games machine manufacturers continues to absorb much of the supply.

By Byron Harding
Mike Glennon

European Semiconductor Market Forecast: 1990-1996

The European semiconductor market in 1992 will grow by an estimated 7.2 percent over 1991, when measured in US dollars, a small reduction in growth compared with the previous year. By 1996 the European market will be valued at $17.8 billion, or ECU 14.1 billion. This represents a compound annual growth rate (CAGR) of 10 percent over the five-year period 1991 to 1996. Table 2 gives Dataquest's estimates of the size of the European market during this period.

This report analyses the factors behind the growth of the semiconductor market in Europe, and looks at the long-, medium-, and short-term factors influencing the market.

Forecast Assumptions

Dataquest's forecast is made assuming certain conditions, and the size and growth rate of the market may alter if these conditions change. The basic assumptions made for this forecast include:

- Exchange rates
- Political environments
- Economic conditions
- Technologies
- Semiconductor production capacity
- End-use applications

In addition to these assumptions, a range of short-term and longer-term forecast model indicators can be used to give a degree of confidence in Dataquest's forecast for the European market.

Exchange Rates

The exchange rates used for this forecast are those valid during the second quarter of 1992. The rates are those supplied by Dataquest's parent, Dun and Bradstreet. The exchange rates are assumed to remain unchanged over the period covered by this forecast.

Political Environments

The most significant political events to occur in the duration of this forecast revolve around the development of the European Community (EC). The introduction of a single market is accelerating, but there is still some resistance from some of the countries involved. The EC is likely to increase its membership during the

Table 2
European Semiconductor Market Forecast, 1990-1996
(Millions of Dollars)

	1990 ($M)	1991 ($M)	1992 ($M)	Growth 1992/91 (%)	1996 ($M)	CAGR 1991-96 (%)
Total Semiconductor	10,415	11,014	11,809	7.2	17,828	10.1
Total Integrated Circuit	8,115	8,701	9,428	8.4	14,974	11.5
Bipolar Digital	565	486	452	-7.0	301	-9.1
MOS Digital	5,224	5,853	6,614	13.0	11,080	13.6
MOS Memory	2,050	2,129	2,418	13.6	4,275	15.0
MOS Microcomponent	1,802	2,082	2,377	14.2	3,867	13.2
MOS Logic	1,372	1,642	1,819	10.8	2,938	12.3
Analog	2,326	2,362	2,362	0.0	3,592	8.7
Discrete	1,895	1,828	1,869	2.3	2,165	3.4
Optoelectronic	405	485	511	5.4	689	7.3

Source: Dataquest (July 1992 Estimates)

next five years, but Dataquest's definition of Europe is not restricted to the European Community. The acceptance of countries such as Sweden and Austria into the EC will therefore not affect the size of the European semiconductor market.

There are other political events revolving around the former Soviet Union. Countries which were formerly in this Union are likely to apply to join the EC in the medium or long term and this would increase the size of Europe, as measured by Dataquest. In our opinion, the semiconductor consumption in these regions will remain small in comparison to the consumption in the rest of Europe. By the end of this forecast period, however, the size of the "Eastern Europe" portion of the semiconductor market will have reached measurable proportions. This is likely to come from foreign investment in the regions by European, Japanese, South Korean and US manufacturers.

Other political considerations that could have an effect during the period of this forecast are those concerning trade issues. The current disagreement between the US and Japan over high-technology trade in each other's country has already spilled over into Europe. The EC has held meetings with the Japanese and US governments in order to have a bilateral EC and Japanese trade agreement, or a trilateral EC, Japan and US trade agreement. Towards this end, the US is nonplussed, and sees no incentive to cooperate with the EC. The growth of Europe, as other countries are added, poses a major threat to the other two major regions, and the rise in power of the four tigers—Korea, Taiwan, Singapore and Hong Kong—will also aggravate trade issues.

The ongoing development of the Uruguay round of the GATT talks is evidence of the conflict which is apparent between these trading nations, and trading blocks. While at Dataquest we can identify the potential trade issues, we cannot speculate on the possible events which may follow, be it a trade war or a complete settlement of the issues. However, the EC has already placed on the negotiating table a reduction in the semiconductor imports tariffs, in return for an equivalent reduction from other nations in their trade tariffs.

Economic Conditions

The European economy in 1992 is weak, and has not grown as expected. In particular, the strength of the German economy has kept Europe's semiconductor market alive over the past two years, and the weakening of growth in this region has had a marked effect on the growth of Europe's semiconductor market as a whole.

The UK economy has also not recovered as was previously expected, and still remains weak. Semiconductor consumption in the United Kingdom has until now retained some health, partly due to the export of completed electronic equipment, and partly due to investment in the region by foreign manufacturers. However, these exports have been to countries such as Germany, whose consumer demand has fallen significantly. The local consumption of consumer goods has failed to compensate for the decline in exports, and UK semiconductor consumption will suffer as a result.

Other economic factors that will affect semiconductor consumption include the ability of local governments to attract foreign investment. The number of foreign-owned manufacturing locations being built in Europe is falling, as demand slows, particularly in consumer goods.

Japanese manufacturers of consumer goods are also suffering in their home market, and the previously unheard-of losses experienced by these manufacturers is forcing them to rethink their strategy for new product development and introduction. There are indications that these companies may choose to move away from the short-lifetime products and develop products which are made to last. If this is the case, it will have a huge impact in the market for consumer goods, and hence semiconductor sales in the consumer market.

The economic outlook for the countries comprising Europe is shown in Table 3, and is the economic forecast prepared by our parent company, Dun & Bradstreet, earlier this year; the source date for this is March. Table 4 gives an alternate view proposed by the OECD, at the later date of June. From this it is clear that the OECD is less optimistic about the economies of Germany and the United Kingdom for

Table 3
Dun & Bradstreet Economic Outlook for European Economies
(Growth, Percent)

Country	1991	1992	1993
France	1.0%	2.0%	3.0%
Germany	3.1%	2.0%	3.5%
Italy	1.0%	1.6%	2.2%
United Kingdom	-2.2%	1.2%	2.6%

Source: Dun & Bradstreet (March 1992)

Table 4
OECD Economic Outlook for European Economies
(Growth, Percent)

Country	1991	1992	1993
France	1.3%	2.0%	2.6%
Germany	3.1%	1.3%	2.3%
Italy	1.4%	1.5%	2.1%
United Kingdom	-2.2%	0.4%	2.6%

Source: OECD (June 1992)

1992. This is significant, as these two economies form the major portion of the powerhouse of Europe's semiconductor consumption. The later date on the OECD's forecast means it is more in tune with the slower recovery apparent in these two countries.

Technologies

The basic technology used in semiconductor manufacture will remain silicon-based CMOS. Bipolar products are declining in use, as the performance offered by CMOS encroaches more into the niche which is now filled by bipolar-based products. There will still be a place for bipolar products, but these will be only in the highest-performance categories, where CMOS or BiCMOS is unable to match the required speed and drive.

The dramatic growth previously forecast for BiCMOS-based products has still failed to appear, and this now casts doubts on the future of this technology. As with bipolar, BiCMOS fits quite well into some niche categories, including high-complexity gate arrays, and mixed analog and digital products. However, its future as a mainstream technology is now in doubt.

Semiconductor Production Capacity

A number of semiconductor manufacturing plants due to be open in the next few years have been delayed, mainly as a result of the overcapacity in the semiconductor market. Some of these plants have been put on indefinite hold, and others have had their prospective capacity reduced. Table 5 shows the Japanese memory plants which are currently on hold, and it is clear from the number that there was the prospect of massive overcapacity in worldwide manufacturing. The delay in the opening of these plants will stabilize the semiconductor market, reducing the swings between high and low growth that have characterized the market. We expect average selling prices to stabilize, particularly in memory products.

End-Use Applications

End-use applications of semiconductor products give a longer term indication of the trends in the market. The expected use and production of equipment is the greatest influence over the five-year period of this forecast. Europe's traditional strength has been in telecoms products, and this is likely to continue, as the major telecoms hardware manufacturers are Europe-based.

While data processing equipment is the major user of semiconductor products within Europe,

Table 5
Delayed 200 mm Fab Plants in Japan

Company	Product	Type
Fujitsu	16M DRAM	Prod.
Hitachi	4/16M DRAM	Prod.
KTI	ASIC	Prod.
Matsushita	16M DRAM	R&D
Matsushita	16/64M DRAM	Prod.
NEC	16M DRAM, MPU	Prod.
NEC	4/16M DRAM, EPROM	Prod.
NKK	4M SRAM, ASIC, MPU	Pilot
Oki	16M DRAM	Prod.
Sanyo	16M DRAM	Prod.
Sharp	4M DRAM, ROM	Prod.
Toshiba	16M DRAM	Pilot

Prod. = production plant
Source: Dataquest (July 1992)

most of the equipment is designed outside the region. The products made in this category are likely to undergo a fundamental change, as portability and consumerization of products occur. Within the period of this forecast the features which differentiate application categories will blur, and cross-application products are already appearing. Products such as personal computers and telephone handsets fall into the data processing and telecoms categories, but they behave in the marketplace as consumer products. Products such as memory cards will exacerbate the applications categorization problem.

Telecoms

The telecoms market in Europe has been its strength for many years. While this situation is likely to continue, growth in the telecoms market is slowing, reflecting economic conditions. The digitization of Europe's telecoms infrastructure is continuing, and the outlook for the future is for growth through exports of exchanges and office equipment, and the digitization of Eastern European states.

Much of the growth in the long term for telecoms products is at the consumer end of the market, which includes digital cordless phones, featurephones, and digital mobile phones. This segment of the market shows signs of being very competitive, and many semiconductor suppliers are already positioning products in these areas, even though the major revenue growth is sometime away.

The videophone is receiving much interest, as the technology and standards are appearing which make the product feasible, and most importantly, cost-effective. Realistically, two options are open for the videophone. The first is a high-quality phone, using advanced video compression techniques, and a digital telephone network such as ISDN for the transmission of the data. The cost and hence price of this product will be high, and is likely to appeal to corporate purchasers only, because of its high price. This product will find applications in videoconferencing.

The other potential market for the videophone is in the home. Here low-cost and lower-quality products are appearing. However, these products are not conformant with the appropriate video standard, and if a range of products appears for this market, then anarchy will break out, and the market will be stifled until a clear winner is seen.

Both of these markets show great potential, but the high cost of image compression to achieve high quality may lower the sales of the corporate videophone. The TV-quality expectations of potential domestic videophone users may also reduce the potential sales of the lower-quality videophone, as these expectations are not met.

Data Processing

The data processing market will remain the biggest user of semiconductor components in Europe. Demand for computer-related equipment is high, but, there is likely to be a change in how this computational power will be delivered to the user. Until now this has been as IBM-compatible personal computers, but a range of portable equipment is beginning to appear with very focused applications. These products take the form of electronic organizers and note-takers, and can include speech storage and handwriting recognition. The market for these products is at too early a stage to predict accurately what will happen, but the products are likely to have a major effect on the computer market.

At the moment most of these portable products are in development, with only a few early models appearing. Most of the products are likely to appear towards the second half of 1993, with volume shipments in 1994. The compactness of these products is such that they will be beyond the current capabilities of many European manufacturing locations, so much of the manufacturing will take place outside Europe. It is possible, therefore, that these products could spell the demise of Europe's PC manufacturing. However, this is unlikely, as the technology needed to make these products could be acquired quickly by Europe-based manufacturers.

Consumer

The consumer market is the market which will show the greatest growth, if only because of its lack-lustre performance over the past two years. A range of consumer products is appearing which will add to existing products, rather than replace them. The introduction of digital audio products with CD players has established a standard, and the next development of consumers expectations is for recordable digital audio. This is appearing now in two forms—MiniDisk from Sony, and the Digital Compact Cassette from Philips. These products should provide some stimulus to the audio equipment market, when confidence returns to consumers. At present the semiconductor content of these products is high, but as the products are developed the value of the semiconductors will fall. This decline will be more than compensated for by the growth in unit shipments.

As well as digital audio, a range of multimedia products is also beginning to appear, and again this will give a stimulus to the consumer market. These products will also stimulate the sales of high-value TV sets, needed for the high-quality graphics output by multimedia products.

Industrial

The industrial market is currently stable but shows low growth. As this market includes a wide range of products and applications it is protected from the wide swings of growth and decline apparent in other product areas. However, the market is a clearer indicator of the overall health of the European economy since, when the industrial market shows low growth, it is because most equipment sales are low.

Transportation

The transport market should show high growth over the next five years, as the electronic content of cars is increasing. The greater environmental demands for car emissions and noise are ensuring that the microcontrollers used to manage the engine are increasing in performance. Legislation comes into force at the end of 1992 which requires cars above a certain size to have a catalytic converter, and to guarantee that the efficiency of the engine is high, complex engine management is needed.

In addition to the growth in engine management systems, new areas such as active suspension, and drive-train management are appearing. At the moment these products are only appearing in the highest-value cars, but a reduced feature set will find its way down to the cheaper models. Safety features such as air bags will also appear in lower-end models.

The potential downside to the major increase in car electronics is the additional weight generated by all of the electric motors to operate windows, mirrors, the sunroof, and seat position. Considerable work has been done to reduce the weight of cars, and this hard-earned weight saving is now being given away to in-car electrics.

The transportion market is forecast to enjoy high growth, but this market is only a small percentage of the semiconductor market as a whole. The high growth in this segment will therefore only have a small contribution to the total semiconductor market.

Military and Aerospace

In military markets the increased rate of disarmament is slowing the use of military electronics. However, many projects, such as the European Fighter Aircraft, are continuing, although even they may be under threat. EFA, in particular, is under the greatest threat, following the pulling out of support from Germany. The major growth area in military in fact is in aerospace. The commercial aerospace market is still healthy, and shows some growth over the next five years.

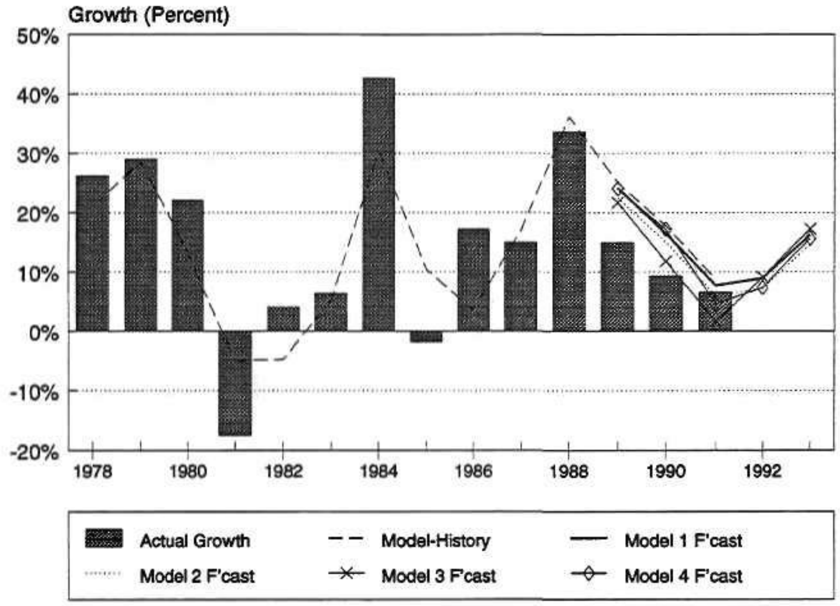
Forecast Models

The longer-term outlook for Europe's semiconductor consumption can be estimated from the trends and expected usage and manufacture of electronic equipment in Europe. The medium- and shorter-term outlook can be forecast with the help of statistical modelling techniques, coupled with shorter-term equipment trends and recent trends in bookings. The models used as part of the forecast process at Dataquest fall into two categories: those related to short-term product performance; and those related to medium-term economic performance. The product models allow us to have a clear indication of the next 6 to 12 months, and the economic models give an understanding of the market over the next 18 months to 2 years, that is to 1993.

Economic Models

Figure 6 shows the expected growth for the semiconductor market as a whole, as is suggested by the four economic forecast models used. From this it is clear the consensus growth for 1992 is between 7 and 9 percent. This confirms the growth expectations using

Figure 6
Economic Forecast Model Predictions



Source: Dataquest (July 1992 Estimates)

the other methods available to Dataquest. The models converge more for 1993, indicating a growth for that year of around 15 percent.

The economic models are based on imports, exports, industrial production and GDP growth for the US, Japan and Europe regions, and the European countries: United Kingdom and Eire, France, Germany, and Italy. The four different models use different parameters, with different weighting to achieve the required forecast. The historical data shows the models to be reasonably accurate over time.

Product Models

Figures 7 and 8 show the performance of the product models and the actual data for the two years, 1991 and 1992. This data is useful for identifying shorter-term deviations from expected performance. These product models are based on trend and seasonal variations for the specific products, together with weighting factors to compensate for underlying growth in the seasonal data. The models forecast a "typical" growth profile, and deviations from this indicate where a product is behaving abnormally. The models provide a shorter-term outlook for the performance of the market, and typically have a forecast window of about 12 months.

Bipolar Digital

The forecast model indicates the bipolar digital market declining by 11 percent over 1991's actual figure. The actual data available to date supports this decline, but the indication of an upturn later in the year should soften the decline slightly. This gives a forecast figure of 7 percent decline for 1992. The use of bipolar products is falling into an ever smaller niche, where absolute performance is required. The longer-term outlook is therefore for a continued decline.

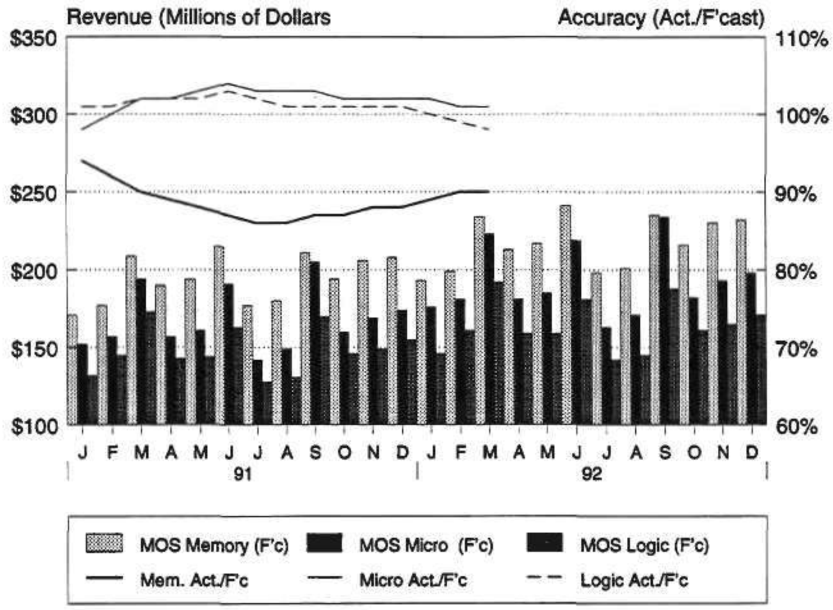
MOS Logic

The forecast model indicates a growth of 10 to 11 percent for MOS logic in 1992. The actual data is running fairly close to this, at 98 percent of the forecast data. The uplift for this market is likely to come later in the year, with the greater use of other logic category products, as equipment such as GSM phones increase in sales.

MOS Memory

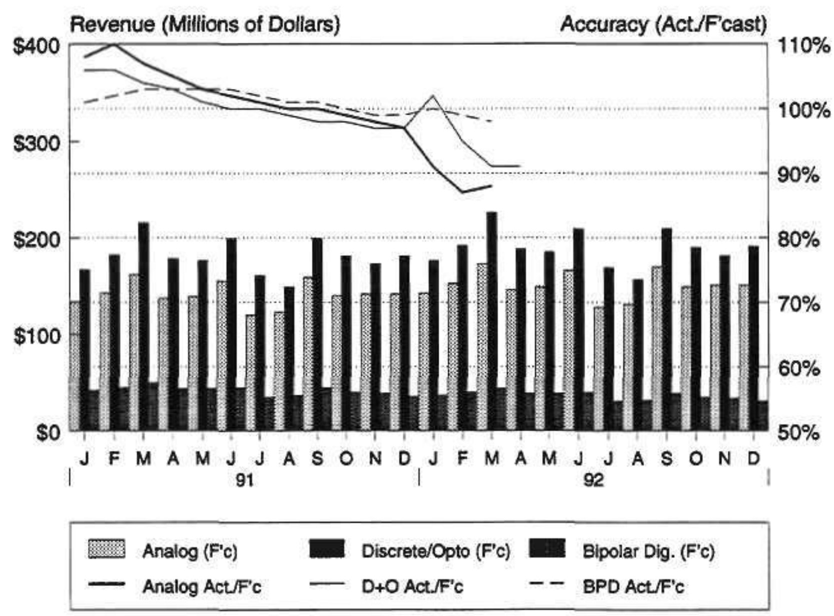
The forecast model indicates a growth of 27 to 28 percent for MOS memory in 1992, but the actual data fails to support this high growth, with the actual running at 90 percent of the forecast. The low growth seen in 1991 and 1990 leave much room for the actual data to catch up with the forecast model, so in this

Figure 7
Short-Term Forecast Model Prediction
Memory, Microcomponent and Logic



Source: Dataquest (July 1992 Estimates)

Figure 8
Short-Term Forecast Model Prediction
Bipolar Digital, Analog, and Discrete and Optoelectronic



Source: Dataquest (July 1992 Estimates)

case the forecast model is much too optimistic. ASP erosion is still prevalent in this market, so growth of nearly 14 percent for the memory market is much closer to the actual data. High growth is likely to return in 1993, with a forecast of 25 percent over 1992.

MOS Microcomponent

This product has been the star of the semiconductor market for the past two years, and its strength is likely to continue. The forecast model suggests a growth of 12 percent over 1991, but the actual data is still running ahead of the forecast model. A growth of 14 percent is more realistic for this product.

Analog

The analog market is in a sorry state, and this is apparent from the comparison of the forecast model and the actual data. The forecast model suggests a growth of 10 percent over 1991, but the actual data is showing a considerable downturn from this. The 12-month average actual over forecast is running at 92 percent, and this gap is widening, as the average includes data for much of 1991, where the analog market outperformed the forecast model. The actual growth for 1992 will in fact be zero, but this is likely to improve with time, as consumer equipment sales improve, bringing analog sales up.

Discrete and Optoelectronic

The discrete market is also underperforming, with the actual sales falling to 91 percent of the forecast model. Discrete sales have been flat for some considerable time, while the forecast model suggests a growth of 8.6 percent over 1991. The shortfall between the model and the actual data suggests the growth should be nearer 2 percent for discrete, and 6 percent for optoelectronic. The greater growth for optoelectronic products comes from the higher use in some telecoms products such as fiber networks.

Dataquest Perspective

The outlook for 1992 is for higher growth than in 1991, as a mild recovery takes place within Europe. The telecoms market is slowing a little, as poor economic conditions bite into government spending plans, but there is room for more growth, as higher-speed networks are required. The transmission of image data requires a large bandwidth, even if the data is compressed, and full-motion video transmission—as video mail becomes available—will increase demand for the existing network capacity.

The rise in distributed computing will also add to the increased demand for digital network capacity, so there will still be a need for faster digital exchanges. At the moment the capacity of the network is limited by the speed of the exchanges, and these can be improved with more up-to-date equipment and network standards.

The consumer market is currently weak, but this will show some recovery when confidence returns to the market, although not until Europe's economies have improved somewhat. Table 2 shows this is unlikely to happen until 1993, so consumer sales will not pick up in any meaningful way until next year. This equipment-led recovery will also be flatter, and will spread across 1993 and 1994.

The four-year growth cycle so often associated with the semiconductor industry appears to be broken, as can be clearly seen from Figure 6. If the cycle still held, 1992 should have been the high-growth year of the cycle. The next high-growth year will now be 1993, falling into 1994. The market is also becoming more stable, as growth is more evenly spread across years. The economic models show the semiconductor market is more in synchronization with economic cycles in Europe, also indicating a stabilizing effect within the industry.

These stabilizing influences come from the fact that the industry is more capital-intensive, and longer planning cycles are needed to match supply and demand. The reduction in capacity suggests also the traditional under- and overcapacity cycles are more under control, although new industrialized regions are entering the semiconductor market, and aim to gain a significant market share. Companies from these regions are building large manufacturing locations, and are prepared to buy market share in order to position themselves in the ranking of high-technology regions. This is the semiconductor equivalent of the nuclear arms race. However, the consequences of a high-technology trade war appear less severe, meaning the mutually assured destruction syndrome which kept nuclear warfare at bay may carry less weight with these semiconductor suppliers. The consequences could be dramatic.

By Mike Glennon

Final 1991 European Semiconductor Market Share Rankings

This report contains Dataquest's final estimates of semiconductor market shares by company in Europe for the calendar year 1991. These final estimates replace preliminary estimates made in January 1992 and published in Research Newsletter 1992-01, "Preliminary 1991 European Semiconductor Market Share Estimates: Intel Leapfrogs the Pack."

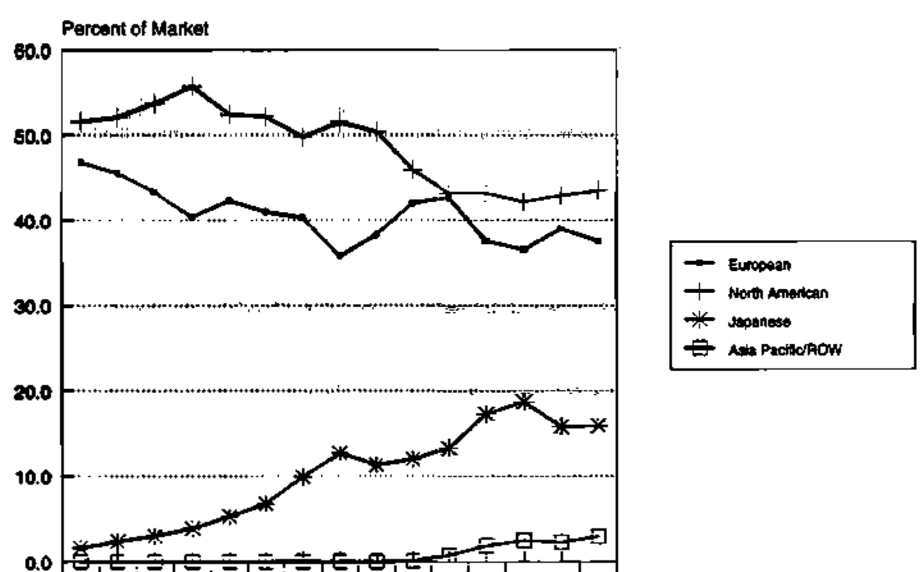
For background information on methodology, sales channels, exchange rates, companies, product categories, geographic regions, and application segments please refer to the booklet entitled *Semiconductor Market Definitions 1992* contained in the Semiconductors Europe, Guides and Reference Material binder.

Figures 9 and 10 show the positions of vendors from Europe, North America, Japan and Asia/Pacific in the European and worldwide markets respectively. Table 6 gives European semiconductor market share by major product category in 1991 by vendor base region. European total available markets (TAMs) for 1989 to 1991 are shown in Table 7. Table 8 shows worldwide 1991 semiconductor market share rankings of European companies. Tables 9 to 17 (at the end of the report) summarize the rankings for overall product categories. Refer also to the Source: Dataquest booklet *Final 1991 European Semiconductor Market Share Rankings and Revised 1990 Rankings* for details of rankings in the individual product categories. Also contained in this report are restated final European market share estimates for the calendar years 1990 and 1989.

Worldwide Market Share Rankings of European Companies

Heading up the rankings of worldwide European companies is Philips Semiconductors (Table 8). Philips is the only European company to appear in the worldwide top 10 hall of fame. It briefly rose to ninth position in 1990 following strong growth in its MOS digital, analog and discrete sales, but moved back down to tenth position again in 1991. In each case, it exchanged positions with Matsushita. Philips' sales to Japan and Asia/Pacific have seen strong

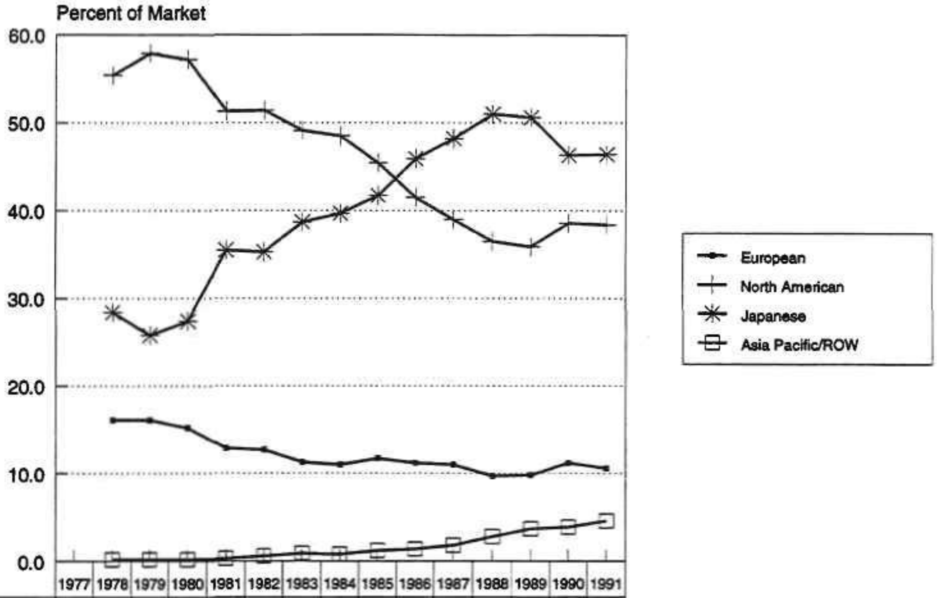
Figure 9
European Semiconductor Market Share by Vendor Base Region



	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
European	46.8	45.5	43.3	40.4	42.3	41.0	40.3	35.8	38.3	42.0	42.7	37.5	36.6	39.0	37.6
North American	51.6	52.1	53.7	55.7	52.4	52.2	49.8	51.5	50.4	45.9	43.2	43.2	42.2	42.9	43.5
Japanese	1.6	2.4	3.0	3.9	5.3	6.8	9.9	12.7	11.3	12.0	13.3	17.3	18.7	15.8	15.9
Asia Pacific/ROW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.9	2.5	2.3	3.0
Total Market	100.0	100.0	100.0	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 (July 1992 Estimates)

Figure 10
Worldwide Semiconductor Market Share by Vendor Base Region



	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
European		16.1	16.1	15.2	12.9	12.7	11.3	11.0	11.7	11.2	11.0	9.7	9.8	11.2	10.6
North American		55.4	57.9	57.2	51.3	51.4	49.1	48.5	45.4	41.5	39.0	36.5	35.9	38.6	38.4
Japanese		28.4	25.8	27.4	35.5	35.3	38.7	39.7	41.7	45.9	48.2	51.0	50.6	46.3	46.4
Asia Pacific/ROW		0.2	0.2	0.2	0.3	0.6	0.9	0.8	1.2	1.4	1.8	2.8	3.7	3.9	4.6
Total Market		100.1	100.0	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 (July 1992 Estimates)

Table 6
European Total Available Market Share 1991 by Product Category and Vendor Base Region (Percent)

Product Category	North American	Japanese	European	Asia/ Pacific	Total	Dominant Vendors
Total Semiconductor	43.4	15.9	37.7	3.0	100.0	North American
Total IC	47.1	17.2	32.1	3.6	100.0	North American
Total Bipolar Digital	64.4	8.6	27.0	0.0	100.0	North American
Bipolar Memory	58.1	23.3	18.6	0.0	100.0	North American
Bipolar Microcomponent	100.0	0.0	0.0	0.0	100.0	North American
Bipolar Logic	63.8	7.5	28.7	0.0	100.0	North American
MOS Digital	47.9	22.7	24.3	5.1	100.0	North American
MOS Memory	29.2	37.7	19.6	13.5	100.0	Japanese
MOS Microcomponent	66.3	16.8	16.8	0.1	100.0	North American
MOS Logic	48.8	10.8	39.9	0.5	100.0	North American
Analog IC	41.7	5.2	52.3	0.8	100.0	European
Total Discrete	29.3	10.3	60.0	0.4	100.0	European
Total Optoelectronic	29.7	15.1	53.6	1.6	100.0	European

Source: Dataquest (July 1992 Estimates)

Table 7
European Total Available Markets by Product Category 1989–1991
(Millions of Dollars)

Product Category	1989 ($M)	1990 ($M)	1991 ($M)	1989–90 AGR (%)	1990–91 AGR (%)	1991–96 CAGR (%)
Total Semiconductor	$9,498	$10,415	$11,014	9.7	5.8	10.1
Total IC	$7,570	$8,115	$8,701	7.2	7.2	11.5
Total Bipolar Digital	$627	$565	$486	-9.9	-14.0	-9.1
Bipolar TTL	487	421	376	-13.6	-10.7	-18.2
Bipolar ECL	140	144	110	2.9	-23.6	8.2
Total Bipolar Digital	$627	$565	$486	-9.9	-14.0	-9.1
Bipolar Memory	71	55	43	-22.5	-21.8	-10.3
Bipolar Microcomponent	NA	21	15	NA	-28.6	-100.0
Bipolar Logic	556	489	428	-12.1	-12.5	-8.3
Bipolar ASIC	256	211	174	-17.6	-17.5	-0.3
Bipolar Standard Logic	271	244	228	-10.0	-6.6	-18.5
Bipolar Other Logic	29	34	26	17.2	-23.5	-1.6
MOS Digital	$5,251	$5,224	$5,853	-0.5	12.0	13.6
Total NMOS	1,841	1,279	1,153	-30.5	-9.9	12.1
Total CMOS	3,344	3,908	4,642	16.9	18.8	11.6
Total BiCMOS	66	37	58	-43.9	56.8	77.0
MOS Digital	$5,251	$5,224	$5,853	-0.5	12.0	13.6
MOS Memory	2,417	2,050	2,129	-15.2	3.9	15.0
MOS Microcomponent	1,442	1,802	2,082	25.0	15.5	13.2
MOS Logic	1,392	1,372	1,642	-1.4	19.7	12.3
MOS ASIC	870	913	1,045	4.9	14.5	16.7
MOS Standard Logic	258	226	210	-12.4	-7.1	1.5
Other MOS Logic	264	233	387	-11.7	66.1	3.2
Analog IC	$1,692	$2,326	$2,362	37.5	1.5	8.7
Monolithic Analog IC	1,556	2,169	2,184	39.4	0.7	9.0
Hybrid IC	136	157	178	15.4	13.4	5.8
Total Discrete	$1,574	$1,895	$1,828	20.4	-3.5	3.5
Total Transistor	768	914	890	19.0	-2.6	3.9
Total Diode	483	617	613	27.7	-0.6	2.7
Thyristor	184	233	233	26.6	0.0	1.3
Other Discrete	139	131	92	-5.8	-29.8	8.8
Total Optoelectronic	$354	$405	$485	14.4	19.8	7.3

NA = Not Applicable
AGR = annual growth rate
CAGR = compound AGR
Source: Dataquest (July 1992 Estimates)

growth in 1991, particularly in MOS digital ICs and analog ICs, but this has been offset by poor sales performances in North America and Europe.

SGS-Thomson Microelectronics lags behind Philips Semiconductors at number 13 worldwide, having lost one place in 1991 to Samsung. Its revenue in 1991 was flat compared with 1990, balancing increased sales to Japan and Asia/Pacific with a decline in North America and Europe. SGS-Thomson's MOS digital ASIC and analog IC sales have been healthy despite an erosion in its MOS memory IC MOS microcomponent IC, and discrete device businesses.

Siemens follows at number 16 worldwide in 1991, moving down two positions from 1990 after being overtaken by Sanyo and Sharp. Its semiconductor revenue grew in all world markets, but its revenue base in Europe representing 76.8 percent of its total sales grew the least. This was largely caused by price erosion in DRAMs and a decline in its analog and discretes sales.

GEC-Plessey Semiconductors stands at number 29 worldwide in 1991, slipping down three positions from 1990. It was overtaken by Analog Devices, Micron Technology, and VLSI Technology. Its semiconductor sales declined in all world markets except Asia/Pacific, with the brunt of this decline mainly in its bipolar digital IC and discrete product areas. However, its MOS digital and mixed signal ASIC product lines have seen strong sales growth.

Collectively, worldwide sales of European companies grew by only 3.7 percent compared with a total worldwide market growth of 9.6 percent. European companies' market share of the worldwide market stands at 10.6 percent in 1991. Figure 10 shows worldwide semiconductor market shares by vendor base region. The trends are similar to those of European semiconductor market shares, namely the rise of Japanese and Asia/Pacific vendors and the fall of European and North American suppliers. However, the market share of Japanese suppliers reached a plateau in 1991, following a decline in 1990 caused partly by dramatic price erosion in memories.

European companies' sales to their own domestic markets account for 65.4 percent of their total worldwide sales. This can be compared with the same figures for: Japanese companies at 69.8 percent; North American companies at 51.7 percent; and Asia/Pacific companies at 58.5 percent. Therefore, it appears that European companies are more dependent upon their own domestic market for sales growth than are most of their competitors. The European semiconductor market grew by 5.8 percent in 1991, compared with a total worldwide average growth of 9.4 percent. This is believed to be a factor in the below-average growth of European companies' worldwide sales in 1991.

European Market Share Rankings of Worldwide Companies

Total Semiconductor

Total European semiconductor market share rankings in 1991 show no change in the names of companies appearing in the top 10. However, there has been some position swapping, with Intel overtaking Texas Instruments and NEC overtaking National Semiconductor.

The leader of the top 10 is Philips Semiconductors with a meagre 1.4 percent growth in sales. This can be compared with the 22.6 percent growth in European sales it saw last year. As already discussed, its semiconductor business is dominated by analog ICs and discretes, which saw poor growth generally in 1991. Added to this, Philips sells over half of its semiconductors to end users in the consumer electronics segment, which was also depressed in 1991. These two factors combined did not help Philips grow its semiconductor sales in 1991.

Siemens has seen better growth than Philips in 1991, but only just at 2.2 percent. The product lines which exhibited significant growth were MOS microcontrollers, analog telecoms ICs and optoelectronic devices. However, the strong growth of Siemens' optoelectronics business has been partly caused by the discovery of previously overlooked sales channels in 1991. Siemens' European sales in ICs and discretes declined in 1991, and it is only the growth in optoelectronics sales that prevented Siemens' overall semiconductor business from declining.

SGS-Thomson Microelectronics suffered from a 4.7 percent decline in total European sales in

Table 8
Worldwide Market Share Rankings of European Companies 1989–1991
(Millions of Dollars)

European Companies	1989 Sales ($M)	1989 WW Rank	1989 WW Share (%)	1990 Sales ($M)	1990 WW Rank	1990 Rank Change	1990 WW Share (%)	1990 WW AGR (%)	1991 Sales ($M)	1991 WW Rank	1991 Rank Change	1991 WW Share (%)	1991 WW AGR (%)
Philips Semiconductors	1,643	10	3.0	1,955	9	1	3.6	19.0	2,022	10	-1	3.4	3.4
SGS-Thomson Microlectronics	1,271	12	2.3	1,441	12	0	2.6	13.4	1,436	13	-1	2.4	-0.3
Siemens	1,154	15	2.1	1,204	14	1	2.2	4.3	1,263	16	-2	2.1	4.9
GEC Plessey Semiconductors	NA	NA	0.0	390	26	NA	0.7	NA	392	29	-3	0.7	0.5
Telefunken Electronic	299	30	0.6	295	31	-1	0.5	-1.3	300	33	-2	0.5	1.7
Semikron	95	58	0.2	106	55	3	0.2	11.6	108	56	-1	0.2	1.9
Mietec	52	77	0.1	92	61	16	0.2	76.9	105	60	1	0.2	14.1
Matra-MHS	85	62	0.2	100	57	5	0.2	17.6	104	61	-4	0.2	4.0
Eupec	NA	NA	0.0	96	59	NA	0.2	NA	93	65	-6	0.2	-3.1
Ericsson	54	74	0.1	56	82	-8	0.1	3.7	74	77	5	0.1	32.1
Austria Mikro Systeme	56	71	0.1	59	79	-8	0.1	5.4	70	80	-1	0.1	18.6
ABB-IXYS	50	79	0.1	58	80	-1	0.1	16.0	54	85	-5	0.1	-6.9
TMS	45	84	0.1	45	92	-8	0.1	0.0	51	89	3	0.1	13.3
ABB-HAFO	37	90	0.1	42	96	-6	0.1	13.5	38	96	0	0.1	-9.5
TAG	22	110	0.0	25	115	-5	0.0	13.6	30	107	8	0.1	20.0
Eurosil Electronic	30	101	0.1	39	100	1	0.1	30.0	29	110	-10	0.0	-25.6
Fagor Electrotécnica	29	102	0.1	30	109	-7	0.1	3.4	29	110	-1	0.0	-3.3
European Silicon Structures	18	117	0.0	27	113	4	0.0	50.0	28	112	1	0.0	3.7
Zetex	NA	NA	0.0	24	117	NA	0.0	NA	26	117	0	0.0	8.3
STC Components	19	116	0.0	24	117	-1	0.0	26.3	18	126	-9	0.0	-25.0
Marconi Electronic Devices Ltd	60	69	0.1	NA	NA	NA	0.0	NA	NA	NA	NA	0.0	NA
Plessey Semiconductors	240	32	0.4	NA	NA	NA	0.0	NA	NA	NA	NA	0.0	NA
Other European Companies	41	NA	0.1	0	NA	NA	0.0	NA	66	NA	NA	0.1	NA
Total European Companies	$5,300		9.8	$6,108			11.2	15.2	$6,336			10.6	3.7
Total Worldwide Market	$54,339			$54,454				0.2	$59,694				9.6

AGR = annual growth rate
WW = worldwide
NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

1991. In fact, its European sales suffered more than its business in any other world region. Much of the sales decline was in the area of MOS microcomponent ICs, EPROMs, and discrete devices where price erosion has taken its toll. There was some positive growth for SGS-Thomson in MOS digital logic ICs and analog ICs, which currently account for half of its sales volume in Europe. The company has plans for new manufacturing facilities in Italy and France.

Motorola's growth was below market average in its European semiconductor sales. Product lines that saw high growth in 1991 were SRAM and MOS ASIC. However, declining sales in bipolar digital ICs, analog ICs, and small signal discrete devices pulled down its overall growth to just 2.0 percent. Motorola has plans to expand its manufacturing base in Scotland.

The highest growth in the top 10 was experienced by Intel, with a 23.0 percent increase in its sales over 1990. Its microprocessor business, representing 54.9 percent of its European semiconductor business, grew by an impressive 32.5 percent. Sales in other product sectors, including microcontrollers and flash memory, also grew. This enabled Intel to overtake Texas Instruments in the European rankings. Intel is in the process of completing a new microprocessor manufacturing facility in Ireland.

Texas Instruments suffered a mild 0.8 percent decline in sales in 1991. Strong growth in its MOS microcomponent IC and MOS ASIC product lines was outweighed by declines in its bipolar standard logic, nonvolatile MOS memory IC, and analog IC product lines. However, its investment in memory manufacturing in Italy should have a positive effect on its market share in Europe.

Toshiba has held onto its position in the European semiconductor rankings despite a 2.0 percent drop in its sales. Toshiba's MOS memory IC and MOS ASIC sales slipped, largely due to price erosion in these areas. All its other major product lines saw healthy growth, particularly MOS microcomponent ICs, discretes and optoelectronic devices.

NEC has overtaken National Semiconductor to attain eighth position in the rankings. This was achieved with a 4.9 percent growth in its semiconductor sales. Product lines which contributed to this positive growth were MOS microcontroller ICs, MOS logic ICs, and discrete devices. However, its bipolar logic IC and MOS memory IC businesses remained flat as a result of price erosion. NEC is expanding its manufacturing base in Scotland.

National Semiconductor, now at ninth position, saw little growth in its semiconductor business. Negative growth was experienced in its bipolar digital IC, MOS memory IC and discrete product lines. This downward pressure was compensated by a pickup in its MOS microcomponent IC, MOS standard logic IC and analog IC product lines to give a top-line growth rate of 0.8 percent. National Semiconductor is also expanding its manufacturing base in Scotland.

AMD has seen the second-highest growth rate of the top 10, with a healthy 7.7 percent increase in semiconductor sales in 1991. It holds its tenth position as a result. This was achieved through strong growth in its MOS microcomponent IC, MOS logic IC, and mixed signal telecoms IC product lines. The only major line to show decline was bipolar digital ICs.

A company that is expected to enter the top 10 in the near future is Samsung, which moved up three places to position 12 with a 27.4 percent growth in sales. This company derives over 80 percent of its sales from DRAM where it is Europe's second-largest supplier. However, it is now diversifying into other product areas to stabilize its growth.

The strong 32.0 percent growth of Analog Devices at position 19 was largely due to its acquisition of Precision Monolithics Inc. Oki moved up 10 places to position 23, aided by an 83.7 percent growth rate in sales which was mainly caused by the inclusion of formerly overlooked sales channels into Europe. AT&T moved up 17 places to position 28 with an incredible growth rate of 144.8 percent for the same reason.

Integrated Circuits

The highest growth rate among the top 10 IC suppliers was experienced by Intel, which overtook SGS-Thomson Microelectronics and Siemens, both with declining sales, and is now close to Philips for the leading position.

Apart from Intel, the only other company in the top 10 to grow above the market average of 7.2 percent was AMD. This is another supplier of microcomponents which benefited from strong growth in market demand.

Bipolar Digital ICs

This is a product market in rapid decline. The only supplier estimated to have any positive growth in 1991 was Toshiba growing from a small base. The top three suppliers, all North American, control more than half the European market.

Bipolar Digital Memory ICs

This market, as above, is in rapid decline. The cosmopolitan top three suppliers—a North American, a European and a Japanese—control around 80 percent of the market between them. Memories produced in BiCMOS (a hybrid technology of bipolar and CMOS) and pure CMOS are stealing business from the bipolar memory market.

Bipolar Digital Microcomponent ICs

There are few suppliers in this small and declining market, and they are all North American. This product market has little to offer except obsolescence.

Bipolar Digital Logic ICs

This is the largest of the bipolar digital IC markets, and is the one in least decline. However, only one supplier in the top 10, Philips Semiconductors, saw any positive growth in 1991.

MOS Digital ICs

Intel continues to hold its leading position unchallenged in this product market. It has a massive 13.1 percent market share of this large market. Generally, North American suppliers performed very well in 1991 while European suppliers declined.

MOS Digital Memory ICs

Samsung has shot to the top of the rankings in 1991 with a growth rate of 22.8 percent, overtaking Siemens and Toshiba which both saw declining sales. Samsung's success has been won by gaining market share in DRAMs with major OEMs. Hitachi also experienced high growth, and overtook SGS-Thomson for sixth place.

MOS Digital Microcomponent ICs

The top three suppliers, Intel, Motorola and NEC, remain unchanged from the previous year. However, the gap is widening between these companies, as each one has a higher growth rate than the one below it. Philips Semiconductors has moved ahead of SGS-Thomson to take fourth place, and AMD has moved up two places by overtaking Toshiba and National Semiconductor.

MOS Digital Logic ICs

Philips Semiconductors continues to lead this market, followed by Siemens. However, LSI Logic has now been displaced by ITT, which has moved up 13 places to third position. The sudden improvement in ITT's MOS logic IC sales is due to the reclassification of some of its dedicated IC business, which was formerly reported under the mixed signal IC category. Also displacing LSI Logic, as well as Motorola, is GEC-Plessey Semiconductors, which saw a very healthy increase in its business for gate arrays and cell-based ICs.

Analog ICs

Philips Semiconductors and SGS-Thomson Microelectronics head up the analog IC rankings, helped by their strong penetration of the communications and consumer electronics end-user segments. Between them these two companies serve a third of the European analog IC market. Analog Devices has moved up two places in the rankings to fifth position, following its acquisition of Precision Monolithics Inc. ITT drops down the rankings due to product reclassification.

Monolithic Analog ICs

While Philips Semiconductors continues to lead the rankings, it does not have positive growth, and is very close to being displaced by SGS-Thomson Microelectronics. Mietec saw a healthy 22.7 percent growth in sales of mixed signal ASICs. Overall, however, the monolithic analog IC market saw very little growth.

Monolithic Linear ICs

SGS-Thomson Microelectronics leads Philips Semiconductors by a small margin in this declining market. There are no changes from last year in the order of the top five ranked suppliers, although Texas Instruments has performed badly in 1991 and was nearly overtaken by Telefunken Electronic.

Monolithic Mixed Signal ICs

The leading supplier in this product market, National Semiconductor, has seen reasonable growth in its dedicated telecoms IC product line. Nonetheless, it has grown below the market average, and is being challenged by Mietec which has already displaced Analog Devices. Harris has jumped up six places to fifth position following very strong growth in its dedicated telecoms IC sales in 1991. Austria Mikro Systeme has moved up seven places to eleventh position as a result of its strong sales in mixed signal ASICs. ITT moved down the rankings due to product reclassification.

Hybrid ICs

Philips Semiconductors has seen strong growth in its hybrid IC product line, and continues to lead this market unchallenged. Another European supplier, GEC-Plessey Semiconductors, has also seen a strong pickup in sales, and moved up two places to fourth position.

Discrete Semiconductors

In a declining product market, it is a reasonable result for Philips Semiconductors to have no growth in sales, and retain its top position. Siemens has moved up two places, overtaking Motorola and SGS-Thomson Microelectronics, despite declining sales in 1991. Another company to move up two places is International Rectifier, although this was managed with a healthy 10.1 percent growth in sales. ITT has had a disastrous year in this product market in 1991, with its sales in small signal discretes plummeting, and moves down four places.

Transistors

Philips leads this market again, but experienced a 9.5 percent erosion in sales. Its immediate competitors, Motorola and SGS-Thomson Microelectronics, also saw declining sales in 1991. Telefunken Electronic, with strong growth in power transistor sales, managed to move up three places to seventh position. Powerex Europe, in contrast, saw significant erosion in its power transistor sales, and moved down six places from eighth position.

Diodes

Nearly one-quarter of the European diode market is supplied by Philips Semiconductors. The company managed to produce the highest growth rate of the top 10, mainly through the strength of its power diode product line. Motorola moved up two places to second position, after displacing General Instrument and SGS-Thomson Microelectronics, which incidentally swapped positions with each other.

Thyristors

Leading the flat thyristor market in 1991 was Eupec, serving nearly 20 percent of demand. Eupec, a joint-venture company founded by Siemens and AEG, experienced declining sales in 1991, as did SGS-Thomson Microelectronics in third place. Powerex Europe and Philips Semiconductors both achieved double-digit growth.

Other Discrete Semiconductors

This product market, covering miscellaneous discrete devices such as microwave diodes, tuning diodes, varactors and selenium rectifiers, was headed up by Siemens in 1991. Its sales declined by 11.1 percent, which was better than the average market decline of 29.8 percent. The only companies to see any positive growth were NEC and International Rectifier, both from a small base.

Optoelectronic Semiconductors

Siemens continues to lead this product market with a 28.0 percent market share in 1991. The substantial 51.1 percent growth in its sales is partly due to the inclusion of revenue from previously overlooked sales channels. Telefunken Electronic's sales declined by 4.4 percent, specifically in photosensors. The order of the top six suppliers is unchanged from 1990. AT&T moved up two places to seventh position, on the strength of its laser diode business, while Sharp moved up five places to ninth position, on the strength of its optocoupler and laser diode businesses.

Dataquest Perspective

Over the last 15 years, Japanese and Asia/Pacific companies have generally gained share while European and North American companies have lost share (see Figure 9). It is interesting to note that European companies have never held a majority share in their domestic market over this time period, although they did come close to overthrowing North American suppliers in 1987.

Referring again to Figure 9, European sales of European companies grew by only 2.0 percent in US dollars in 1991, the lowest rate since 1982. In contrast, Japanese and Asia/Pacific companies managed a reversal of fortunes in 1991 following poor growth in 1990.

The poor performance of European companies in 1991 can be mainly attributed to their product portfolios, which are typically dominated by mature and slow-growth products. As can be seen from Table 6, European companies have majority shares in the European markets for analog ICs and discretes. These are large markets, together representing 38.0 percent of the total European semiconductor market in 1991, but with low growths of 1.5 percent and minus 3.5 percent respectively in 1991. It is difficult for European companies to achieve strong growth while at the same time dominating these low-growth product markets.

In contrast to European companies' dominance of low-growth markets, North American companies dominate the high-growth markets of MOS microcomponents and MOS logic, which together represented 33.8 percent of the total European semiconductor market in 1991. The MOS microcomponent market saw growth of 15.5 percent and 19.7 percent in 1991, and helped to lift North American companies' semiconductor market share in Europe.

Japanese companies dominate the MOS memory market, although they also have a significant share of the MOS microcomponent market. The MOS memory market represented 19.3 percent of the total European semiconductor market in 1991 but saw growth of only 3.9 percent. This slow growth was caused by continuing price erosion of memory devices.

It is important to recognize that in 1990, the product markets of analog and discrete experienced strong growth, while memory and logic experienced a decline. This is opposite to the trends seen in 1991. Table 7 demonstrates the relative sizes and growth rates of each product market. Year-to-year fluctuations in growth rates of product markets are caused by short-term changes in supply and demand. The long-term growth trends of each product market can also be seen in Table 7 by the five-year CAGR.

These long-term growth rates confirm that European companies do dominate low-growth product markets while North American, Japanese and Asia/Pacific companies dominate high-growth product markets. Therefore it appears that European companies' share of the European market is set to decline unless they can successfully establish market share in high-growth product markets.

By Byron Harding

Table 9
European 1991 Semiconductor Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Semiconductors	1,128	1,144	1.4	1,144	10.4	10.4
2	2	0	Siemens	949	970	2.2	2,114	8.8	19.2
3	3	0	SGS-Thomson Microelectronics	897	855	-4.7	2,969	7.8	27.0
4	4	0	Motorola	761	776	2.0	3,745	7.0	34.0
6	5	1	Intel	622	765	23.0	4,510	6.9	40.9
5	6	-1	Texas Instruments	637	632	-0.8	5,142	5.7	46.6
7	7	0	Toshiba	450	441	-2.0	5,583	4.0	50.6
9	8	1	NEC	386	405	4.9	5,988	3.7	54.3
8	9	-1	National Semiconductor	397	400	0.8	6,388	3.6	57.9
10	10	0	AMD	273	294	7.7	6,682	2.7	60.6
11	11	0	Hitachi	246	276	12.2	6,958	2.5	63.1
15	12	3	Samsung	190	242	27.4	7,200	2.2	65.3
12	13	-1	ITT	232	240	3.4	7,440	2.2	67.5
14	14	0	Telefunken Electronic	213	222	4.2	7,662	2.0	69.5
13	15	-2	GEC Plessey Semiconductors	217	215	-0.9	7,877	2.0	71.5
17	16	1	Fujitsu	153	148	-3.3	8,025	1.3	72.8
18	17	1	Mitsubishi	122	143	17.2	8,168	1.3	74.1
16	18	-2	Harris	166	141	-15.1	8,309	1.3	75.4
19	19	0	Analog Devices	103	136	32.0	8,445	1.2	76.6
23	20	3	Mietec	84	102	21.4	8,547	0.9	77.5
21	21	0	LSI Logic	85	100	17.6	8,647	0.9	78.4
21	22	-1	Matra-MHS	85	93	9.4	8,740	0.8	79.2
20	23	-3	Hewlett-Packard	88	90	2.3	8,830	0.8	80.0
33	23	10	Oki	49	90	83.7	8,920	0.8	80.8
25	25	0	VLSI Technology	74	89	20.3	9,009	0.8	81.6
27	26	1	International Rectifier	69	76	10.1	9,085	0.7	82.3
24	27	-3	Eupec	78	73	-6.4	9,158	0.7	83.0
45	28	17	AT&T	29	71	144.8	9,229	0.6	83.6
28	29	-1	Semikron	66	67	1.5	9,296	0.6	84.2
30	30	0	Austria Mikro Systeme	59	62	5.1	9,358	0.6	84.8
31	31	0	Sony	58	61	5.2	9,419	0.6	85.4
38	32	6	Ericsson	43	55	27.9	9,474	0.5	85.9
29	32	-3	General Instrument	65	55	-15.4	9,529	0.5	86.4
37	34	3	Cypress	44	49	11.4	9,578	0.4	86.8
26	34	-8	Matsushita	70	49	-30.0	9,627	0.4	87.2
35	36	-1	ABB-IXYS	47	47	0.0	9,674	0.4	87.6
39	37	2	TMS	41	46	12.2	9,720	0.4	88.0
36	38	-2	Micron Technology	46	45	-2.2	9,765	0.4	88.4
33	39	-6	Burr-Brown	49	43	-12.2	9,808	0.4	88.8
39	40	-1	Siliconix	41	41	0.0	9,849	0.4	89.2
47	41	6	Sharp	28	39	39.3	9,888	0.4	89.6
57	42	15	Western Digital	18	38	111.1	9,926	0.3	89.9
32	43	-11	Powerex	50	37	-26.0	9,963	0.3	90.2

(Continued)

Table 9 (Continued)
European 1991 Semiconductor Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
39	44	-5	Rockwell	41	36	-12.2	9,999	0.3	90.5
44	45	-1	IDT	30	34	13.3	10,033	0.3	90.8
63	46	17	Goldstar	9	33	266.7	10,066	0.3	91.1
43	47	-4	ABB-HAFO	32	32	0.0	10,098	0.3	91.4
51	48	3	Sanyo	22	31	40.9	10,129	0.3	91.7
54	49	5	Rohm Electonics	20	30	50.0	10,159	0.3	92.0
42	50	-8	Allegro Microsystems	33	28	-15.2	10,187	0.3	92.3
48	51	-3	European Silicon Structures	25	27	8.0	10,214	0.2	92.5
49	52	-3	Unitrode	23	24	4.3	10,238	0.2	92.7
54	53	1	Honeywell	20	21	5.0	10,259	0.2	92.9
54	53	1	TAG	20	21	5.0	10,280	0.2	93.1
58	53	5	Zilog	17	21	23.5	10,301	0.2	93.3
51	56	-5	Fagor Electrotécnica	22	20	-9.1	10,321	0.2	93.5
59	57	2	Mitel	16	18	12.5	10,339	0.2	93.7
49	57	-8	STC	23	18	-21.7	10,357	0.2	93.9
51	59	-8	Eurosil	22	15	-31.8	10,372	0.1	94.0
61	60	1	Zetex	13	14	7.7	10,386	0.1	94.1
60	61	-1	Raytheon	14	10	-28.6	10,396	0.1	94.2
64	62	2	Seiko Epson	1	9	800.0	10,405	0.1	94.3
62	63	-1	NMB	10	5	-50.0	10,410	0.0	94.3
45	-	NA	Precision Monolithics	29	-	NA	NA	NA	NA
			North American Others	397	470	18.4	10,880	4.3	98.8
			Japanese Others	28	29	3.6	10,909	0.3	99.0
			European Others	0	48	NA	10,957	0.4	99.5
			Rest of World Others	40	57	42.5	11,014	0.5	100.0
			Total All Companies	10,415	11,014	5.8		100.0	
			Total North American	4,469	4,780	7.0		43.4	
			Total Japanese	1,643	1,756	6.9		15.9	
			Total European	4,064	4,146	2.0		37.6	
			Total Rest of World	239	332	38.9		3.0	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Table 10
European 1991 IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Semiconductors	762	775	1.7	775	8.9	8.9
4	2	2	Intel	622	765	23.0	1,540	8.8	17.7
2	3	-1	SGS-Thomson Microelectronics	694	666	-4.0	2,206	7.7	25.4
3	4	-1	Siemens	657	634	-3.5	2,840	7.3	32.7
5	5	0	Texas Instruments	606	601	-0.8	3,441	6.9	39.6
6	6	0	Motorola	549	577	5.1	4,018	6.6	46.2
7	7	0	National Semiconductor	390	394	1.0	4,412	4.5	50.7
9	8	1	NEC	359	375	4.5	4,787	4.3	55.0
8	9	-1	Toshiba	372	353	-5.1	5,140	4.1	59.1
10	10	0	AMD	273	294	7.7	5,434	3.4	62.5
11	11	0	Hitachi	234	263	12.4	5,697	3.0	65.5
13	12	1	Samsung	186	236	26.9	5,933	2.7	68.2
12	13	-1	GEC Plessey Semiconductors	187	187	0.0	6,120	2.1	70.3
16	14	2	ITT	121	180	48.8	6,300	2.1	72.4
17	15	2	Analog Devices	103	136	32.0	6,436	1.6	74.0
15	16	-1	Fujitsu	130	119	-8.5	6,555	1.4	75.4
19	16	3	Mitsubishi	86	119	38.4	6,674	1.4	76.8
14	18	-4	Harris	138	111	-19.6	6,785	1.3	78.1
22	19	3	Mietec	84	102	21.4	6,887	1.2	79.3
20	20	0	LSI Logic	85	100	17.6	6,987	1.1	80.4
18	21	-3	Telefunken Electronic	91	95	4.4	7,082	1.1	81.5
20	22	-2	Matra-MHS	85	93	9.4	7,175	1.1	82.6
27	23	4	Oki	49	89	81.6	7,264	1.0	83.6
23	23	0	VLSI Technology	74	89	20.3	7,353	1.0	84.6
24	25	-1	Austria Mikro Systeme	59	62	5.1	7,415	0.7	85.3
25	26	-1	Sony	57	60	5.3	7,475	0.7	86.0
31	27	4	Ericsson	43	55	27.9	7,530	0.6	86.6
40	28	12	AT&T	21	54	157.1	7,584	0.6	87.2
30	29	1	Cypress	44	49	11.4	7,633	0.6	87.8
29	30	-1	Micron Technology	46	45	-2.2	7,678	0.5	88.3
27	31	-4	Burr-Brown	49	43	-12.2	7,721	0.5	88.8
44	32	12	Western Digital	18	38	111.1	7,759	0.4	89.2
32	33	-1	Rockwell	41	36	-12.2	7,795	0.4	89.6
34	34	0	IDT	30	34	13.3	7,829	0.4	90.0
52	35	17	Goldstar	9	33	266.7	7,862	0.4	90.4
26	36	-10	Matsushita	51	31	-39.2	7,893	0.4	90.8
36	37	-1	TMS	26	30	15.4	7,923	0.3	91.1
37	38	-1	European Silicon Structures	25	27	8.0	7,950	0.3	91.4

(Continued)

Table 10 (Continued)
European 1991 IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
38	39	-1	Sharp	24	26	8.3	7,976	0.3	91.7
33	40	-7	Allegro Microsystems	31	25	-19.4	8,001	0.3	92.0
47	40	7	Sanyo	16	25	56.3	8,026	0.3	92.3
40	42	-2	ABB-HAFO	21	21	0.0	8,047	0.2	92.5
46	42	4	Zilog	17	21	23.5	8,068	0.2	92.7
40	44	-4	Hewlett-Packard	21	19	-9.5	8,087	0.2	92.9
47	45	2	Mitel	16	18	12.5	8,105	0.2	93.1
44	45	-1	Siliconix	18	18	0.0	8,123	0.2	93.3
40	47	-7	STC	21	16	-23.8	8,139	0.2	93.5
39	48	-9	Eurosil	22	15	-31.8	8,154	0.2	93.7
53	48	5	Rohm Electonics	8	15	87.5	8,169	0.2	93.9
49	50	-1	Unitrode	13	14	7.7	8,183	0.2	94.1
49	51	-2	Raytheon	13	10	-23.1	8,193	0.1	94.2
54	52	2	Seiko Epson	1	9	800.0	8,202	0.1	94.3
51	53	-2	NMB	10	5	-50.0	8,207	0.1	94.4
-	54	NA	Honeywell	-	1	NA	8,208	0.0	94.4
35	-	NA	Precision Monolithics	29	-	NA	NA	NA	NA
			North American Others	342	429	25.4	8,637	4.9	99.3
			Japanese Others	8	6	-25.0	8,643	0.1	99.3
			European Others	0	11	NA	8,654	0.1	99.5
			Rest of World Others	28	47	67.9	8,701	0.5	100.0
			Total All Companies	8,115	8,701	7.2		100.0	
			Total North American	3,710	4,101	10.5		47.1	
			Total Japanese	1,405	1,495	6.4		17.2	
			Total European	2,777	2,789	0.4		32.1	
			Total Rest of World	223	316	41.7		3.6	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Table 11
European 1991 Monolithic Bipolar Digital IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Texas Instruments	138	131	-5.1	131	27.0	27.0
2	2	0	AMD	86	75	-12.8	206	15.4	42.4
3	3	0	National Semiconductor	71	59	-16.9	265	12.1	54.5
4	4	0	Philips Semiconductors	56	54	-3.6	319	11.1	65.6
5	5	0	Motorola	47	41	-12.8	360	8.4	74.0
7	6	1	Siemens	40	38	-5.0	398	7.8	81.8
8	7	1	NEC	25	24	-4.0	422	4.9	86.7
6	8	-2	GEC Plessey Semiconductors	45	21	-53.3	443	4.3	91.0
9	9	0	Fujitsu	12	8	-33.3	451	1.6	92.6
10	10	0	STC	10	7	-30.0	458	1.4	94.0
11	10	1	Telefunken Electronic	7	7	0.0	465	1.4	95.4
14	12	2	Hitachi	4	4	0.0	469	0.8	96.2
15	12	3	Toshiba	2	4	100.0	473	0.8	97.0
12	14	-2	Raytheon	5	2	-60.0	475	0.4	97.4
-	15	NA	IDT	-	1	NA	476	0.2	97.6
17	15	2	Matsushita	1	1	0.0	477	0.2	97.8
17	15	2	Mitsubishi	1	1	0.0	478	0.2	98.0
15	-	NA	AT&T	2	-	NA	NA	NA	NA
12	-	NA	SGS-Thomson Microelectronics	5	-	NA	NA	NA	NA
			North American Others	8	4	-50.0	482	0.8	99.2
			Japanese Others	0	0	NA	482	0.0	99.2
			European Others	0	4	NA	486	0.8	100.0
			Rest of World Others	0	0	NA	486	0.0	100.0
			Total All Companies	565	486	-14.0		100.0	
			Total North American	357	313	-12.3		64.4	
			Total Japanese	45	42	-6.7		8.6	
			Total European	163	131	-19.6		27.0	
			Total Rest of World	0	0	NA		0.0	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Table 12
European 1991 Monolithic MOS Digital Memory IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
3	1	2	Samsung	184	226	22.8	226	10.6	10.6
1	2	-1	Siemens	238	224	-5.9	450	10.5	21.1
2	3	-1	Toshiba	222	199	-10.4	649	9.3	30.4
4	4	0	Texas Instruments	181	171	-5.5	820	8.0	38.4
5	5	0	NEC	164	164	0.0	984	7.7	46.1
7	6	1	Hitachi	140	159	13.6	1,143	7.5	53.6
6	7	-1	SGS-Thomson Microelectronics	143	134	-6.3	1,277	6.3	59.9
9	8	1	Intel	84	93	10.7	1,370	4.4	64.3
11	9	2	Mitsubishi	63	86	36.5	1,456	4.0	68.3
10	10	0	Motorola	76	72	-5.3	1,528	3.4	71.7
8	11	-3	Fujitsu	87	67	-23.0	1,595	3.1	74.8
12	12	0	AMD	61	61	0.0	1,656	2.9	77.7
17	13	4	Oki	30	57	90.0	1,713	2.7	80.4
13	14	-1	Micron Technology	46	45	-2.2	1,758	2.1	82.5
24	15	9	Goldstar	8	33	312.5	1,791	1.6	84.1
15	16	-1	Matra-MHS	32	32	0.0	1,823	1.5	85.6
16	17	-1	National Semiconductor	31	27	-12.9	1,850	1.3	86.9
19	18	1	Cypress	28	26	-7.1	1,876	1.2	88.1
18	18	0	Philips Semiconductors	29	26	-10.3	1,902	1.2	89.3
21	20	1	Sharp	22	23	4.5	1,925	1.1	90.4
22	21	1	IDT	18	22	22.2	1,947	1.0	91.4
20	22	-2	Sony	23	21	-8.7	1,968	1.0	92.4
13	23	-10	Matsushita	46	8	-82.6	1,976	0.4	92.8
28	23	5	Sanyo	1	8	700.0	1,984	0.4	93.2
26	25	1	Harris	3	5	66.7	1,989	0.2	93.4
-	25	NA	ITT	-	5	NA	1,994	0.2	93.6
23	25	-2	NMB	10	5	-50.0	1,999	0.2	93.8
-	28	NA	Rohm Electonics	-	3	NA	2,002	0.1	93.9
-	28	NA	Seiko Epson	-	3	NA	2,005	0.1	94.0
-	30	NA	AT&T	-	1	NA	2,006	0.0	94.0
-	30	NA	Eurosil	-	1	NA	2,007	0.0	94.0
25	-	NA	GEC Plessey Semiconductors	5	-	NA	NA	NA	NA
26	-	NA	VLSI Technology	3	-	NA	NA	NA	NA
			North American Others	60	93	55.0	2,100	4.4	98.6
			Japanese Others	0	0	NA	2,100	0.0	98.6
			European Others	0	0	NA	2,100	0.0	98.6
			Rest of World Others	12	29	141.7	2,129	1.4	100.0
			Total All Companies	2,050	2,129	3.9		100.0	
			Total North American	591	621	5.1		29.2	
			Total Japanese	808	803	-0.6		37.7	
			Total European	447	417	-6.7		19.6	
			Total Rest of World	204	288	41.2		13.5	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Table 13
European 1991 Monolithic MOS Digital Microcomponent IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Intel	528	663	25.6	663	31.8	31.8
2	2	0	Motorola	233	264	13.3	927	12.7	44.5
3	3	0	NEC	138	150	8.7	1,077	7.2	51.7
5	4	1	Philips Semiconductors	112	115	2.7	1,192	5.5	57.2
4	5	-1	SGS-Thomson Microelectronics	126	108	-14.3	1,300	5.2	62.4
6	6	0	Texas Instruments	99	107	8.1	1,407	5.1	67.5
7	7	0	Siemens	83	87	4.8	1,494	4.2	71.7
8	8	0	Hitachi	69	75	8.7	1,569	3.6	75.3
11	9	2	AMD	47	65	38.3	1,634	3.1	78.4
10	10	0	National Semiconductor	49	58	18.4	1,692	2.8	81.2
9	11	-2	Toshiba	51	56	9.8	1,748	2.7	83.9
16	12	4	Western Digital	18	38	111.1	1,786	1.8	85.7
13	13	0	VLSI Technology	28	34	21.4	1,820	1.6	87.3
14	14	0	Matra-MHS	24	29	20.8	1,849	1.4	88.7
15	15	0	ITT	21	23	9.5	1,872	1.1	89.8
17	16	1	Zilog	17	21	23.5	1,893	1.0	90.8
12	17	-5	Harris	31	18	-41.9	1,911	0.9	91.7
18	17	1	Oki	15	18	20.0	1,929	0.9	92.6
-	19	NA	Matsushita	-	17	NA	1,946	0.8	93.4
19	20	-1	Fujitsu	10	15	50.0	1,961	0.7	94.1
20	20	0	Mitsubishi	9	15	66.7	1,976	0.7	94.8
25	22	3	AT&T	4	13	225.0	1,989	0.6	95.4
22	23	-1	TMS	8	9	12.5	1,998	0.4	95.8
23	24	-1	Analog Devices	6	7	16.7	2,005	0.3	96.1
26	25	1	Cypress	3	5	66.7	2,010	0.2	96.3
20	26	-6	Rockwell	9	4	-55.6	2,014	0.2	96.5
29	27	2	LSI Logic	2	2	0.0	2,016	0.1	96.6
23	28	-5	GEC Plessey Semiconductors	6	1	-83.3	2,017	0.0	96.6
26	28	-2	IDT	3	1	-66.7	2,018	0.0	96.6
-	28	NA	Rohm Electonics	-	1	NA	2,019	0.0	96.6
-	28	NA	Samsung	-	1	NA	2,020	0.0	96.6
30	28	2	Sanyo	1	1	0.0	2,021	0.0	96.6
30	28	2	Sharp	1	1	0.0	2,022	0.0	96.6
26	-	NA	Eurosil	3	-	NA	NA	NA	NA
			North American Others	46	58	26.1	2,080	2.8	99.9
			Japanese Others	0	0	NA	2,080	0.0	99.9
			European Others	0	0	NA	2,080	0.0	99.9
			Rest of World Others	2	2	0.0	2,082	0.1	100.0
			Total All Companies	1,802	2,082	15.5		100.0	
			Total North American	1,144	1,381	20.7		66.3	
			Total Japanese	294	349	18.7		16.8	
			Total European	362	349	-3.6		16.8	
			Total Rest of World	2	3	50.0		0.1	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Table 14
European 1991 Monolithic MOS Digital Logic IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Semiconductors	160	171	6.9	171	10.4	10.4
2	2	0	Siemens	138	133	-3.6	304	8.1	18.5
16	3	13	ITT	25	124	396.0	428	7.6	26.1
5	4	1	GEC Plessey Semiconductors	75	104	38.7	532	6.3	32.4
3	5	-2	LSI Logic	81	98	21.0	630	6.0	38.4
4	6	-2	Motorola	78	95	21.8	725	5.8	44.2
8	7	1	Texas Instruments	63	88	39.7	813	5.4	49.6
6	8	-2	SGS-Thomson Microelectronics	70	71	1.4	884	4.3	53.9
6	9	-3	Toshiba	70	66	-5.7	950	4.0	57.9
9	10	-1	National Semiconductor	60	65	8.3	1,015	4.0	61.9
10	11	-1	AMD	58	64	10.3	1,079	3.9	65.8
12	12	0	VLSI Technology	43	55	27.9	1,134	3.3	69.1
25	13	12	AT&T	14	36	157.1	1,170	2.2	71.3
13	14	-1	Austria Mikro Systeme	37	33	-10.8	1,203	2.0	73.3
11	14	-3	Harris	53	33	-37.7	1,236	2.0	75.3
14	16	-2	NEC	28	32	14.3	1,268	1.9	77.2
16	17	-1	European Silicon Structures	25	27	8.0	1,295	1.6	78.8
15	17	-2	Matra-MHS	26	27	3.8	1,322	1.6	80.4
23	19	4	Fujitsu	17	22	29.4	1,344	1.3	81.7
18	20	-2	ABB-HAFO	21	21	0.0	1,365	1.3	83.0
22	20	2	Mietec	18	21	16.7	1,386	1.3	84.3
18	22	-4	Hewlett-Packard	21	19	-9.5	1,405	1.2	85.5
24	22	2	Hitachi	16	19	18.8	1,424	1.2	86.7
26	24	2	Cypress	13	18	38.5	1,442	1.1	87.8
30	25	5	Ericsson	8	16	100.0	1,458	1.0	88.8
32	26	6	Oki	4	14	250.0	1,472	0.9	89.7
28	27	1	IDT	9	10	11.1	1,482	0.6	90.3
20	27	-7	Telefunken Electronic	19	10	-47.4	1,492	0.6	90.9
28	27	1	TMS	9	10	11.1	1,502	0.6	91.5
27	30	-3	Intel	10	9	-10.0	1,511	0.5	92.0
34	30	4	Mitsubishi	1	9	800.0	1,520	0.5	92.5
20	32	-12	Eurosil	19	8	-57.9	1,528	0.5	93.0
34	33	1	Seiko Epson	1	6	500.0	1,534	0.4	93.4
-	34	NA	Samsung	-	5	NA	1,539	0.3	93.7
31	35	-4	STC	5	4	-20.0	1,543	0.2	93.9
33	36	-3	Sanyo	2	2	0.0	1,545	0.1	94.0
34	36	-2	Sharp	1	2	100.0	1,547	0.1	94.1
34	36	-2	Sony	1	2	100.0	1,549	0.1	94.2

(Continued)

Table 14 (Continued)
European 1991 Monolithic MOS Digital Logic IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
34	39	-5	Allegro Microsystems	1	1	0.0	1,550	0.1	94.3
-	39	NA	Rohm Electonics	-	1	NA	1,551	0.1	94.4
34	-	NA	Goldstar	1	-	NA	NA	NA	NA
			North American Others	69	86	24.6	1,637	5.2	99.7
			Japanese Others	1	2	100.0	1,639	0.1	99.8
			European Others	0	0	NA	1,639	0.0	99.8
			Rest of World Others	1	3	200.0	1,642	0.2	100.0
			Total All Companies	1,372	1,642	19.7		100.0	
			Total North American	598	801	33.9		48.8	
			Total Japanese	142	177	24.6		10.8	
			Total European	630	656	4.1		40.0	
			Total Rest of World	2	8	300.0		0.5	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Table 15
European 1991 Analog IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Semiconductors	405	409	1.0	409	17.3	17.3
2	2	0	SGS-Thomson Microelectronics	350	353	0.9	762	14.9	32.2
3	3	0	National Semiconductor	179	185	3.4	947	7.8	40.0
4	4	0	Siemens	158	152	-3.8	1,099	6.4	46.4
7	5	2	Analog Devices	97	129	33.0	1,228	5.5	51.9
6	6	0	Motorola	115	105	-8.7	1,333	4.4	56.3
5	7	-2	Texas Instruments	125	104	-16.8	1,437	4.4	60.7
9	8	1	Mietec	66	81	22.7	1,518	3.4	64.1
10	9	1	Telefunken Electronic	65	78	20.0	1,596	3.3	67.4
11	10	1	GEC Plessey Semiconductors	56	61	8.9	1,657	2.6	70.0
12	11	1	Harris	51	55	7.8	1,712	2.3	72.3
13	12	1	Burr-Brown	49	43	-12.2	1,755	1.8	74.1
14	13	1	Ericsson	35	39	11.4	1,794	1.7	75.8
15	14	1	Sony	33	37	12.1	1,831	1.6	77.4
16	15	1	Rockwell	32	32	0.0	1,863	1.4	78.8
21	16	5	AMD	21	29	38.1	1,892	1.2	80.0
20	16	4	Austria Mikro Systeme	22	29	31.8	1,921	1.2	81.2
8	18	-10	ITT	75	28	-62.7	1,949	1.2	82.4
19	18	1	Toshiba	27	28	3.7	1,977	1.2	83.6
17	20	-3	Allegro Microsystems	30	24	-20.0	2,001	1.0	84.6
23	21	2	Mitel	16	18	12.5	2,019	0.8	85.4
22	21	1	Siliconix	18	18	0.0	2,037	0.8	86.2
25	23	2	Sanyo	12	14	16.7	2,051	0.6	86.8
24	23	1	Unitrode	13	14	7.7	2,065	0.6	87.4
27	25	2	TMS	9	11	22.2	2,076	0.5	87.9
28	26	2	Rohm Electonics	8	10	25.0	2,086	0.4	88.3
25	27	-2	Mitsubishi	12	8	-33.3	2,094	0.3	88.6
28	27	1	Raytheon	8	8	0.0	2,102	0.3	88.9
32	29	3	Fujitsu	4	7	75.0	2,109	0.3	89.2
-	30	NA	Eurosil	-	6	NA	2,115	0.3	89.5
31	30	1	Hitachi	5	6	20.0	2,121	0.3	89.8
35	32	3	Matra-MHS	3	5	66.7	2,126	0.2	90.0
32	32	0	Matsushita	4	5	25.0	2,131	0.2	90.2
32	32	0	NEC	4	5	25.0	2,136	0.2	90.4
30	32	-2	STC	6	5	-16.7	2,141	0.2	90.6
38	36	2	AT&T	1	4	300.0	2,145	0.2	90.8
36	36	0	Samsung	2	4	100.0	2,149	0.2	91.0
-	38	NA	Honeywell	-	1	NA	2,150	0.0	91.0

(Continued)

Table 15 (Continued)
European 1991 Analog IC Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
36	-	NA	LSI Logic	2	-	NA	NA	NA	NA
18	-	NA	Precision Monolithics	29	-	NA	NA	NA	NA
			North American Others	159	188	18.2	2,338	8.0	99.0
			Japanese Others	7	4	-42.9	2,342	0.2	99.2
			European Others	0	7	NA	2,349	0.3	99.4
			Rest of World Others	13	13	0.0	2,362	0.6	100.0
			Total All Companies	2,326	2,362	1.5		100.0	
			Total North American	1,020	985	-3.4		41.7	
			Total Japanese	116	124	6.9		5.2	
			Total European	1,175	1,236	5.2		52.3	
			Total Rest of World	15	17	13.3		0.7	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Table 16
European 1991 Discrete Semiconductor Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Semiconductors	340	340	0.0	340	18.6	18.6
4	2	2	Siemens	202	200	-1.0	540	10.9	29.5
2	3	-1	Motorola	208	195	-6.3	735	10.7	40.2
3	4	-1	SGS-Thomson Microelectronics	203	189	-6.9	924	10.3	50.5
7	5	2	International Rectifier	69	76	10.1	1,000	4.2	54.7
6	6	0	Eupec	78	73	-6.4	1,073	4.0	58.7
8	7	1	Semikron	66	67	1.5	1,140	3.7	62.4
10	8	2	Telefunken Electronic	54	62	14.8	1,202	3.4	65.8
5	9	-4	ITT	111	60	-45.9	1,262	3.3	69.1
11	10	1	Toshiba	51	58	13.7	1,320	3.2	72.3
9	11	-2	General Instrument	65	55	-15.4	1,375	3.0	75.3
13	12	1	ABB-IXYS	47	47	0.0	1,422	2.6	77.9
12	13	-1	Powerex	50	37	-26.0	1,459	2.0	79.9
15	14	1	GEC Plessey Semiconductors	30	28	-6.7	1,487	1.5	81.4
16	15	1	Harris	24	27	12.5	1,514	1.5	82.9
18	16	2	NEC	22	24	9.1	1,538	1.3	84.2
22	17	5	Fujitsu	18	23	27.8	1,561	1.3	85.5
14	17	-3	Mitsubishi	35	23	-34.3	1,584	1.3	86.8
17	17	0	Siliconix	23	23	0.0	1,607	1.3	88.1
21	20	1	TAG	20	21	5.0	1,628	1.1	89.2
18	21	-3	Fagor Electrotécnica	22	20	-9.1	1,648	1.1	90.3
20	21	-1	Texas Instruments	21	20	-4.8	1,668	1.1	91.4
24	23	1	Rohm Electonics	12	14	16.7	1,682	0.8	92.2
24	24	0	Zetex	12	13	8.3	1,695	0.7	92.9
24	25	-1	Matsushita	12	11	-8.3	1,706	0.6	93.5
22	26	-4	Hewlett-Packard	18	10	-44.4	1,716	0.5	94.0
27	26	1	Unitrode	10	10	0.0	1,726	0.5	94.5
28	28	0	Hitachi	8	8	0.0	1,734	0.4	94.9
29	29	0	National Semiconductor	7	6	-14.3	1,740	0.3	95.2
31	29	2	Samsung	4	6	50.0	1,746	0.3	95.5
30	31	-1	ABB-HAFO	5	4	-20.0	1,750	0.2	95.7
33	32	1	Allegro Microsystems	2	3	50.0	1,753	0.2	95.9
31	32	-1	Sanyo	4	3	-25.0	1,756	0.2	96.1
33	34	-1	STC	2	2	0.0	1,758	0.1	96.2
35	35	0	Sony	1	1	0.0	1,759	0.1	96.3
35	35	0	TMS	1	1	0.0	1,760	0.1	96.4
35	-	NA	Raytheon	1	-	NA	NA	NA	NA
			North American Others	13	13	0.0	1,773	0.7	97.0
			Japanese Others	20	23	15.0	1,796	1.3	98.2
			European Others	0	30	NA	1,826	1.6	99.9
			Rest of World Others	4	2	-50.0	1,828	0.1	100.0
			Total All Companies	1,895	1,828	-3.5		100.0	
			Total North American	622	535	-14.0		29.3	
			Total Japanese	183	188	2.7		10.3	
			Total European	1,082	1,097	1.4		60.0	
			Total Rest of World	8	8	0.0		0.4	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

Table 17
European 1991 Optoelectronic Semiconductor Market Share Rankings
(Millions of Dollars)

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Siemens	90	136	51.1	136	28.0	28.0
2	2	0	Telefunken Electronic	68	65	-4.4	201	13.4	41.4
3	3	0	Hewlett-Packard	49	61	24.5	262	12.6	54.0
4	4	0	Toshiba	27	30	11.1	292	6.2	60.2
5	5	0	Philips Semiconductors	26	29	11.5	321	6.0	66.2
6	6	0	Honeywell	20	20	0.0	341	4.1	70.3
9	7	2	AT&T	8	17	112.5	358	3.5	73.8
7	8	-1	TMS	14	15	7.1	373	3.1	76.9
14	9	5	Sharp	4	13	225.0	386	2.7	79.6
8	10	-2	Texas Instruments	10	11	10.0	397	2.3	81.9
11	11	0	ABB-HAFO	6	7	16.7	404	1.4	83.3
10	11	-1	Matsushita	7	7	0.0	411	1.4	84.7
12	13	-1	Fujitsu	5	6	20.0	417	1.2	85.9
12	13	-1	NEC	5	6	20.0	423	1.2	87.1
14	15	-1	Hitachi	4	5	25.0	428	1.0	88.1
14	16	-2	Motorola	4	4	0.0	432	0.8	88.9
14	17	-3	Harris	4	3	-25.0	435	0.6	89.5
18	17	1	Sanyo	2	3	50.0	438	0.6	90.1
19	19	0	Mitsubishi	1	1	0.0	439	0.2	90.3
-	19	NA	Oki	-	1	NA	440	0.2	90.5
-	19	NA	Rohm Electonics	-	1	NA	441	0.2	90.7
19	19	0	Zetex	1	1	0.0	442	0.2	90.9
			North American Others	42	28	-33.3	470	5.8	96.9
			Japanese Others	0	0	NA	470	0.0	96.9
			European Others	0	7	NA	477	1.4	98.4
			Rest of World Others	8	8	0.0	485	1.6	100.0
			Total All Companies	405	485	19.8		100.0	
			Total North American	137	144	5.1		29.7	
			Total Japanese	55	73	32.7		15.1	
			Total European	205	260	26.8		53.6	
			Total Rest of World	8	8	0.0		1.6	

NA = Not Applicable
Source: Dataquest (July 1992 Estimates)

In Future Issues

Along with our regular features, "European Pricing Update" and "State of the Industry," forthcoming issues of *Dataquest Perspective* will report on:

- RISC in Europe
- Semiconductor supplier of the year

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9208 July 3, 1992

In This Issue...

Pricing Analysis

European Pricing Update

The memory reference prices are now released, and these have been revised downward. The European Commission has granted a tariff preference arrangement to South Korea for certain products, reducing the duty payable on semiconductors, within certain guidelines. This should impact South Korean suppliers' prices. The summer slowdown is starting to affect business in Europe, with volumes weakening.

By Byron Harding and Mike Glennon *Page 1*

Market Analysis

State of the Industry

The SIA European book-to-bill ratio for May was 1.02, falling slightly from April's revised 1.03. The 12-month moving-average growth is showing tentative signs of stabilizing, with booking growth lifting for the first time in 12 months. While this gives some optimism for the rest of the year, caution should be exercised before the party begins, as this is based on preliminary data, which is notoriously unstable. It should be two to three months before the celebratory wine flows, as by then the upturn should be more certain, with three months of positive data.

By Mike Glennon *Page 4*

Conferences and Exhibitions

Dataquest's Eleventh European Semiconductor Industry Conference

Dataquest's eleventh annual European semiconductor conference took place in June at Jurys Hotel, Dublin, Ireland. Two previous *Dataquest Perspectives* covered the speeches made by Dataquest analysts, and this article summarizes the speeches made by Dataquest's invited speakers. Topics covered range from protecting Europe's semiconductor industry, to an overview of fuzzy logic.

By Jim Eastlake *Page 9*

Pricing Analysis

European Pricing Update

Industry Events

The European Commission has granted a tariff preference arrangement to South Korea on imports of certain products. This means there is no import duty payable on semiconductors (up to an annual ceiling of around $7 million at current exchange rates), and memory modules (for which there is no ceiling). This arrangement is part of the EC's generalized tariff preferences for 1992 in respect of certain products originating in developing countries. The arrangement with South Korea was suspended between 1987 and 1991, while a mutually acceptable understanding was reached on the protection of EC intellectual property rights. EC Council Regulation 282/92, dated February 3, 1992 ruled that such an understanding had been reached, and that the tariff preference arrangement was reinstated with South Korea on January 1 this year. This arrangement has an impact on the prices of SIMMs originating from South Korea, and Dataquest recommends buyers to consider this. In addition, Singapore has had a long-standing tariff preference arrangement with the EC, and imports of SIMMs from this country are rising.

Table 1 shows European semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Standard Logic

There are no significant changes in standard logic prices, and lead times are lengthening. This is relieving pressure on prices.

Analog

The mono operational amplifier arena in Europe is fairly stable, with no price changes.

Microcomponents

Business is good, but the summer slowdown is beginning to appear. There is a large supply of 386SX-16 products, as many users switch to the SX-25, and the spot price for the SX-16 has fallen below $40 in some cases. The Intel–AMD microcode case, which has just been found in Intel's favor, should delay the introduction of AMD's 486, and therefore reduce downward pressure on Intel's prices for the product.

Memory

DRAM

Prices for 256K remain flat in contract volume. End users are typically from the industrial segment, where design cycles are long, and production runs are small. Prices cannot realistically go any lower, except on the spot market, where some very low prices have been seen. In 1M DRAM, prices have stabilized in contract volumes as well. Like the 256K part, spot market and distribution prices seem to have fallen below contract prices. This is normal in times of oversupply.

The 4M DRAM price has dropped a little again, with some good prices available on the spot market. Demand is particularly growing for wide organized versions. The 16M DRAM is still in its infancy in terms of demand. The current price is about $140, although new reference prices indicate it can fall to about $120 during the third quarter of 1992, which is roughly 10 times the 4M price. Siemens and IBM will be releasing commercial samples in October. These will actually be 18M parts (in 1M×18 and 2M×9 configurations) because of IBM's internal requirements for parity check on chip. Siemens will later release true 16M versions, with a consequential reduction in chip area.

The 1M×9 DRAM SIMM is continuing to fall in price, below other world markets. In fact it is believed that South Korean vendors have substantial stock to ship. In addition, there are no import duties on SIMMs from South Korea. Likewise, no duties are payable on SIMMs imported to the EC from Singapore.

The average contract price per Mbit is as follows: 256K = $6.30; 1M = $3.20; 4M = $2.88; 1M×9 = $3.00; 16M = $8.75.

EPROM

European prices for UV EPROM are very attractive, and erosion continues at most densities. Europe has some of the most competitive prices in the world, except in South Korea. In both of these markets, it is understood the European and US suppliers are fighting for market share. Profit margins are believed to be very low, and this level of competition cannot be sustained for long. Intel has already withdrawn from lower-density EPROM, and others are sure to follow.

The average contract price per Mbit is as follows: 1M = $2.85; 2M = $2.10; 4M = $2.65.

SRAM

Prices for 64K slow SRAM are flat in Europe. The main source of supply is now South Korea. Supply and demand are both declining. In 256K slow SRAM, prices have slightly eroded again. Some manufacturers will be performing die shrinks at the end of the year, so prices may drop again in the first quarter of 1993. In late summer watch out for heavy demand from games machine manufacturers such as Nintendo. This could extend lead times in Europe.

Prices of 1M parts have also slighly eroded, and are still the lowest in the world. Some users are asking still lower prices. Duty suspension on all speeds of 1M SRAM continues. This may be changed at the end of the year, when local supply of certain speeds become available.

The average contract price per Mbit is as follows: 64K = $25.00; 256K = $13.00; 1M = $9.25.

Current Exchange Rates

1 US dollar =
- 0.540 UK pounds
- 1.577 deutsche marks
- 5.315 French francs
- 0.769 ECU

By Byron Harding
Mike Glennon

Table 1
European Semiconductor Pricing July 1992
All Prices in US Dollars (including import duty where relevant)

Device Family	Product	Package	Mean 1K Price	Mean 10K Price	25K+ Contract Price	Lead Time in Weeks
Standard Logic	74F00	PDIP	0.12	0.10	0.09	12–18
Fast TTL	74F74	PDIP	0.14	0.13	0.12	12–18
	74F138	PDIP	0.18	0.17	0.15	12–18
	74F244	PDIP	0.25	0.24	0.21	12–18
Standard Logic	74AC00	PDIP	0.19	0.17	0.15	12–16
Advanced CMOS	74AC74	PDIP	0.24	0.21	0.20	12–16
	74AC138	PDIP	0.35	0.30	0.26	12–16
	74AC244	PDIP	0.43	0.37	0.35	12–16
Analog	741 Op. Amp.	TO92	0.17	0.12	0.11	4–6
	CODEC/Filter 1	[1]	2.90	2.65	2.50	6–10
	CODEC/Filter 2	[2]	5.75	5.45	5.00	6–10
Microcomponents	80386SX-16	PQFP	47.00	46.00	45.00	4–6
	80386DX-25	CPGA	101.00	97.00	94.00	4–6
	80286-16	PLCC	11.70	11.00	10.00	4–6
	68020-16	PQFP	31.00	27.30	26.00	6–8
	R3000-25	CPGA	135.00	120.00	110.00	4–10
Memory						
DRAM	256K-8 (256K×1)	PDIP	1.75	1.55	1.55	2–8
	1M-8 (1M×1)	SOJ	3.40	3.10	3.20	2–6
	1M-8 (256K×4)	SOJ	3.40	3.10	3.20	2–6
	4M-8 (4M×1)	SOJ	12.00	11.80	11.50	2–8
	9M-8 (1M×9)	SIMM	28.50	27.50	27.00	1–2
	1M-7 (1M×1)	SOJ	3.40	3.10	3.20	2–8
	1M-6 (1M×1)	SOJ	3.54	3.22	3.20	4–10
	4M-7 (4M×1)	SOJ	12.00	11.80	11.50	4–8
	4M-6 (4M×1)	SOJ	12.70	12.50	12.00	6–10
	16M-8 (4M×4)	SOJ	140.00	140.00	140.00	8–14
UV EPROM	1M-17 (128K×8)	CDIP	3.30	3.10	2.85	2–6
	2M-17 (256K×8)	CDIP	6.30	5.00	4.20	2–8
	4M-17 (512K×8)	CDIP	15.00	12.20	10.60	4–10
SRAM	64K-85 (8K×8)	PDIP	2.00	1.65	1.55	4–10
	256K-85 (32K×8)	PDIP	3.60	3.40	3.25	4–8
	1M-85 (128K×8)	PDIP	10.50	9.65	9.25	2–10

[1] Group 1: Commercial temp, serial, PDIP, A/μ law
[2] Group 2: Commercial temp, serial, PLCC, A/μ law, programmable
Source: Dataquest (July 1992 Estimates)

Market Analysis

State of the Industry

The WSTS flash three-month average book-to-bill ratio for May was 1.02, a decrease from April's restated 1.03. Figure 1 shows the book-to-bill ratio for the past 12 months, and the bookings and billings. Three-month average orders booked totalled $923.1 million, a 1.3 percent decline on April. Three-month average orders billed totalled $907.9 million, a 0.2 percent decline on the previous month. April's previous low billings have been restated upwards by 2.2 percent to the new value, resulting in an increase in the book-to-bill ratio for the month from 1.02 to 1.03. WSTS's estimate for the actual month's billings in May was $863.8 million, a 1.7 percent increase from April's restated estimate of $849.3 million.

May is normally a quiet month for bookings and billings, and the slowdown is beginning to appear as Europe winds down for the summer. The slight dip in three-month average bookings and billings is therefore to be expected.

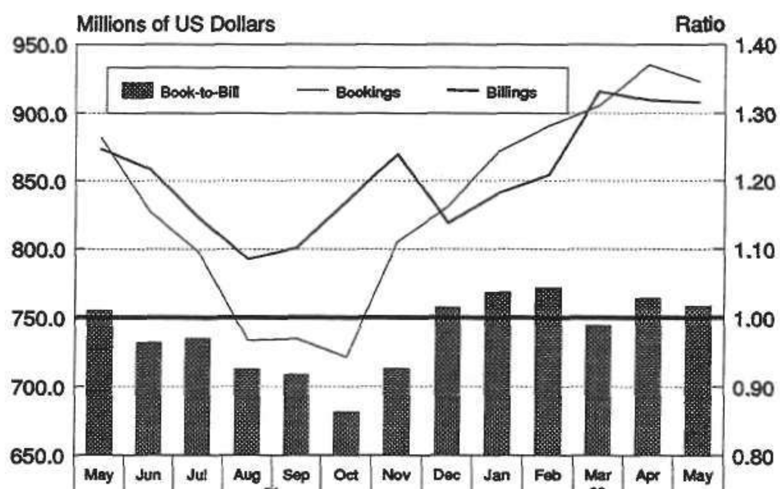
European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trend and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billing and three-month average booking figures. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

Figures 2, 3 and 4 show the forecast and actual three-month average bookings, actual monthly billings, and book-to-bill ratio from the Dataquest forecast model.

The billing data for April has been restated, as was hinted in last month's report, and this has improved the picture marginally. However, the booking and billing data is still running well below the model, while the book-to-bill indicator is only slightly below that indicated by the

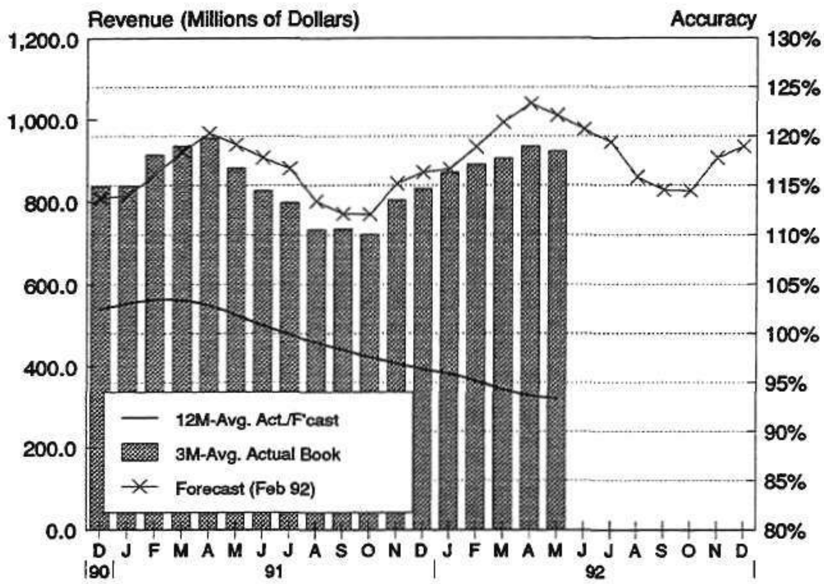
Figure 1
European Total Semiconductor Orders Booked and Sales Billed (Three Month Average)



	May	Jun	Jul	Aug	Sep 91	Oct	Nov	Dec	Jan	Feb	Mar 92	Apr	May
Book-to-Bill	1.01	0.96	0.97	0.93	0.92	0.86	0.93	1.02	1.04	1.04	0.99	1.03	1.02
Bookings	882.4	827.3	798.3	733.5	734.6	721.4	805.1	831.0	871.0	891.0	905.4	935.1	923.1
Billings	873.5	858.7	823.0	792.7	800.8	835.2	869.4	818.7	840.5	854.0	915.9	909.5	907.9

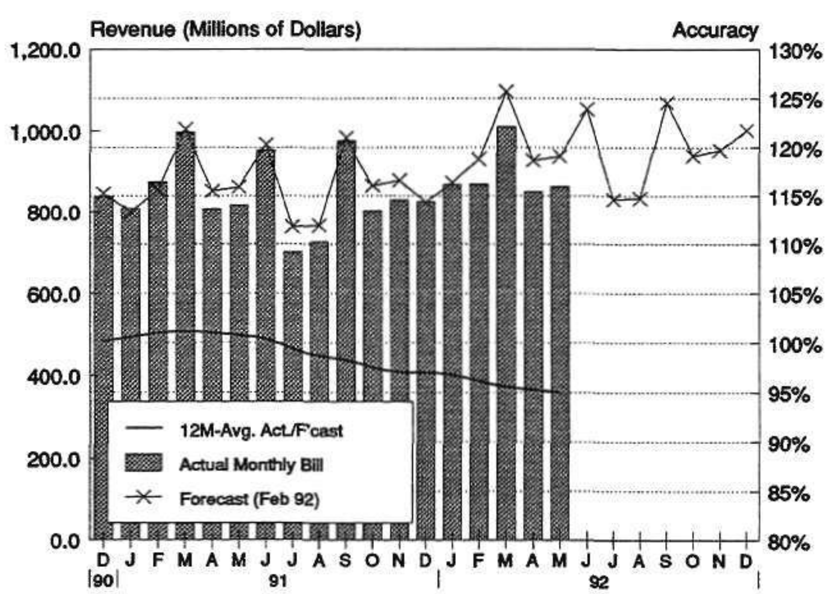
Note: Last two months are preliminary.
Source: WSTS, SIA

Figure 2
European Total Three-Month Average Bookings



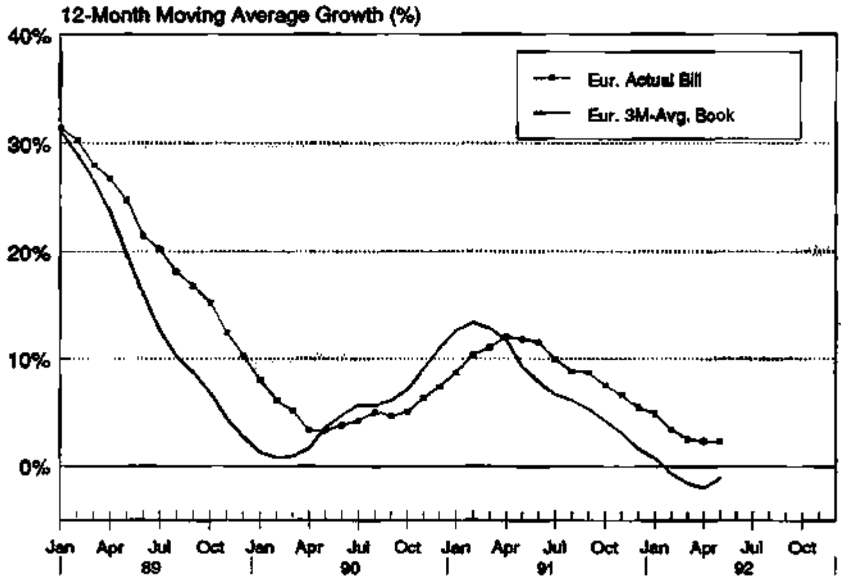
Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (July 1992)

Figure 3
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (July 1992)

Figure 4
US and European Total Semiconductor 12-Month Average Growth



Source: WSTS, SIA

model. This shows the book-to-bill indicator is not a fair measure of the health of the market, as both bookings and billings are weak in unison. The gap between the forecast data and the actual data is not getting any bigger, though, indicating the bottom of the trough may have been reached. The billing data still has some momentum, as the booking data is only just showing signs of improvement, and thus there should be a small delay before real signs of improvement in billings appear in the data.

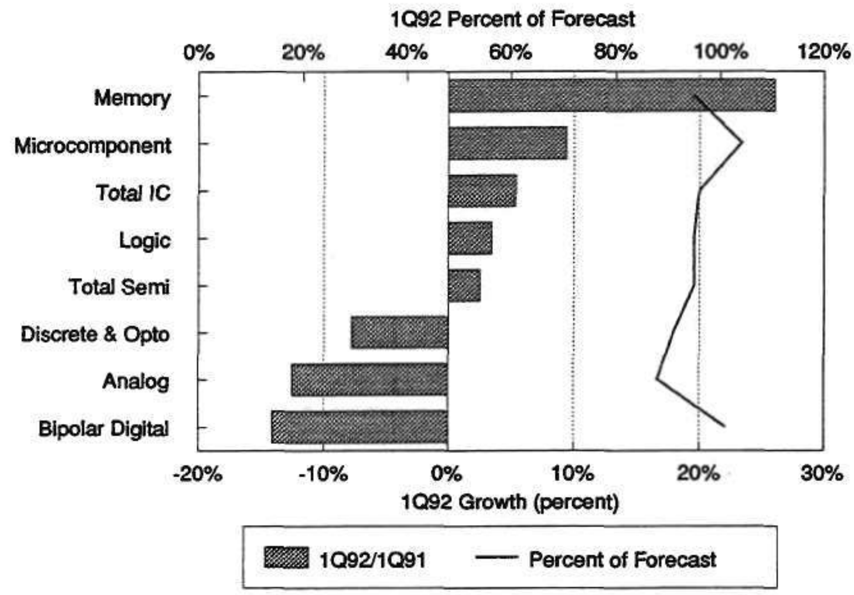
The most positive indicator for the month is the 12-month moving average growth, as shown in Figure 5. The adjustments made to last month's data, and the inclusion of this month's data, show an upturn in booking growth. This is likely to be the turning point, but caution should be exercised as this is only preliminary data. The upturn in booking growth will stall the decline in billing growth, indicating that growth for the year will be at least 4 percent.

Dataquest Perspective

An analysis of the product detail for the first quarter of 1992 indicates where the low growth occurs, and which products are supporting the meagre growth apparent in Europe. Figure 5 shows the growth for the first quarter, when compared with the same quarter the previous year. From this it is apparent that memory and microcomponent are showing significant growth, and the greatest shortfalls are occurring in analog, and digital bipolar.

It is perhaps surprising therefore to see significant price pressure on memory products, with revenue growth for memory so high. The pressure is related to the oversupply of products, and the decline in selling prices has been more than compensated for by the growth in unit shipments. This has resulted in the significant revenue growth. When the forecast model is examined, though, the memory market is still below that forecast by the model. This is related to the two previous years, when the memory market showed very little growth. The forecast model indicates a growth of 12 percent over 1991's forecast figure, but this translates to a growth of 27 percent over 1991's actual figure because of this poor performance. Demand for memories comes mainly from PCs, and PC manufacture is growing at a reasonable rate across Europe, hence the high growth. A significant proportion of memory sales is in the form of memory modules, as many users upgrade their PCs to run memory-intensive applications such as Windows.

Figure 5
European Product Growth
First Quarter 1992 over First Quarter 1991



Source: Dataquest (July 1992 Estimates)

Microcomponent is showing a much lower growth than memory; this is because of the high growth in microcomponents which occurred in the previous year. Demand is still significant for microprocessors. Microprocessor sales in 1991 showed a phenomenal 42 percent growth in the first quarter of that year when compared with the first quarter of 1990. The lower growth in 1992 is related to this significant growth in 1991's first quarter. This high growth is also a reflection of the state of the PC manufacturing market, and is not as high as the growth in memory because for memory, the reverse occurred: the memory market in the first quarter of 1991 actually declined by 6 percent when compared with the first quarter of 1990. In these two cases the growth is therefore very deceptive. The actual data for microcomponents is in fact ahead of the forecast model, indicating a consistent healthy growth to the market.

This high growth in microprocessors reflects the good health of the EDP sector of the market, but the consumer segment is not as healthy. The microcontroller market is showing significantly lower growth, at only 1.5 percent for the first quarter. The main use of microcontrollers, especially 4- and 8-bit controllers, is in consumer products. This market is not performing as well as the EDP market, and is pulling down the total possible growth for microcomponents. The low growth in microcontrollers is significant, as it represents over 40 percent of the total microcomponent market in Europe.

The logic market is performing less well, closer to the market average. This is in tune with the spread of logic applications, which is fairly even over all application areas. The logic market is therefore representative of the market as a whole. The market is also underperforming, when compared to the forecast model. As Figure 5 shows, the actual data for the first quarter is only 95 percent of the forecast model.

Moving to the other end of the product spectrum, the bipolar digital market is showing the lowest growth (or biggest decline). This is not entirely unexpected, as bipolar products are finding the high-performance niche into which they fit gradually reducing in size. However, much bipolar logic product appears in PC applications, so this market should be declining less than would normally be expected, as the PC market is showing reasonable growth. This is in fact confirmed by the comparison of the actual data with the forecast model, and the bipolar digital market is outperforming the model, albeit only just.

Analog products appear heavily in consumer applications, and the weakness of the consumer market shows in the analog market's performance. Although the decline in this market is not as great as digital bipolar, the forecast model indicates the market should be growing, rather than declining. At only 88 percent of the forecast model, the analog market is the worst performer for the first quarter of 1992. The analog market has in fact performed poorly for the past year, and this quarter's performance is only a continuation of this trend.

The UK market is heavily biased towards EDP and consumer, as many of the manufacturers in this region are Japanese- and North American-owned equipment manufacturers. The region is therefore torn between the two extremes of the market: those semiconductor suppliers who are delivering EDP-related products will be enjoying at least some growth in their revenue; whereas those who are supplying consumer-related products will be less healthy.

In Germany the decline in consumer spending is also affecting semiconductor sales, and many consumer equipment manufacturers are significantly reducing their semiconductor spend. There are high levels of inventory for most consumer equipment, and this inventory must be worked off before consumer electronics sales can return to their previous levels. However, the telecoms and industrial markets in Germany are healthy, and are supporting some of the suppliers in the region. The larger industrialized companies are therefore suffering less than the consumer-oriented ones.

In the Nordic countries the market is more telecoms- and EDP-based, with Ericsson, Nokia and ICL the major consumers of semiconductors. Delays in the approval of GSM phones have put back the volume take-up of the system, but self-certification of the phones for many of the final tests has overcome these delays, and the GSM handsets are beginning to appear in the shops. Take-up is most likely to occur in Germany first, as the network there is reaching capacity limits.

In France the transfer of equipment manufacture overseas continues, and Italy is threatening to follow the same route. Olivetti has publicly stated that labor costs are much cheaper in Singapore, and the company is likely to transfer production overseas. However, this could be political posturing in an effort to get support from the government.

In general then, the market is weak in consumer, and strong in telecoms and PC applications. This is reflected in the strength of memories and microcomponents, and the poor first-quarter performance of analog, discrete and optoelectronic products. The outlook for the short term is that this will continue, with some consumer recovery beginning to appear towards the end of the year. There are already signs of an improvement, but the summer slowdown will shortly be upon us, and this will mask any continued improvement.

By Mike Glennon

Conferences and Exhibitions

Dataquest's Eleventh European Semiconductor Industry Conference

Dataquest's eleventh annual European semiconductor conference took place between June 3 and 5 at the Jurys Hotel, Dublin, Ireland. It was chaired by Bipin Parmar, Director of the European Semiconductors Group. In two earlier Conference Special issues of *Dataquest Perspective* we covered the speeches given by Dataquest analysts at the conference. In this article, we give synopses of the speeches of Dataquest's invited speakers from the industry.

Welcome to Ireland
Michael Ahern
Minister for Science and Technology
Irish Government

Intel's choice of Ireland for its semiconductor plant marks the coming of age of the technological infrastructure of Ireland. Ireland is more than a place just for assembly; the Republic's support infrastructure now includes suppliers of gases, chemicals and quartzware. This is a result of a consistent policy of support from the government.

Labor costs are among the lowest in Europe with pay rises averaging 3.5 percent this year—agreed between government, employers and unions—and inflation is only 3.5 percent this year. Ireland is top of the league for return on US capital for manufacturing in Europe with a rate of 24.1 percent, which is four times the EC average of 6.6 percent.

Investing in Electronics
Dan Flinter
Executive Director
Industrial Development Authority of Ireland (IDA)

World electronics output was worth $750 billion in 1990 and is set to rise 40 percent to $998 billion by 1995. The IDA's aim is to facilitate economic growth and job creation, and means to achieve that by encouraging inward investment. Just 20 years ago electronics accounted for less than 2 percent of the industrial work force and generated 6 percent of industrial exports. Now 200 companies employ almost 10 percent of the industrial work force and account for almost 30 percent of industrial exports.

The IDA looks to find competitive advantage for Ireland as an inward investment target and was the first country to provide fiscal incentives. A current incentive is the large number of people in education—1 million out of a total population of 3.5 million—and considerable improvements in the tertiary education system. The result has been to enhance Ireland's attractiveness as a place for value-added activities such as product design, technical market support and software development. Ireland's maximum rate of corporate tax is 10 percent, guaranteed until the year 2010.

Semiconductor Distribution in the '90s
Gary Kibblewhite
Managing Director
Europartners

Distribution is becoming more important, today serving 30 percent of component demand by value, and 98 percent by number of customers. It also is changing as mainland European and US companies become more acquisitive. Distributors are having to decide whether to centralize or decentralize. They are not as prepared for the single European market in 1993 as the manufacturers, particularly in the adoption of electronic trading techniques. Financial measurements—sales growth, profits growth, margins, and return on capital employed—vary widely between major players.

There is a trend to polarization between catalogue players such as Farnell, RS, ESD and Newark, which are more profitable than the industry norm; and broadliners such as Avnet, Arrow, Lex and Tekelec, which are less profitable. The rise in acquistion activity is a trend that will continue for at least the next two years as the single market gets going. The single market will make service aspects key, such as cross-border dealing, kitting, programming, and ship and debit. Why the Japanese distributors, which are very mainly owned by the major manufacturers, have not made acquisitions in Europe is a mystery.

PC Cards
John Reimer
Chairman and President, PC Memory Card International Association
Vice President Marketing, SunDisk Corporation

The PCMCIA has 200 member companies, but Europe is "under-represented." Originally regarded as just for memory, a PC card nowadays can hold the storage capacity of a hard disk or it can include a modem, a fax modem or a wireless LAN.

Solid state storage allows computers to be built which can perform "a whole day's work without a recharge, sometimes a whole month's," which is one reason why a third of all computers sold in 1995 will be mobile. Application-specific computers will be a growing market, for example as test equipment with calibration done by PCMCIA cards. Pen computing will be a big area for PC cards and "virtually all" pen-based computers have PCMCIA slots.

Flash Memory Revolutionizes Portable Computing

Anthony G. Barre
Director of Strategic Planning, Memory Components Group
Intel Corporation

Why has mobile computing not taken off? For two reasons: first, it takes so much longer to extract information from a computer than from a diary; and second, hard disks can get shaken up and lose data. Flash memory is the ideal memory for mobile computers. It has a cell 30 percent smaller than DRAM and one which is more scalable because it does not use capacitors which are not easily scalable without losing capacity to store a charge. Compared with hard disk, flash is 100 times more shock-resistant, 10 times more reliable, 7 times faster and uses 5 percent of the power.

Byte-for-byte cross-over in price between flash and small form-factor hard disk is expected by the year 2000. Flash will be used in mobile computers: for storing the operating system and communications media; for removable media in the form of cards; as a hard disk; for updatable BIOS; for embedded firmware in cellular phones and wirelesss pagers. A unit mobile computer market 20 million strong is expected in 1995, with each unit using 20MB to 40MB of flash; 20MB on a card is now available at $30 per Mbyte; and 40MB cards will be available in 1995 at a price of $10 per Mbyte.

Fuzzy Logic

Professor A.J. van der Wal
Manager, European Technical Centre
Omron Electronics Europe BV

Fuzzy logic is a means of modelling qualitative, as opposed to quantitative, information in response to the difficulty of modelling reality as observed by Heisenberg: "Uncertainty is inherent to physical observations;" and Albert Einstein: "So far as the laws of mathematics refer to reality they are not certain. And so far as they are certain, they do not refer to reality." So fuzzy logic tries to model human logic.

Normal computer logic requires precise logic which means it is unsuitable for modelling the "grey scales" of human logic. Normal computer logic has two values, true and false, whereas fuzzy logic deals with many more than two values (a multiple input domain), for example linguistic variables, skill levels of users and other real-life variables.

Fuzzy logic is an important technology in all control applications and as an enabling technology for expert systems where inferencing and heuristic knowledge rules need to be implemented. Fuzzy logic can be implemented in hardware and software. Omron produces a range of processors optimized for fuzzy logic, but fuzzy logic can be implemented on standard processors such as the x86 family. Omron sees a ¥100 billion market for fuzzy logic in 1994 rising to ¥300 billion in 1997. Fuzzy logic is very popular in Japan, it can be found virtually everywhere—including cars, vacuum cleaners, rice cookers and, for instance, for reducing jitter in camcorders.

Is Standard Logic Dead?

Glenn Louch
Director, Standard Products Division
National Semiconductor Europe

1967 to 1988 were the "glory years" for standard CMOS logic, with fast growth to reach a market peak in Europe in 1988. However, only this year, for the first time, will standard CMOS logic overtake standard bipolar logic in market size in Europe—12 years after CMOS logic was first introduced. Why are people still using standard CMOS logic? Because they are used to it, because it cuts time to market compared with ASICs, because there is no risk attached, because it is easy to use, and because it is multisourced.

Significant developments are taking place in reducing voltages and power consumption, in bringing down costs, in developing wide bus products and in producing ruggedized products to cope with EC regulations on EMC which are scheduled for 1996. Furthermore, National Semiconductor and Texas Instruments (TI) have done a lot of work on reducing ground bounce. Though Dataquest figures predict a flat market for standard CMOS logic between now and 1996, National and TI expect an "assured demand" for ACT and FCT products and a healthy growth for CMOS logic as a whole in the next four years, although as a share of the semiconductor total available market it will decline.

Future Trends in General-Purpose Logic
Peter Dennstedt
Manager, European General-Purpose Logic
Texas Instruments Europe

There will be a continuous future demand for advanced general-purpose bus drivers. With systems running faster and faster, bus drivers are becoming a more important element with impedances down to 10 ohm. With 80 percent of microprocessor shipments coming from 16- and 32-bit devices, there is a need for wider bus interface circuits in new packages such as 100- and 120-pin shrink quad flat packs; 18- and 36-bit universal bus transceivers are available in advanced BiCMOS. TI has 30 bus driver products that incorporate testability, and 3.3V devices "are coming." All these developments, which are driven by the needs of the computer market will open up new applications for standard logic. So, even though the overall standard logic market will not grow because of the use of ASIC, there will be growth in the newer product families such as: advanced CMOS logic (ACL), BiCMOS technology (BCT), advanced BiCMOS technology (ABT) and low-voltage technology (LVT). Although vendors of standard logic will drop out "we think TI will be the last one."

PANEL SESSION 2: Semiconductor Manufacturing in Europe

Panellists were asked by Dataquest to respond to the following five questions:

- Why do you think manufacturing semiconductors in Europe is more expensive than in other parts of the world?
- Why is it important to manufacture in Europe if it is more costly here?
- Is it viable to expect a European plant to be constructed to supply just local market needs or must it supply products for worldwide consumption?
- Do you think there are factors that lead to a European plant being more inefficient than elsewhere, for example training skills, supplies, local government?
- How do you think government policies affect manufacturing in Europe? Which policies help and which hinder?

Panellists' Position Statements
Thomas E. Hartmann
General Manager, Ireland Components Manufacturing
Intel Corporation

Q1: Intel expects that the start-up costs of its Irish plant will be more expensive initially but that it will be competitive with Intel's other plants when in full production. Construction costs are the same as in the United States, materials costs are marginally higher because of duty and transport costs; people costs are lower; and costs of manufacturing equipment are higher because 75 percent of it has to be imported and attracts duty of 5 to 7 percent, whereas in the United States only 25 percent of the manufacturing equipment would have to be imported.

Q2: Because customers want products made in Europe; because Intel as a worldwide supplier believes it should supply locally where possible; because of the duty advantages; because "in the long run we do not think it will be more costly."

Q3: Intel does not have every process running at every location; instead, each factory concentrates on just one or two processes. So the Irish plant will supply the world.

Q4: Intel has had the most difficulty with its own local government in California, particularly in respect of environmental regulations and the cost of living. Intel looks for governments responsive to responsible manufacturing companies and to the availability of a local, skilled labor force.

Q4: Europe is no different to Japan 20 years ago [Hartman built TI's first Japanese fab]. Intel has had a lot of help from the IDA and the government.

George Bennett
Vice President and General Manager
MOS Memory and Microprocessor Division (Europe)
Motorola Ltd

Manufacturing in Europe is cost-effective. Motorola has been doing it for 25 years and has 4,500 European employees engaged in design and manufacturing. It would not do that unless it was cost-effective. A disadvantage is that the semiconductor manufacturing equipment industry is dominated by US and Japanese companies, many of which do not have global support infrastructures. This gives a cost disadvantage. Against that should be set Scotland's two big advantages: people skills and an engineering heritage. Scottish people are "as productive as American or Japanese people and I'm sure NEC, National and Digital Equipment would agree."

Customers want manufacturing close to them to provide flexible production volumes and flexible response. They want local stocks of globally sourced products and they want the local facility to design and build customized products. Partnering with major customers is the key.

Larry Murtagh
Managing Director
NEC Semiconductors Ireland Ltd

Start-up costs of a European wafer fab are slightly higher than in Japan. Although the cost of land, construction costs, and the cost of services are lower, equipment costs are higher. However, these are offset by benefits from having Europe-based wafer fabrication, such as service and flexibility to meet customers' needs, shorter cycle times, improved logistics and communication with local customers, and a defusing of trade friction by eroding trade and technology imbalances. Worldwide engineering and manufacturing is a more logical and equitable answer to these problems than the mechanism of the reference price which has distorted markets.

The European manufacturing environment is good as regards education and training—"The people are as good as you'll get anywhere." Government policy is supportive with investment incentives, capital allowances and preferment for local sourcing. But a negative aspect of policy is the import duty on semiconductor manufacturing equipment. This is particularly a problem because of the absence of major European semiconductor equipment vendors and the consequent need to import much of it from the United States and Japan.

Laurent Bosson
Corporate Vice President, Manufacturing
SGS-Thomson

SGS-Thomson diffuses silicon in France, the United Kingdom, northern Italy, Sicily, Philadelphia, Dallas and Singapore. The US cost trend is flat and costs are under control, but European costs are rising and are difficult to stop. The cost of employing indirect personnel in Singapore is half the European cost and although the cost of direct labor in Singapore has doubled, it is still four times cheaper than in Europe. SGS-Thomson's experience is that the European cost of manufacturing is 18 to 25 percent more than in Singapore, but it needs to manufacture in Europe because the R&D bases are close to hand, the product groups are in Europe and so are the customers. SGS-Thomson's fabs build products for the worldwide market, not local needs, and its European fabs are as efficient as Asian or US fabs except for the cost of labor, cost of money, rates of tax and hours worked. Hours worked vary from 2,100 in Asia, to 1,900 in the United States and to 1,600 in Europe. Hindering European manufacturing are nonflexible social regulations, immobile labor, a lack of graduate engineers, high labor cost, and no reciprocal support for non-European semiconductor manufacturing—that is, no government help in building a fab in Japan.

Discussion Session

Issue of Labor Costs

Hartman: In Ireland the labor cost is lower than in the United States and lower than in New Mexico.

Bennett: Motorola benchmarks the productivity of its plants worldwide and Scottish productivity is world-class.

Murtagh: European labor costs are not the same all over—a German work force costs twice as much as an Irish one.

Bosson: In the United States and the United Kingdom it is possible to have 12-hour shifts. That is not possible in the rest of Europe.

Bennett: Motorola believes 12-hour shifts are not productive.

Issue of Graduate Shortages

Hartman: Intel has found no shortage of graduate engineers. Ireland is graduating enough engineers in the disciplines Intel needs.

Bennett: The claim of a shortage of graduates is very surprising. Motorola has almost a surfeit of graduates and helps that by sponsoring graduates through university. Motorola is also hiring Eastern European graduates.

Issue of Cost of Capital

Bosson: SGS-Thomson can get 18-year loans at 4 to 5 percent in Singapore because of the local connection. In Europe it costs 9 to 12 percent.

Issue of Import Tariff on Semiconductor Equipment

Bennett, Murtagh and Hartman agreed that scrapping this would benefit semiconductor manufacturers in Europe by levelling up the overhead cost of setting up plants in all regions of the world. Bennett pointed out the difficulty of sourcing equipment locally when companies need to have unification of processes across a number of plants worldwide.

Future Trends in LCD Markets and Technologies

Isamu Washizuka
Corporate Director
Sharp Electronics GmbH

LCDs have made possible new products such as portable PCs. They are the display with the highest cost-performance and applications are exploding into areas such as LCD projectors, virtual reality and as "electronic writing paper" in pen-based computing. New products include: 32-bit color notebook PCs with 8.4-inch thin-film transistor (TFT) displays; multimedia panels capable of 260,000 pixels and 16.7 million different colors (compared with the maximum of 512 colors last year); wall-hung TVs using 8.6-inch TFT panels; widescreen HDTV with a 16:9 aspect ratio.

Sharp expects last year's $2.3 billion market for LCDs to rise to $7.8 billion in 1995—a compound annual growth rate (CAGR) of 36 percent—and to $15.6 billion by 2000. Half of today's usage is for PCs and some 17 percent for amusement purposes. The market for LCD peripherals such as backlight, polarizer, glass, ICs, and so on will grow from 1991's $1.47 billion to $5.4 billion in 1995, with ICs accounting for 28.6 percent of that figure. The peripherals have been much improved in areas such as spectral characteristics, chemical and thermal stability of the color filter, reduction of power consumption, thickness and weight of backlight and reductions in the ICs and drive voltages.

Production throughput is improving, test equipment has been improved and the industry is moving from batch processing to single-plate processing. Integrating multiple processes to single-plate production is one problem to be solved. Yield on the manufacturing of the 10-inch panels themselves is now in the 80 percent region, and the yield of 10-inch panels as finished modules is in the 50 percent region.

Achieving Critical Mass Through Industrial Cooperation

Marcel Hugen
DG XIII, European Commission

One of the weaknesses of European industry is that the R&D spend lags behind that of Japan and the United States. In Europe it repesents 2.1 percent of GNP, in the United States 2.8 percent, and in Japan 3.5 percent. Moreover, the growth rates in the R&D spend are 4.6 percent in Japan, 4.4 percent in the United States and 4.1 percent in Europe. In semiconductor R&D in 1991 Japan spent $6.6 billion, the United States spent $3.4 billion and Europe spent $1.2 billion. Europe produces 10 percent of the world output of semiconductors and uses 19 percent, whereas Japan produces 37 percent and uses 48 percent—"The EC can't afford to lose further ground to foreign companies."

Some European companies are responding well: Siemens and IBM are approaching high-volume production of 16M DRAMs; and SGS-Thomson and Philips are cooperating on R&D. Investment in DRAM over the lifetime of a product is $2 billion for 4M, $4 billion for 16M and $7 billion for 64M—"These investments cannot be carried by any one company." But such investments have big effects on other companies, giving them early access to the latest technologies.

Due to shorter product life-cycles it is essential to be the first to exploit innovation. The EC has decided to increase resources for precompetitive R&D on semiconductors from 2.6 percent of the EC R&D budget to 3.8 percent in 1992 and it will be necessary to increase it to 5 percent meaning $2.4 billion will be spent in 1992 and $4.2 billion in 1997. The EC has selected four priority areas for research: semiconductors, LCDs, software, and high-performance computing. It will focus R&D spending on commercial targets.

Horizontal Integration in Europe
Guy Dumas
Matra-MHS Honorary President
Representative of the Telefunken Electronic Group for European Affairs

Europe has been losing ground in the electronics business for two decades. Although semiconductors are the key to the industry, European companies now have only 10 percent of the world market. The costs of staying in the semiconductor race are so high proportionate to the sales of European semiconductor companies that they have to cooperate or disappear. Cooperation should be both on the horizontal model, for example precompetitive R&D collaboration, and on the vertical model, such as Japan's vertically integrated electronics industry.

Europe's JESSI program has devised a model for precompetitive R&D which organizes clusters of related projects with each member project of the cluster aimed at supporting a flagship project, that is 0.5 µm CMOS manufacturing. An industrial example of both horizontal and vertical integration is the amalgamation of the semiconductor interests of Deutsche Aerospace, Daimler-Benz and AEG Telefunken, which links six semiconductor companies: Siliconix, Telefunken, Dialog, AEG EZIS, Matra-MHS and Eurosil. The working name for the amalgamated group is MEG (Mikroelektronik GmbH) but this is not the final name. It will be legally incorporated later this year and its initial revenue will be some $1 billion. It will be a "fourth force" in European semiconductors.

Riding the Second Wave in Europe
Hans Geyer
Director and General Manager
Intel, Europe

Europe is becoming the world's largest PC market. Already it is the highest by value because European prices are higher than in the United States. In unit terms it is currently 10 percent less than the United States but in 1993—or by the latest 1994—the European PC market will be larger than the US market in unit terms, led by Germany and the United Kingdom. There is a shift from the 386 to the 486 and by the second quarter of 1992 Intel will be shipping 80 percent 486s and 20 percent 386s. The reason for upgrading is the software driving the market that requires new microprocessors to make the software run faster. Next-generation microprocessors from Intel, the P5, will be in the 100-Mips league.

With European sourcing from Intel's Irish fab, European PC makers who buy in populated boards from the Far East on which they pay a 4.8 percent tariff will be better off putting in the CPU in Europe, which will save paying the tariff on the CPU, amounting to $15 on a $300 CPU. Intel's Irish fab is the biggest building in Ireland, the largest commercial investment ever made in Ireland and the largest fab ever built by Intel.

How to Safeguard Europe's Technological Future
Heinz Hagmeister
Chairman and CEO
Philips Semiconductors International BV

Europe's high-technology future is endangered. By 2000, electronics will be Europe's largest industry representing 8 percent of the total industrial activity in Europe. Electronics is the cornerstone of an industrial society guaranteeing Europe's political and economic sovereignty, but Europe has a large and growing deficit in electronics trade, some $34 billion in 1989, and expected to rise to $51 billion in 1995. That is Europe's problem. In the product challenges of the '90s—high-performance TV, telecommunications, multimedia computing and automotive—semiconductors will be the driving force. But wafer fab costs are rising from $400 million for 0.8 µm manufacturing, to $600 million for 0.5 µm to $900 million for 0.35 µm.

One need is for horizontal cooperation, not mergers, but the joining of forces like that between Philips and SGS-Thomson in process development. Another need is for independence in one or two of the big clusters in semiconductor manufacturing equipment, or Europe will become dependent. Actions on the electronics industry level should be: creation of standards; the creation of European centers of competence; developing user-friendliness and software competence; and the formation of vertical risk-sharing partnerships. At government level there should be faster reactions to industry needs; technology-push program such as R&D; market-pull program such as the French Minitel; and other infrastructure programs such as a worldwide personal communications system where government drive is needed to create markets. Other areas for government action should be skills training and education, and the maintenance of free, fair trade through antidumping policies to promote sustainable coexistence with Japan.

By Jim Eastlake

In Future Issues

Along with our regular features, "European Pricing Update" and "State of Industry," the next issue of *Dataquest Perspective* will report on:

- 1991 market share
- Five-year forecast

For More Information . . .

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Dataquest Perspective

Semiconductors *Europe*
Conference Special, Part 2

SCEU-SVC-DP-9207 June 26, 1992

In This Issue...

End-User Analysis

End-User Strategic Trends

This *Dataquest Perspective* is the second part of two special reports on Dataquest's eleventh annual semiconductor conference held on June 3 to 5 at the Jurys Hotel, Dublin, Ireland.

This speech is the first of three remaining Dataquest speeches which are reported in this issue. It was given by Bipin Parmar, Group Director of European Semiconductors at Dataquest, and Conference Chairman. In his speech he discusses every aspect of end-user trends within the semiconductor industry and gives an insight into which strategies players should adopt to produce future success.

By Bipin Parmar *Page 1*

Market Analysis

Personal Communications

The next speech was given by Dean Eyers, an Industry Analyst from Dataquest's European Telecommunications Group, specializing in personal communications. He discussed this subject in relation to semiconductor applications covering: implementation, pricing, standards and market trends.

By Dean Eyers *Page 14*

Videophones

Dataquest's final speech was given by Jeffrey Goldberg, Industry Analyst for the European Document Management Group, specializing in facsimile and software related to document management technology. In his speech he looked at videotelephony covering: implementation, demand, standards, key players and Dataquest's own view of the technology.

By Jeffrey Goldberg *Page 26*

These three speeches have been reproduced here accompanied by a close representation of their slide shows for the benefit of those clients who could not attend the conference.

End-User Analysis

End-User Strategic Trends

Bipin Parmar

In this speech I plan to walk you through some of the issues that are affecting your customers and how that will affect you.

Slide 1—End-User Strategic Trends

My agenda is to address trends in technology, standards, and the impact of confused marketing channels. At previous conferences we have emphasized the importance of understanding not only the end users of semiconductors, but also their customers in order to position for the future.

The electronics industry increasingly represents a very large part of many economies. In the United States it employs more people than the automotive and steel industries together. Yet the electronics industry has a long way to go before it matures fully. There are, however, segments within our total industry which are maturing faster than others.

It will be very difficult to present issues and trends covering the entire electronics industry in such a short speech; therefore, I want to focus on the segment which today represents the largest market for semiconductors.

Slide 2—Worldwide Semiconductor Consumption

The EDP or computer sector is the largest consumer of semiconductors worldwide. This industry is going through a very turbulent period. Issues facing this sector are similar to the ones that the semiconductor industry is quite used to, such as diminishing product life cycles, near commodity market conditions with severe open competition. The huge improvements in price/performance in microprocessor and memory technology is forcing some of the players in this industry into a fight for survival. Let me expand on this further.

Slide 3—Worldwide Computer Systems

This chart shows that starting in 1987, mainframe, midrange and PC factory revenues were on a par at roughly $22 billion. The availability of reasonably low-cost semiconductor technology has revolutionized the PC industry. The PC industry is now roughly twice as big as the mainframe or the midrange industry. Notice how the mainframe revenue rose steadily until 1990 and then suddenly started to nose-dive in 1991. Please also note how the midrange market remains almost flat, even with the launch of new platforms like the AS/400. There is another rising star which we will have to start giving serious attention to. I am, of course, referring to revenue from workstations.

We forecast that by 1996 workstation revenues will be higher than either the mainframe or the midrange. So what does this all mean? When you have such a big transformation taking place, I believe the winners in this market will be different from those of today. In other words, your customer base is going to be transformed in the coming decade. So who are these top customers today?

Dataquest's estimate of the top 10 semiconductor users in Europe is as follows:

1. IBM
2. Siemens
3. Philips
4. Bosch
5. Alcatel
6. Olivetti
7. Grundig
8. Nokia
9. Matsushita
10. Ericsson

Clients of Dataquest's application services should refer to their binders for the top 50 accounts in Europe where actual dollar estimates are also provided. We routinely survey these companies in order to assess their inventories and buying patterns. As I said earlier, we use this information as an input to our forecasting model.

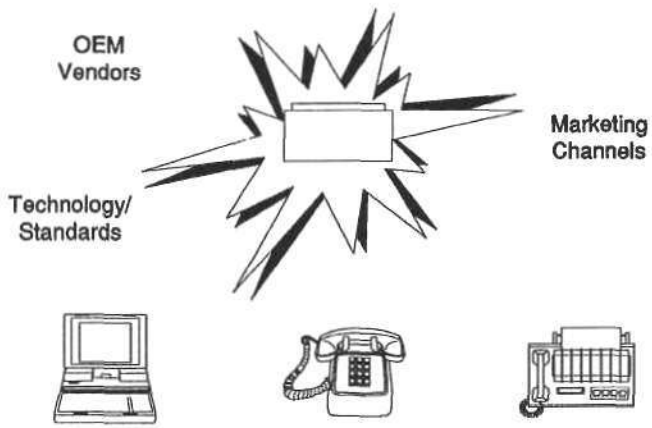
I now want to assert that this list will look totally different in five years' time, which means you will have to be careful that you not only back the right companies, but also continuously reassess your strategic partnering and major accounts programs. Of course, Dataquest will be carrying out more in-depth studies on this subject in the future.

In the time available today, I want to examine the fortune of the top player in this sector, namely IBM. As many of you are already aware of its problems, let me focus on the reasons behind some of them.

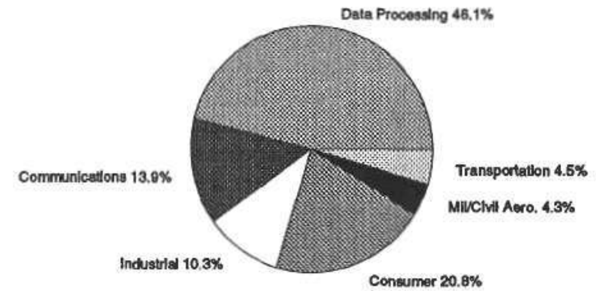
Slide 4—IBM Market Share of Computer Systems

The biggest problem for IBM is to maintain its market share in total computer systems. I expect that it will have to pull out of a few more sectors of the market and outsource more manufacturing. For example, it has pulled out of the printer and PBX business. It is quite ironic when you consider that it was IBM which revolutionized the computer industry by launching the IBM personal computer. This, as we all know, was cloned by the whole industry. As a matter of fact we now know that IBM originally intended the PCs to be used by private users at home; it did not envisage the PCs having a massive uptake in the business community at the expense of mainframe revenue. What we see here is the inability of large organizations to compete with themselves. While the whole world was eating their lunch, the corporation was heavily focused on its proprietary mainframes, which were increasingly becoming outdated. Popular democracy at end-user level meant that all white-collar workers had access to low-cost distributed computing on their desks. So declining market share also has its impact on the bottom line.

END-USER
STRATEGIC TRENDS

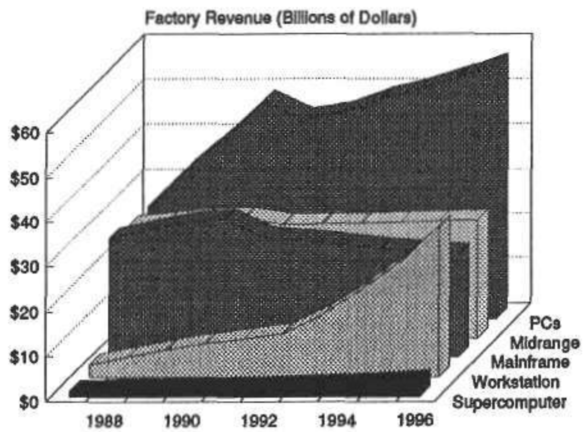


WORLDWIDE SEMICONDUCTOR CONSUMPTION
BY APPLICATION SEGMENT



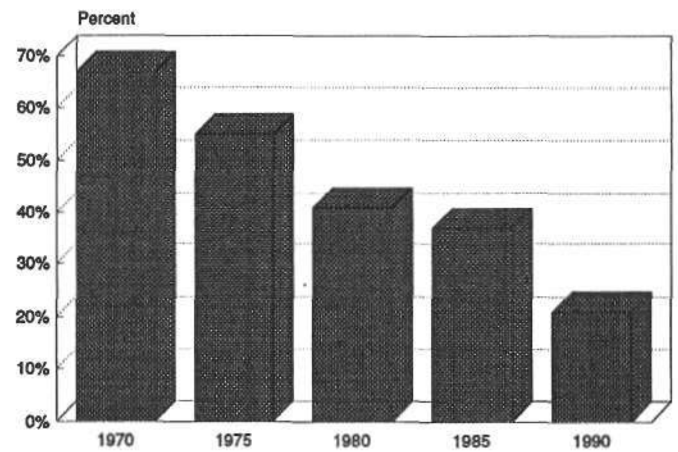
Source: Dataquest (June 1992 Estimates)

WORLDWIDE COMPUTER SYSTEMS
PRODUCT SEGMENTATION



Source: Dataquest (June 1992 Estimates)

IBM MARKET SHARE OF COMPUTER SYSTEMS
WORLDWIDE



Source: Dataquest (June 1992 Estimates)

Slide 5—IBM Net Earnings

As a matter of fact, we think that the IBM PC division is a major contributor to these problems in the company, and by now you should have heard of how IBM is going to market its own clones with a new company called ICPI Ltd. By the way, nobody knows what ICPI stands for, but I believe it should be called IBM Clone Peddlers International.

Well the picture is very clear here for IBM. From 1986 to the end of this year, IBM will have reduced its worldwide work force by more than 80,000 employees, and eliminated 94,000 staff positions and 11,000 management functions. The company now claims that it is transforming itself into better focused, independent units. Each unit will have a faster pace and will be in charge of its own destiny. For example, the personal systems business has been segregated into more than a dozen businesses, and some will compete against each other. IBM has also created an OEM division which will sell components in the merchant market. So watch out. Your biggest customer might also be a potential competitor or a source of cheap technology transfers. Some claim that the problems are IBM's own making, but I want to show you that these problems are inherent in the whole computer industry.

Slide 6—1991 Selected Companies' Profit Margins

Companies in similar businesses are also going through such pains. If the computer industry was as good at inventing profits as it is at inventing jargon like open systems, ACE and UNIX International, the whole industry would be in better shape. In contrast, companies involved in telecommunications are returning respectable margins except when they don't stick to their core business. Nokia's ill fortunes are due to its defunct PC division (which has been sold now) and its consumer business. I have selected an unusual company in this list. Remember those "boom and bust" video games industries in the early 1980s? Well, Nintendo declared a profit of over $660 million, even bigger than Philips. Video games use similar components as the PC but not the most powerful processors and latest memories.

Part of the profit problem is related to the overall manufacturing costs, and it is claimed that the current 14 percent tariff on semiconductor imports does not help. Well as you heard earlier, memory prices are quite cheap in Europe and most of Intel's processors don't carry any duties. As a matter of fact, quite a large number of PC manufacturers import motherboards without the processor or the memory, which in turn affects the semiconductor market in Europe. So who are these top PC manufacturers in Europe?

Slide 7—Top PC Manufacturers

We have produced a special report* which lists both the screwdriver plants and the partial screwdriver plants. There is no such thing as a true manufacturer nowadays, as these companies use a combination of all three. The report gives our estimates of the quantity produced by different types of processor platform as well as detailed semiconductor content analysis of the popular PCs. Many of our clients are using this report as an independent measure of their penetration into these accounts and also for addressing new sets of customers. It is also used for hedging their position in case some of these producers do not fare well in their own marketplace. So how are some of these producers faring in the different markets across Europe?

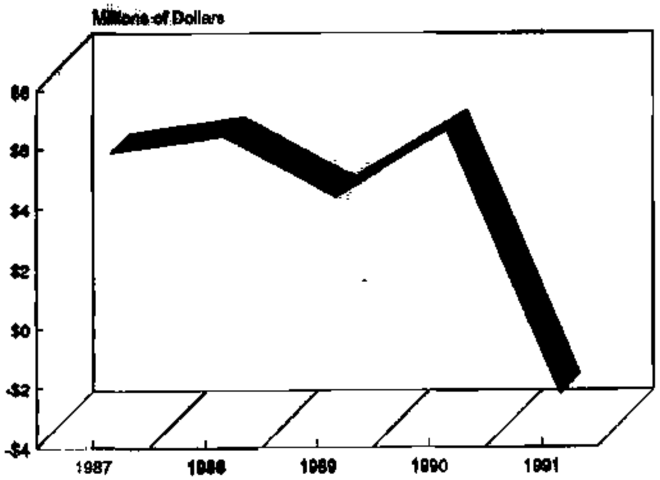
Slide 8—Unit PC Market Share

As you can see, with the exception of France, IBM is no longer a top player in Europe. And notice Commodore, the ex-video games company taking the top spot in the United Kingdom and Germany. Also note Atari, coming up in the list. For a while, a very unusual company called Vobis had the number-one spot in the German market. So this is further proof that the traditional leaders in the industry are being replaced by younger, more innovative firms, which are borrowing their lessons from the mature consumer industry.

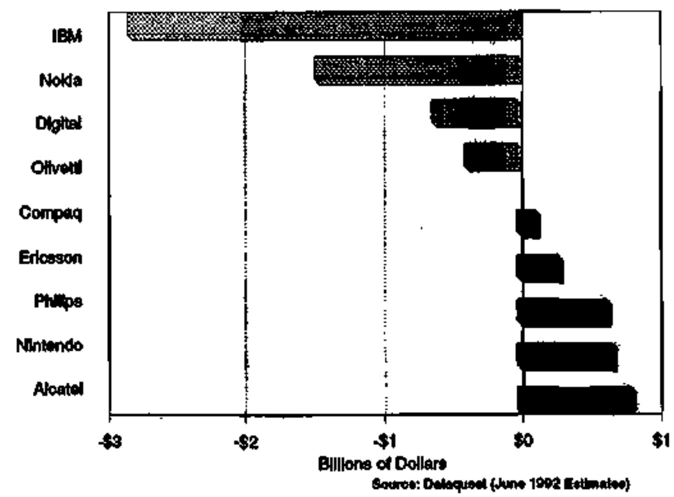
We don't expect this ranking to remain static either, as the battle for winning the most appropriate marketing channels will determine the winners and losers.

* Note: *European PC Manufacturing and Semiconductor Demand* available from Dataquest's marketing department.

IBM NET EARNINGS



1991 SELECTED COMPANIES PROFIT MARGINS



TOP SEMICONDUCTOR USERS IN EUROPE

1. IBM
2. Siemens
3. Philips
4. Bosch
5. Alcatel
6. Olivetti
7. Grundig
8. Nokia
9. Matsushita
10. Ericsson

Top 50 are available in your ESAM binders

UNIT PC MARKET SHARE BY MAIN MARKETS

United Kingdom

1. Commodore
2. IBM
3. Compaq
4. Atari
5. Apple

GERMANY

1. Commodore
2. Vobis
3. IBM
4. Atari
5. Siemens Nixdorf

FRANCE

1. IBM
2. Apple
3. Compaq
4. Commodore
5. Atari

ITALY

1. Olivetti
2. IBM
3. Commodore
4. Apple
5. Zenith Data Systems

Slide 9—Channels

This shows the various channels used today to supply PCs to end users. Yes, it looks more complex than the latest RISC processors.

I don't intend to describe each of the channels and overlaps that exist. The message here is that it is a jungle out there. One of the reasons that PC vendors have thin margins is that they are supporting so many marketing channels, which are squeezing their margins, or in some cases, as I will show you, stealing their lunch.

So what, you might say! Well, understanding and capitalizing on this confusion could lead *you*, the semiconductor vendor, into some very profitable and exciting new business. With the exception of some value-added resellers, the rest don't provide much value to the ultimate end users. Remember the 1990s will be the decade of 3Cs which is cooperation, competition and coexisting with your own customers. So semiconductor vendors should outsmart their traditional OEMs. Let me show you one example of this.

Slide 10—1Mx9 SIMM (Memory Module)

Those of you who have purchased memory modules for your PCs would have been astounded by how much you have to pay for 1Mx9 SIMM module. It is almost criminal. Today it varies between $230 to $350 depending on where you purchase it from. But when you check the *DQ Monday* prices that a PC OEM pays to the semiconductor vendor, roughly $30, you see there are a lot of parasites in the market, which rightly do not deserve to exist. The semiconductor industry is sometimes its own worst enemy by being very loyal to its traditional OEMs. So if you want to bypass some of these channels, and sell directly to value-added resellers, would you know where to find these people? Well don't panic.

Slide 11—New Customers

Dataquest has produced a special report* on the top 500 resellers in Europe. Sorry, I am not trying to be a salesman here, but it is our duty to provide you with the right information in order for you to be in a competitive and profitable business.

We believe there are roughly 30 to 40 million end users in Europe and they are getting tired of having to replace their whole PCs just to get extra performance. They would instead prefer to buy simple add-ons which stretch the life cycle of their initial investment.

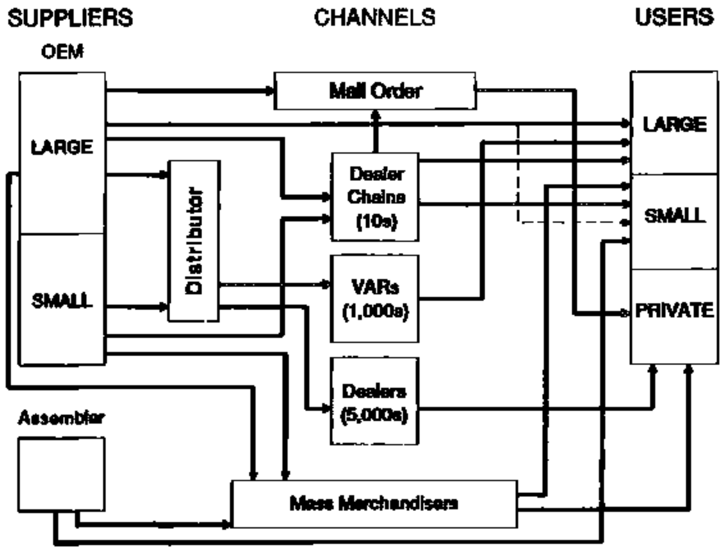
Some PC vendors are already supplying models which could easily be upgraded. The new PC card standard and the popularity of flash memory will further enhance this process. So I believe that the semiconductor vendors will see a whole set of new customer who will help end users to enhance their products with add-on graphics, modems, fax and networking facilities. One word of caution, though; this business could easily become similar to the video games cartridge business, with whole operating systems and application packages made available from your local retail store at knockdown prices.

I would now like to turn to some technology, price/performance and standard issues which I believe will also have a major impact on the PC industry.

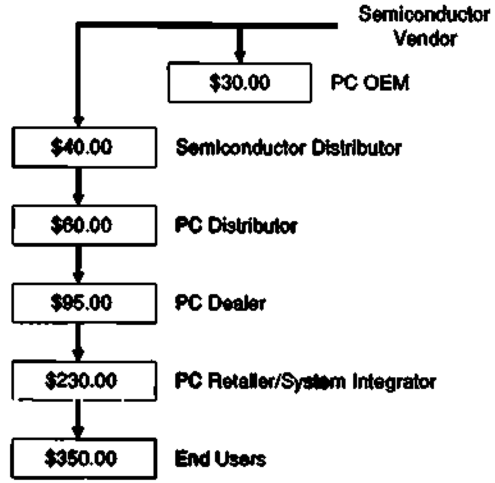
Slide 12—Downsizing

I don't know how many of you actually use notebook PCs. They are the hottest item on the market currently. Well, I have a notebook PC and I use it when I am away from my office for mundane tasks like word processing and simple spreadsheets. After a while, my eyes get very tired as the screen is too small, not to mention the keyboard. So to summarize, I use it for entering data. I don't really use the 386 processing power which is made available to me. So I believe the notebook is all right for those 30 million Europeans who are used to desktop PCs, but you see there are 70 million other potential customers out there who do not use PCs at all today. The industry will have to find these new customers, and I believe we in the semiconductor industry will have to play a large part in this. Let me explain my thinking.

* Note: *Top 500 European Microcomputer Resellers* available through Dataquest's marketing department.



1Mbx9 SIMM (MEMORY MODULE)



THE BIRTH OF A NEW SET OF CUSTOMERS

UK

1. Computercenter
2. Dixons
3. Centre File
4. Specialist Computers
5. Businessland UK

GERMANY

1. Component Computer Gruppe
2. Computerland Deutschland
3. Taylorix
4. House of Computers
5. Metro

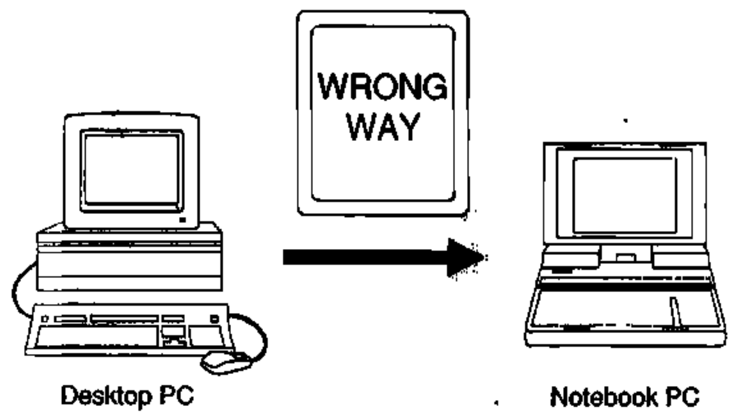
FRANCE

1. Agena
2. ISTA
3. Random
4. Asystel Conseil et Service
5. ECS Diffusion

ITALY

1. Metos
2. Asystel Sirio
3. TC Sistema
4. Winline
5. Systex Informatica

DOWNSIZING



Slide 13—Emulation of Function

If you look at the functions that most people carry out, especially managers of businesses, projects and departments, diaries and time organizers play an important role in the lives of business people. Also, the majority of us are quicker at writing than typing. So we believe the advantages of palmtop PCs and pen-based PCs will give another jump start to the whole industry. The 70 million potential users need low-cost solutions. Although the PC cards seem to be very expensive today, it will provide a lower cost of entry and ownership of information. Let me explain why.

Slide 14—The Cost of Using Information

Although the good old floppy seems to be very cheap, it requires a notebook with a disk drive, which makes notebooks heavier, power-hungry and hence expensive. On the other hand, a palmtop with PC card provides a lower cost of ownership, as you can see from the slide. A palmtop does not need expensive high-speed processors and memories either. The basic function that people want is storing and retrieving daily information like telephone numbers and business records.

Slide 15—PC Cards

The only way the industry can move forward is if semiconductor vendors start shipping volume PC cards via alternative channels directly to the end users, otherwise the various channels' margins will make these solutions not viable.

In other words, the semiconductor industry will have to learn a whole new set of tricks, like brand awareness and recognition, mass merchandising and maybe even advertising on TV. So you might want to start recruiting people from the consumer industry, which also has its own set of problems, some of which I will discuss later.

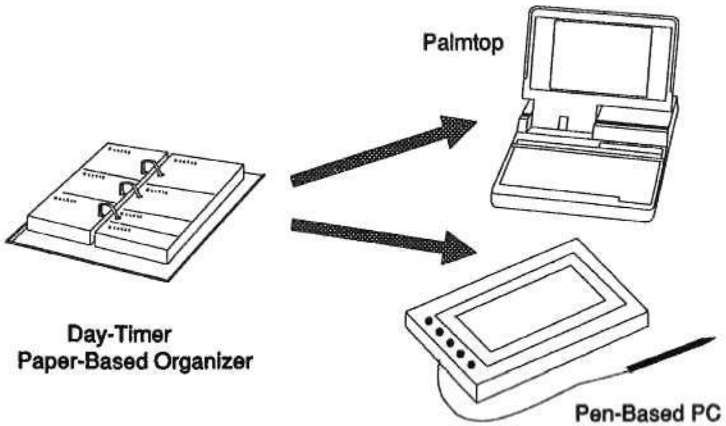
The PC card and its sister smart cards will also transform the way in which telecommunications companies address the explosion of wireless and digital communications.

Slide 16—Going Wireless

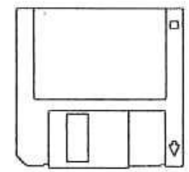
The advance in voice and picture compression technology will increasingly blur the picture between computer and telecoms products. Already computer companies are taking a distinct interest in the consumer electronics business. The reason for this is that towards the end of this decade, the consumerization of the telecoms industry will be even more severe than in the PC industry. It will make the PC industry look like a picnic. Once the standards for digital communications have been set, you cannot enhance it with higher-performance chips, like in the PC industry. The only way is to keep reducing costs. But don't worry, we in the semiconductor industry are quite used to that. I am not sure whether the telecoms vendors know what cost really is.

We expect that like suppliers of PC chip sets today, there will be a host of chip set vendors for GSM, videophone and personal fax. The PC OEMs are looking at embedding these functions with the advent of the single-chip PC in order to provide differentiation to their products. So if the PC vendors start taking the lunch away from the telecoms vendors, what will the telecoms vendors do? There are two distinct directions they can go in: one is to get into the service business; the other is to make an alliance with consumer electronics.

EMULATION OF FUNCTION



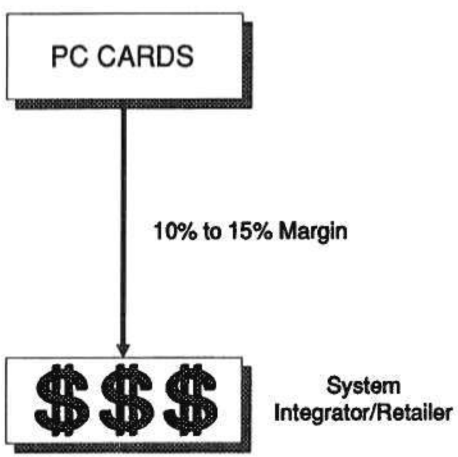
THE COST OF USING INFORMATION



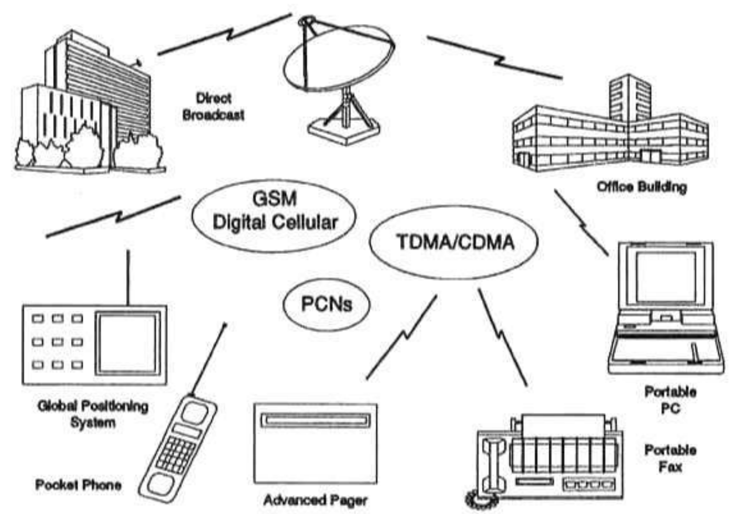
	Cost		Cost
Floppy:	$1	Memory Card:	$300
Notebook:	$3,000	Palmtop:	$600
Total	$3,001	Total	$900

The Floppy Is More Expensive!

PC CARDS



GOING WIRELESS (AND DIGITAL)



Slide 17—Consumer Electronics

So, if both the computer and telecoms industries are forced to move towards the consumers electronics scene, what is currently happening to the dominant players in the market, namely the Japanese companies?

Slide 18—1990 to 1991 Consumer Profit Declines

The recession in the major economies of the world is having an impact on the leading consumer electronics companies, as in the computer industry. Profit margins in consumer electronics have dropped considerably since last year, as this chart shows. Sony declared a net loss this year in its consumer division and, in combination with this reduced profit, its source of virtually interest-free capital is drying up. Japanese companies used to access cheap capital issuing bonds and securities. The major customers of these bonds and securities were the Japanese banks, which became very rich (on paper at least).

Slide 19—Top Five Banks

As you see, the top four banks in the world are now Japanese. Having said that, the squeeze for better returns on this investment is coming very rapidly, as they have to increase their capital ratio in line with the world standard from the Bank of International Settlements. The Japanese need to do this in order to continue operating in the global markets. Also, the valuation of the securities were mostly based on property assets. When the property price balloon burst, most companies' total assets had to be revalued.

The situation is further exacerbated by the high losses these banks have declared on their paper securities, some of it due to "bad loans" to property companies. Now Japanese companies face $9,635 million in losses (Table 1).

So what does this mean? Will the Japanese companies slow down a little? Let us not delude ourselves. Japan's corporation squeeze for better profits will make the Japanese more aggressive in the marketplace with value-added products like videophones and personal faxes. The playing field will be more levelled, so there are tremendous opportunities for the European telecoms vendors to strike alliances with the Japanese.

Table 1
Bank Losses on Securities

Bank	Loss ($M)
Sanawa Bank	$1,077
Industrial Bank of Japan	$732
Fuji Bank	$716
Sumitomo Bank	$655
Tokai Bank	$629
Sakura Bank	$586
Diawa Bank	$540
Dai-Ichi	$535

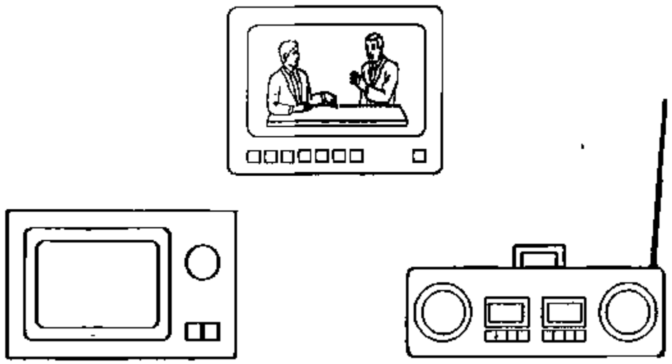
Source: Financial Times

We believe that these companies will reduce the number of products that they design and modify continuously, in order to get more efficiency out of their scarce R&D centers. In the past it was not unusual for a Japanese company to develop 10 new competing TV models in parallel to see which will best suit the market. We also believe that the higher interest rates and squeeze on profits will slow down the massive foreign investments abroad. So the Japanese will be looking for local partners, and telecoms vendors in Europe are reasonably cash rich. It will be some time before you see another Japanese fab in Europe.

Some Japanese companies which have diversified will return to their core business where they can muster better returns on their scarce capital. For example, Toshiba is closing down its audio division and merging it with its video divisions. You might also, for the first time, see consolidation in the three major plug-compatible computer companies—NEC, Fujitsu and Hitachi—where one of them might give up. Already there is a degree of inter-cooperation taking place. So what about the European companies' positions?

I was recently talking to some Japanese stock analysts who were visiting German banks. When I asked them which bank, they said Siemens and Diamler-Benz.

CONSUMER ELECTRONICS



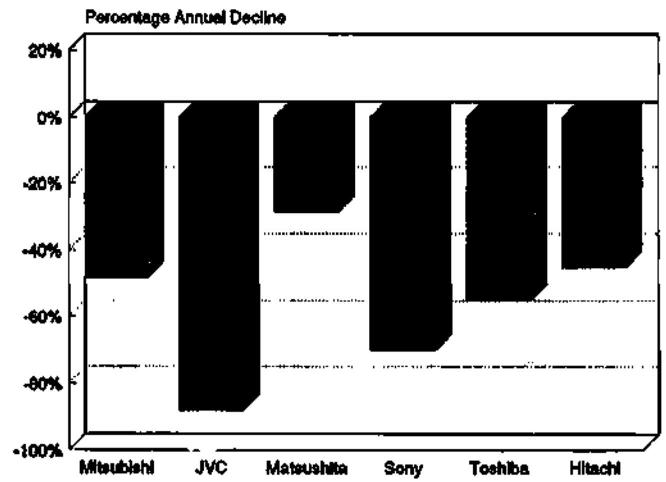
TOP 5 BANKS

(by Capital)

1980	1990
1. Crédit Agricole (France)	1. Sumitomo (Japan)
2. National Westminster (UK)	2. Dai-Ichi Kangyo (Japan)
3. Barclays (UK)	3. Fuji (Japan)
4. Bank America (US)	4. Sanawa (Japan)
5. Citicorp (US)	5. Union Bank of Switzerland (Switz.)

Source: The Banker

1990-1991 CONSUMER PROFIT DECLINES



Source: Yomiuri-Shimbun

Slide 20—European Ziabatsus

Although Siemens and Diamler-Benz do not participate in retail banking, their assets portfolio is almost similar to a normal bank with increasing investments in turnkey projects involving construction, maintenance and services contacts. With all the recent acquisitions that these companies have done recently, we are seeing the birth of the European "ziabatsus."

For those of you who have been sceptical about the health of European-owned companies, please think again. These companies have strong balance sheets and liquidity to gobble up many computer or telecoms companies around the world. So, let me conclude my presentation by summarizing the strategies that major OEMs in the computer and telecoms industries might follow.

Slide 21—Strategies for OEMs

Possible strategies for OEMs include:

- Outsource manufacturing
- Concentrate on channels/mail order/mass merchandisers
- Provide application-specific PCs, PBX, telephones
- Retrench to core activities
- Software and professional services

As I showed you, the 1990s will be the decade for the battle of marketing channels. OEMs will increasingly outsource more and more activities to subcontractors. They will do this in order to concentrate their firepower into winning marketing channels and mastering their core activities. They will be looking to survive by providing application-specific products to suit different vertical markets. They will increase their investments in software and professional services. The service business is very profitable and it is difficult for services to become a commodity item as they involve manpower at point of delivery. There are some lessons to be learned from this trend for the semiconductor industry.

Semiconductor Vendors' Strategies

Strategies for semiconductor vendors can be summed up as:

- Continuously monitor customers' strategic directions
- High growth areas may not return the best margins
- Create new organizations to address/develop new customers
- Subcontract for customer product development
- Enter the service business: training, consultancy, standards setting

Those vendors who fail to grasp the strategic trends of their major customers will be left empty-handed. The increasing consumerization of the PCs and wireless products will result in high growth but very low margins as the industry repeats the lessons learned in the PC chip set business.

Opportunities exist for semiconductor vendors to develop a whole new set of customers by delivering shrink-wrapped solutions to end-user needs via alternative channels, even if this means competing with your own customer. The customer, by the way, will increasingly compete with its suppliers in any case. As major OEMs look to outsource more activities and more and more intellectual value is added on the chip sets, be prepared to offer your valuable R&D resources to your customer.

Those of you who have attended any standards committees such as FDDI, MPEG, JPEG or GSM will see that there are more semiconductor companies represented than OEMs, so strategic partnering with OEMs can allow these costs to be shared. As the complexity and size of semiconductor devices grow, new opportunities will be created for semiconductor vendors to offer their OEM customers consultancy and training services, which could return higher margins.

By Bipin Parmar

THE BIRTH OF EUROPEAN ZIABATSU/KEIRETSU

(Banks/Industrial/Electronics/Construction/Services)

Daimler-Benz

Siemens

Alcatel

Thomson

Bosch

Philips

France Telecom

POSSIBLE STRATEGIES FOR OEMs

- Outsource manufacturing
- Concentrate on channels/mail order/mass merchandisers
- Application-specific PCs, PBX, telephones
- Retrench to core activities
- Software and professional services

Market Analysis

Personal Communications

Dean Eyers

Personal communications is expected to represent one of the greatest opportunities for the semiconductor industry over the next few years. I will cover four main topics. During my presentation I will show that, while technology plays a key role in determining the future of this market, there are a number of other factors over which manufacturers have less control. Firstly, I will talk about analog cellular in Europe; and secondly, digital cellular or GSM, which is the next big opportunity in this field. This leads on to an assessment of the GSM-derived DCS 1800 standard, the proposed technology for PCN. Finally, I will discuss our view of digital cordless telephony—CT2 and DECT.

Slide 1—Analog Cellular Systems, Implementation by Country

The market is fragmented with several different standards in operation and launch dates ranging from late 1981 to early 1990. The most successful standards are NMT-450, NMT-900 and TACS-900. This patchwork of systems represents not one market for analog cellular but several. While creating certain problems for marketeers, this also provides an opportunity to analyse the factors in the development of cellular markets through comparison of growth patterns against varying national conditions and offerings.

Slide 2—Penetration by Major Country by Year

This chart shows cellular penetration per thousand inhabitants after a given number of years in operation. As you can see, rates of adoption have varied considerably in these countries.

Slide 3—Key Factors in Cellular Markets

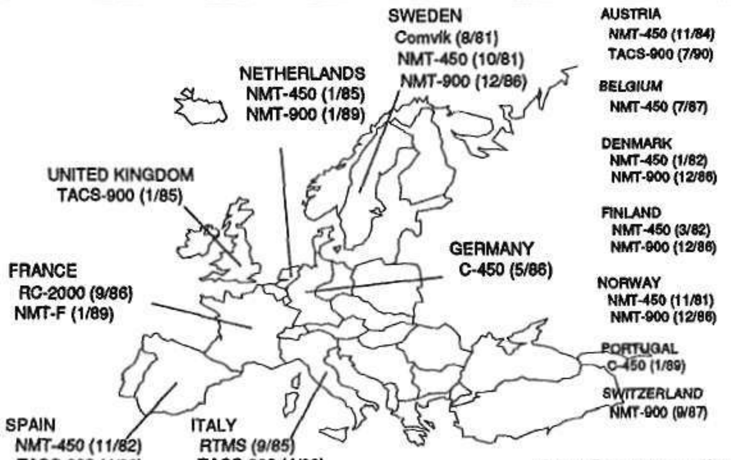
What factors have created such variance? It will be no surprise to learn that cost and perceived benefits determine the rate of uptake of individual cellular offerings. Cost, in this case, is a combination of equipment price and ongoing cost of use.

Factors influencing benefits include the geographical coverage of a service: capacity, the number of users which can be supported in a given area; features and quality of service; and availability of certain equipment types and their features, for example hand portables and innate potential as defined by a country's demographic profile and current economic conditions.

Slides 4, 5 and 6—European Cellular Subscription Fees, Call Charges and End-User Prices

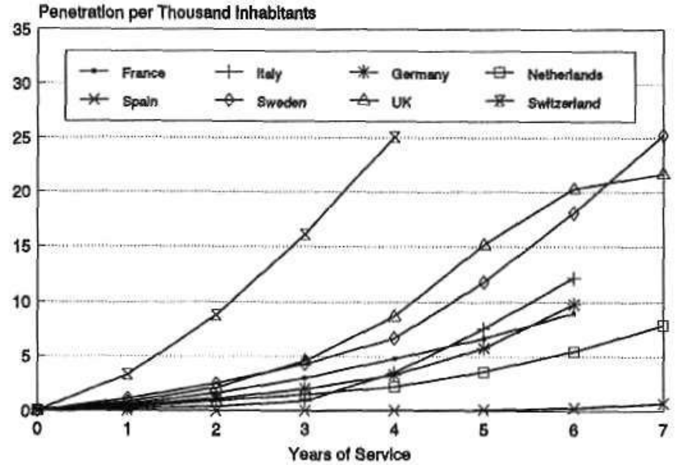
These three additional charts show how the three main elements of the cellular package prices vary across Europe. As you will see, individual operators have taken differing approaches to marketing their services.

ANALOG CELLULAR SYSTEMS
IMPLEMENTATION BY COUNTRY



Source: Dataquest (June 1992)

PENETRATION BY MAJOR COUNTRY BY YEAR

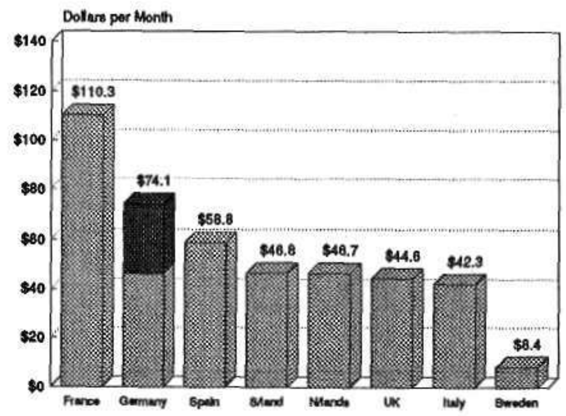


Source: Dataquest (June 1992 Estimates)

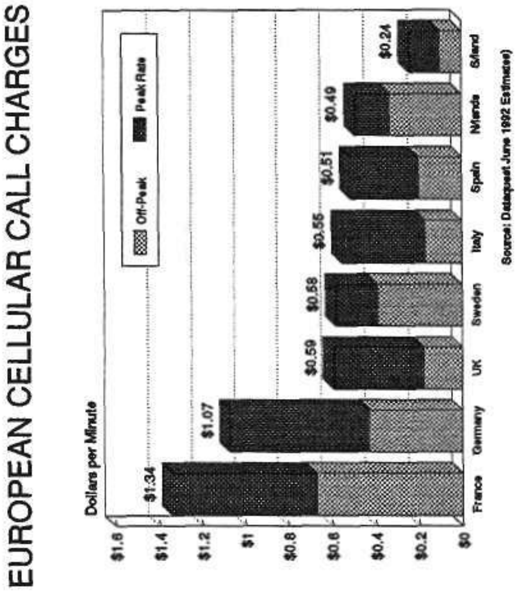
KEY FACTORS IN CELLULAR MARKETS

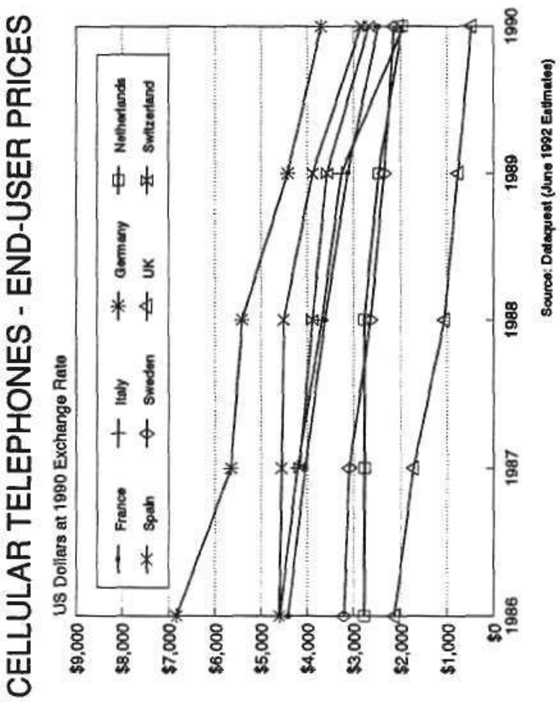
- Pricing
  - Equipment
  - Tariffs
- Coverage
- Capacity
- Service/quality
- Equipment features/availability
- Demographics/economics

EUROPEAN CELLULAR SUBSCRIPTION FEES



Source: Dataquest (June 1992 Estimates)





Slide 7—Analog Cellular Market Trends

Looking briefly at market trends, 90 percent of cellular subscriptions are still supported by the user's business. Slowdown created by the recession in many markets has been offset partly by growth on second analog networks in others. Capacity is still available on many systems and recently, Scandinavian operators have introduced new tariff packages aimed at attracting individual rather than business users.

Within terminal markets the trend towards hand portables continues to gain momentum, having become the largest sector in a number of countries. The major players in analog cellular are generally those whose distribution channels and product portfolios cover the whole of Europe. Many of the small cellular specialists, set up in the early 1980s, have been acquired by larger companies eager to strengthen their technology base and product portfolios. On the other hand, a number of new entrants have emerged in the last couple of years, mainly from the Far East.

Slide 8—European Analog Cellular Shipments

Just to illustrate a couple of these points, this chart shows our historical and forecast analysis of the split between larger units and hand portables in the analog cellular market. From a very low base, hand portables had reached nearly 46 percent of the market during 1991 and are forecast to grow to over 69 percent of the market in 1995.

Slide 9—European Cellular Telephone Market

Of the top five players, only NEC does not cover the major technologies and territories. Rather, it has focused on the largest single market, TACS equipment. However, NEC has this year re-entered the NMT-900 market, starting in Sweden. Note in this slide the relatively small shares of European telecoms giants, Alcatel and Siemens; and also the absence of certain Japanese suppliers active in the US market, particularly Uniden, Toshiba and Fujitsu.

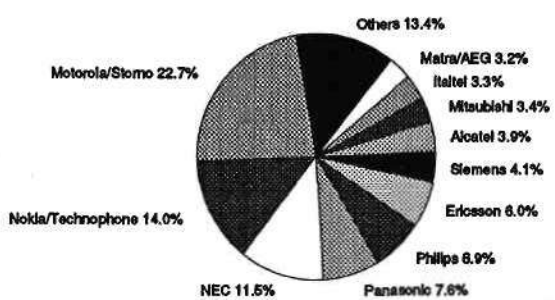
Slide 10—Analog Cellular Limitations

Limitations on the development of analog cellular relate to the previously discussed factors and are closely interlinked. The limited amount of

ANALOG CELLULAR MARKET TRENDS

- Still predominantly business market
- Recession leading to slowdown
- Interim analog networks supporting growth
- Capacity available on many systems
- New tariff packages in Nordic countries
- Strongest growth in hand-portable sector
- Major players cover Europe
- Some new entrants

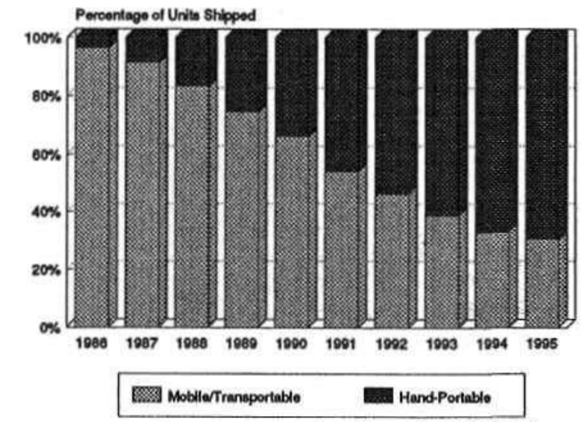
EUROPEAN CELLULAR TELEPHONE MARKET



Total 1990 Shipments
1.26 Million Units

Source: Dataquest (June 1992 Estimates)

EUROPEAN ANALOG CELLULAR SHIPMENTS



Source: Dataquest (June 1992 Estimates)

ANALOG CELLULAR LIMITATIONS

- Spectrum availability limits capacity
- Economies of scale for infrastructure and terminal suppliers limited by fragmented market
- Tariffs and terminal prices relatively high
- Scope for further growth is generally limited to business users
- Congestion in areas of high user density
- Potential new competitors deterred from entry

spectrum made available to analog cellular operators ultimately restricts the capacity on their networks.

As I said earlier, this is not one market but several. With limited economies of scale, margins must be higher—a factor reflected in the prices for both terminals and infrastructure. With a high cost per subscriber, subsequent tariffs limit the market to those for whom the cost can be justified by measurable business benefits.

While spare capacity may be available nationally, congestion occurs more rapidly around urban areas. All of this adds up to volumes which are not sufficient to justify the cost of involvement for some potential manufacturers.

Slide 11—Reasons for GSM

Many of these issues were taken into account in the development of the pan-European digital cellular standard—GSM. The support of the European Commission guaranteed a directive to national governments to make adequate spectrum available. A common standard across Europe has the benefits of providing greater economies of scale, allowing a common type-approval process, and enabling roaming across the whole of Europe.

In choosing and developing a digital standard, particular attention was paid to ensuring that GSM gained advantages over its analog precursors in terms of spectral efficiency, more sophisticated services and greater transmission security. Ultimately it is hoped that this cooperative development will benefit the region, both in terms of the standard's exportability and through the advantages it provides to users.

Slides 12 and 13—Key Factors for GSM, Pricing

How will GSM fare in the European market? Pricing will be a key issue and one factor is that components will be more expensive. Suppliers to this market must also repay the heavy cost of research and development.

On the positive side, however, the volumes *are* potentially much greater than for individual analog cellular standards, which in turn will attract greater competition. So, while in most countries GSM terminals will initially cost more than analog alternatives, significant erosion will occur once volume growth begins.

For the first time in most countries there will be competition to provide cellular services. Those operating analog networks must guard their existing investment. New operators wish to achieve fast growth gaining maximum market share and returns within a few years of launch. Air time retailers will also come into existence in Germany and France at least. As in the United Kingdom, the signs are that equipment subsidies will form a key weapon in their armouries.

Competition is already greater for the supply of infrastructure, as the radio specialists which dominated the analog market have been joined by others such as Alcatel, Philips, and to a greater extent than before, Siemens. AT&T, Northern Telecom and other non-European companies have also signalled their intent to enter this market.

Combining these factors with GSM's innately higher spectral efficiency will ultimately lead to a lower cost per subscriber. Competition will lead to a drop in cellular tariffs, or in the package price, through terminal subsidization.

Slide 14—Key Factors for GSM

Coverage in most countries will initially be limited. In time, national coverage will match that of analog, and international roaming will broaden users' horizons. We do not foresee capacity as a limiting factor for GSM in the first few years; and this will prove beneficial from the standpoint of improved service reliability, which will be complemented by digital-quality speech. Ultimately more sophisticated services will be available, with innovative product differentiation in both terminal and service sectors being stimulated by competition. That, at least, is the theory.

REASONS FOR GSM

- Realization of spectrum limitation
- Harmonized system in all CEPT countries
- Digital technology
- Gives Europe a leading edge

KEY FACTORS FOR GSM - PRICING

Handsets

- Components more expensive
- Heavy cost of research & development
- Economies of scale potentially greater
- Greater competition

Initially higher price than analog, significant erosion once critical market size attained

KEY FACTORS FOR GSM - PRICING

Service Tariffs

- Competing operators
  - Existing operators want smooth migration
  - New operators want fast growth, max. ROI
- Service providers in major territories
- Greater competition for infrastructure supply
- Innately higher spectrum efficiency
- Ultimately, lower cost per subscriber

Tariffs/package price to drop with competition

KEY FACTORS FOR GSM

Coverage	- Initially limited compared to analog
Capacity	- More spectrum available - EC directive - More spectrum efficient
Quality	- Better speech quality, more reliable
Features	- More sophisticated services available - Product differentiation stimulated by competition

Slide 15—Delays in GSM

Anyone who has followed GSM will know that there have been delays in development, which have led to problems for manufacturers trying to meet the specifications—not least for the company chosen to supply type-approval testing sets. Reduced interim specifications have been agreed in order to expedite the commercial availability of terminals, culminating in May's decision to allow self-certification on the final few test specifications. Questions have been asked regarding the commitment of existing analog operations to developing interim GSM products and helping to meet any subsequent lists of retrofitting. Realizing the innate potential for GSM depends largely on the support the technology receives from manufacturers and operators.

Slide 16—GSM Market Prospects

There are still uncertainties about the future of the market. Nevertheless, Dataquest takes the view that GSM has slipped rather than fallen. Commercial services will start in a number of countries in the next few months. We expect to see significant growth beginning next year led by Germany and France.

Competition will be fierce. Dataquest expects to see a second wave of manufacturers entering the market starting in 1993, and including a number of new players. These will focus on the hand portable sector which, after the launch of first products towards the end of this year, will increasingly dominate the market. We expect GSM terminal shipments to overtake combined analog around 1994 to 1995, representing a $2.3 billion market by 1995.

Slide 17—European Cellular Shipments

In unit terms, we expect to see GSM shipments rising to just over 1.8 million by 1995. Do bear in mind, however, that the pattern will vary greatly by country, and that many of the factors impacting development come under direct control of operators and regulators. A change in strategy could adversely impact market potential. This is more likely to be an issue during the early part of the forecast.

Slides 18 and 19—DCS 1800 in Europe

Up until now I have focused on giving Dataquest's view of the development of GSM against a background of existing services. The next step is to look at how future technologies will develop. Because of its links with GSM, the obvious place to start is with DCS 1800.

The concept of personal communications networks was first put forward by the UK government in early 1989. The concept was of a microcellular, mass-market service in which the phone number would be associated with a person rather than a place with a single handset, on which it would be possible to make and receive calls anywhere. Operators would compete both with cellular services and with BT for a sector of the residential market. Three licenses were issued in December 1989 with a view to launching in 1992.

Basing the underlying technology on GSM was aimed at generating support throughout Europe. The spectrum around 1.8 GHz is far less congested than at 900 MHz—allowing much greater traffic densities to be supported.

A number of industry observers, Dataquest included, have come to question whether DCS 1800 can actually provide a basis for true personal communications services. In the United Kingdom two of the three licensees have combined their operations, following consortia members dropping out. A license to operate DCS 1800-based services will be issued in Europe. However, this is seen more as an opportunity to gain access to cellular users than to compete for PSTN services.

DCS is very similar to a GSM. Its main benefit is additional capacity, and hence, eventually, of lower cost per subscriber. The main disadvantage is that maximum cell size is limited, demanding a high level of investment to achieve adequate geographical coverage. Operators need deep pockets and to be able to take a long-term view on their investment. There are also doubts over how many countries will have competing operators with licenses for domestic services. This will be a matter of national importance, setting a precedent for the future of state-owned utilities in any given country.

In virtually every case in Europe, the PTO will be one of the operators of GSM services. Will

DELAYS IN GSM

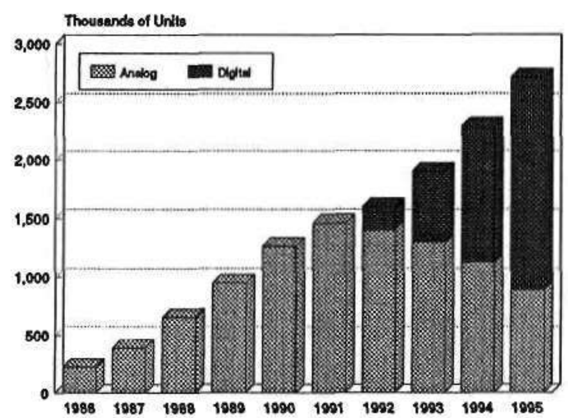
- Specifications set late, incomplete
  - Still changing
  - Some features delayed until phase 2
  - Ongoing problems with type approval
- Operators still have capacity on analog networks
- Intercountry roaming arrangements to be agreed
- Second operators licensed late, more to come

Market development largely dependent on level of support from operators and manufacturers

GSM - MARKET PROSPECTS

- GSM has slipped but not fallen
- Growth will begin in earnest next year, driven by majors with unexploited potential - Germany and France
- Competition will be fierce - expect second wave of terminal suppliers during 1993
- GSM terminal shipments to overtake combined analog in 1994/5
- Terminal market to grow to $2.3 billion by 1995

EUROPEAN CELLULAR SHIPMENTS



Source: Dataquest (June 1992 Estimates)

DCS 1800 IN EUROPE

- PCN concepts of UK's DTI
- GSM specification at 1.8 GHz
- Microcellular applications
- Three licenses in UK - down to two
- License to be issued in Germany

DCS 1800 be stimulated by PTO adoption? Well maybe, but for what reason? To compete with their own fixed services? The investments and running costs would certainly be lower than for a private operator, but so would the returns.

One factor which may help to speed acceptance of this technology is that radio-based communications become more competitive with copper alternatives in lower population densities. Some Western PTOs are looking to take advantage of such economies in rural areas. Of course, wireless communications are most competitive with fixed alternatives when the latter is not already in place. Already one can see the advantages of wireless communications at work in parts of Eastern Europe, where analog cellular technologies are being used to provide reliable communications for a limited number of users. DCS 1800 will certainly be considered in these countries as they plan to modernize their networks.

In Western Europe, however, the current emphasis is upon widening the scope and accessibility of mobile communications offerings. Partly for this reason, Dataquest sees the window of opportunity for DCS falling mainly in the late 1990s, when capacity is again an issue but when further technologies may have arisen to challenge its suitability to provide true personal communications networks [PCNs].

Slide 20—Digital Cordless Telephony

Another area of development is digital cordless telephony. Analog cordless telephones have been with us for some time, but have mainly been confined to the residential environment. Two main digital cordless standards have been developed—the official digital European cordless telephony standard, DECT, and CT2.

Three main applications exist for digital cordless telephony:

- In the office
- On the back of cordless PBX platforms (providing access to the public network via public base stations or telepoints—sometimes referred to as the portable payphone scenario)
- In the home (as with analog cordless units)

Possible future developments may also see digital cordless standards modified for use in the local loop, or integrated into future PCN services.

Slide 21—Telepoint Status in Europe

Of these applications, the earliest to be put to the commercial test was telepoint. In early 1989, the United Kingdom's DTI licensed four operators. And, later that year, three launched services, using proprietary CT2 standards. The exercise failed. By late 1991 the three had all suspended services, never having gained more than a few thousand subscribers between them.

In Dataquest's view, this was not a valid test of telepoint's potential. The operators launched too early, using what was not yet a fully developed technology, and suffered adverse publicity. Base station rollout and marketing of the service were both limited in anticipation of upgrading to the increasingly delayed CAI standard. Tariffs and equipment prices were unrealistically high given the one-way nature of the service and alternatives available within the United Kingdom.

The failure of telepoint in the United Kingdom was predictable.

This does not mean, however, that telepoint will always fail. The service launched in Singapore earlier this year is gaining tremendous support. Last month, CAI-based services were launched on consecutive days by the Dutch PTT and by Hutchison Telecom—the fourth license holder in the United Kingdom. France Telecom will follow later this year. Other European PTOs are watching closely and more announcements may be made soon.

There is no doubt that a national PTO, viewing telepoint as an opportunity to generate traffic on the PSTN, is in a better position to stimulate growth and ensure success than a private operator. Growth in the cordless PBX sector would boost telepoint services by creating a pool of potential subscribers already with handsets.

While in theory either DECT or CT2 could form the platform for telepoint systems, the latter has always been developed with this sector as a primary application, and units will be priced competitively with DECT's for some time. There is still a window of opportunity for CT2 to succeed in this sector.

Slide 22—Cordless PBX Environment

Both DECT and CT2 supporters have great hopes of the potential for their products within the office systems environment. In order for

DCS 1800 IN EUROPE

- Main advantage over GSM is extra capacity
- Disadvantage is network investment
- PSTN competition demands political will and long-term investment
- Possible application in underdeveloped territories
- Western Europe - focus is mobility

DIGITAL CORDLESS TELEPHONY

- Two major standards:
  - DECT
  - CT2/CAI
- Three major applications:
  - Office System - cordless PBX platform
  - Telepoint - portable PSTN access service
  - Residential - home base station
- Possible future applications:
  - Local loop - Telepoint to the home
  - Personal communications network

TELEPOINT STATUS IN EUROPE

- UK failure - not a valid test
- Services to launch this year in France, Netherlands and UK - others watching
- Success will depend on positioning and operator support in national market
- Critical mass of business terminals would provide major boost
- CT2 still has window of opportunity

CORDLESS PBX ENVIRONMENT

- Products must meet general price/feature criteria
- Competition between standards and with analog cordless alternative
- Standards/approvals bodies play key role
- Telepoint may be a differentiator
- Related technologies may influence market

such aims to be realized, digital cordless products must meet the general price/performance requirements within this fiercely competitive sector.

While there is certainly a great deal of interest in the benefits which mobility within the office would bring, the value and cost of digital cordless will be weighed up, in the context of other requirements, by professional telecoms managers. Such users will be aware of both current and future options, and in some countries recent developments in analog cordless systems will also be considered.

Dataquest sees digital cordless developing as a niche within the business telephone market. Just as a limited number of individuals within an organization require top-of-the-range featurephones, telecoms managers will limit the purchase of digital cordless units to those with a genuine need for mobility.

In setting the options available, standards and type-approval authorities will still play a key role in deciding the future of the market. An example was given last month when the DTI cast doubt over the implementation of DECT in the United Kingdom because of possible interference with DCS 1800.

Factors other than those strictly relating to competitiveness in the cordless PBX environment may also play a part. The success of telepoint within a country may impact a telecoms manager's choice of technology.

On the supply side, work on DECT-based cordless LANs or the similarity between DECT and the Japanese digital cordless standard, may prove long-term advantages over CT2.

Slide 23—European Digital Cordless Telephony (Technology Applications Trends)

The development of the market for digital cordless technology will initially be determined by the interaction between the two key applications of office systems and telepoint services.

In some countries, telepoint may provide a differentiator for those choosing between competing technologies for cordless PBX systems. In others the office market may determine whether telepoint services are launched at all. The influence of national telecoms administrations in adopting standards will continue to be a major factor.

Towards the latter half of this decade, Dataquest expects to see digital cordless prices reduced to levels competitive within the residential cordless market. The terminal market will generally be dominated by specialist suppliers, working partly in conjunction with office systems vendors. Leading companies in the development of CT2 technology are Motorola, GPT, Shaye and Orbitel. Ericsson leads the DECT camp for the time being, with Philips, Dancall and Olivetti promising to be early players.

Slide 24—Personal Communications in Europe

In the course of this presentation, I have briefly covered four major technology groups within European personal communications which exist or are under development today. What lessons can we draw from such an assessment about the potential for true, mass-market personal communications in Europe?

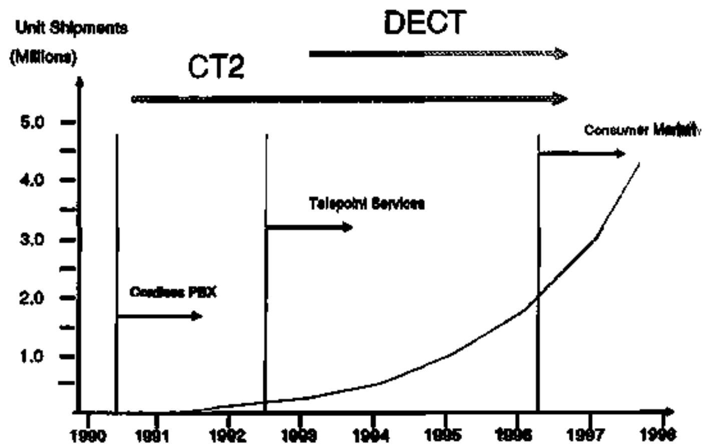
Well, for one thing, a pan-European market would provide economies of scale and subsequent equipment prices which would greatly heighten the chances of success on a mass-market basis. As we have seen, however, there are a number of technologies which could provide some of the applications of a true PCN without any single one having the advantage across all applications.

Indeed, the very concept of one technology meeting all needs is greatly under question. It seems far more likely at this stage that true PCN services will ultimately be provided by not one technology but a combination. This in itself poses a question over the current tendency of most national telecoms administrators to issue single standard licenses to private operators, while allowing PTOs access to all technologies.

There may be further technologies on the horizon which will also play a part in the development of PCNs in Europe. One thing, which can be said with some certainty, is that despite the technological, economic and political complexities of this market, Europe is still setting the pace for the rest to follow in the world of personal communications. Technologies developed here will gain success throughout many other parts of the world.

By Dean Eyers

EUROPEAN DIGITAL CORDLESS TELEPHONY
(TECHNOLOGY APPLICATION TRENDS)



Source: Dataquest

PERSONAL COMMUNICATIONS IN EUROPE

- A pan-European market
- Technologies in competition
- A realistic dream?
- Leading the world

Videophones

Jeffrey Goldberg

Today TV, cinema and video dominate the media. They give us colorful, moving images to try to convince us to buy washing powder while politicians try to convince us to vote for them.

Yet, the main means of business communications is the telephone, which only uses sound and, if you are lucky, fax, which uses only still, black-and-white images. Today we are going to look at how the telecoms companies are trying to put moving images down a phone system made only for sending audio across the world.

Slide 1—What Is Videotelephony?

But first, what is videotelephony? For the sake of simplicity we are going to divide it into three categories:

- Videophones
- PC videophones
- Videoconferencing

Videoconferencing is happening now: a room set up for videoconferencing or a floor-standing machine. These typically use proprietary protocols linked sometimes by private lines.

At the other end of the spectrum are videophones, which are very much like an ordinary phone but with a camera and a screen so that you can see the person on the other end.

In between these are PC videophones that are add-in boards to a personal computer which with a camera allow a PC to be a videophone. The person at the other end is shown in a small window overlaying the current task. The addition of a PC allows a great deal of flexibility such as the sending of spreadsheets and the ability to see more than one caller simultaneously,

Today we can't cover every sector of the market so we are going to concentrate on the high-volume end of the market rather than the high-cost, low-volume, videoconferencing end.

Slide 2—Who Wants It?

So who wants it? Videophones are an easy sell. As I am speaking, you are concerned both with the sound coming out of my mouth and the nonverbal communication such as a raised eyebrow or a ruffle of the hair. Indeed, research tells us that over 60 percent of the message comes through nonverbal means.

Everyone knows what a phone is. Everyone knows how to use it. We even have a universal symbol for one. The phone is a familiar object to everyone in Europe. And everyone knows of the problems with a telephone. You cannot see the person at the other end. Video is an obvious extension. This is probably best summed up by the adverts AT&T have in the United States where two doting grandparents are shown gazing longingly at the screen of a videophone watching their young grandchildren. It is this sort of parental pressure that will sell videophones.

But it is not only residential users who will buy such a product as there are clear cost savings for business users. No longer will you have to fly to the United States for a meeting if you can see the people on the videophone or videoconferencing device. This has been the main selling point for videoconferencing and anyone who has used it will vouch that it is better than taking the red-eye across the United States.

Slide 3—Technology

So if everyone wants it why doesn't it exist today? The problem is bandwidth. An audio signal for the phone takes 3 kHz of bandwidth whereas a TV picture takes 6 MHz. That means a difference of several orders of magnitude. And the problem is that the phone companies have a whole infrastructure devoted to taking 3 kHz around the world. So you need to squeeze 6 MHz into 3 kHz—no easy task. The usual way to do this is to compress the image in some way. Typically, this would involve only sending the changes in the picture and slowing down the refresh rate to only send the changes when they are needed.

Slide 4—Standards

But there is another reason why the videophone revolution has not happened—standards. In the telecoms industry these are incredibly important, after all nobody is going to buy a phone if they cannot speak to anyone? So for the videophone to succeed a worldwide standard must be in place. The CCITT, the telecoms standards body,

WHAT IS VIDEO TELEPHONY?

- Videophones
- PC Videophones
- Videoconferencing

WHO WANTS IT?

- 60 percent of message = nonverbal
- Phone familiar object
- Video obvious extension
- Clear cost savings

TECHNOLOGY

- Why does it not exist today?
- Bandwidth, Bandwidth...
- Image compression

STANDARDS

- Why important?
- CCITT H.261
- Problems...

took a long time to have a standard in this area partly because of immaturity and partly because of the huge technical task.

It eventually did it in 1991 when most of the videophone standards were ratified. The most important one, and the one you are likely to hear of most, is the one related to video compression: H.261 sometimes called Px64. Unfortunately, already companies have come up with better compression algorithms that give better pictures over the same bandwidth.

Slide 5—Analog versus Digital

The other problem with H.261 is that it requires a digital connection to the phone system—ISDN for those who know. This is not what most people have; instead, they have an analog connection to the phone system or PSTN. ISDN is not in widespread use across the world because most people cannot get hold of it. In telecoms terms the coverage is small.

The cost of ISDN is high too, both in equipment and line rental terms. In the United Kingdom, ISDN is about four times more expensive than the PSTN in terms of initial line connection and rental charges. The call costs, except for some international calls, are the same. The equipment costs are much more expensive, for example an analog phone will cost about $1,000 to $1,500, while the current ISDN videophones cost $5,000 to $7,000

Slide 6—Quality

So if few people could get ISDN and it cost a huge amount more, why did the CCITT and others push for it. Well, it is to do with quality:

- VGA (640 pixels by 480 lines), a standard computer screen display
- CIF (352 pixels by 288 lines), typical videoconferencing display
- QCIF (176 pixels by 144 lines), typical digital videophone display
- Analog (128 pixels by 96 lines), typical analog videophone

Doesn't the analog videophone look terrible?

Slide 7—A Videophone Is ...

So what is inside a videophone? Your face is filmed by a CCD camera whose output is then fed into an A/D which goes into the video CODEC. This compresses the picture and sends it to the line interface. A similar thing happens to the audio. These are combined and sent as sounds down an analog line via a modem, while they are kept separate when sent through an ISDN line interface.

At the other end the line interface or modem receives the sounds from the line and parcels it to the codes. The video CODEC decompresses the image and sends it to a color LCD screen if it is a videophone or becomes an overlay into VGA memory for a PC videophone. The audio gets decompressed and comes out of a speaker. An MCU controls the videophone and grabs user input.

The only new part of the videophone from a semiconductor view is the CODEC, so we will look a bit further into that.

Slide 8—H.261 Video CODEC

To give you an idea of what the encoding does, here is a list of the six stages of video encoding:

- Discrete cosine transform (DCT)—is where a frame is subdivided into blocks of 8 × 8 pixels and converted into values that represent the spatial frequencies.
- Motion estimation and compensation—is where adjacent frames are compared to identify moving patterns. These movements are transmitted as displacements of pixel blocks between frames, as opposed to fully reconstructing each block in each frame.
- Quantization—is the technique used to represent the DCT values as a small number of discrete integer values. This minimizes the amount of data that must be transmitted to describe them.
- Loop filtering—is a simple, low-pass digital filter that removes unwanted edges which are a byproduct of interframe compression.
- Variable length coding/decoding—is the process of converting the quantized DCT coefficients into a serial bit stream.
- Error correction—a BCH error correction is used with the serial bit stream to permit detection and correction of errors on reception by the receiving videophone.

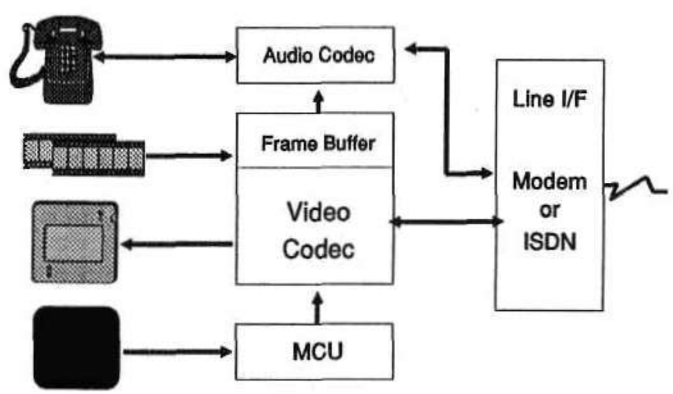
ANALOG VERSUS DIGITAL

- ISDN or PSTN
- Coverage
- Cost
- Quality

QUALITY

- VGA (640 pixels by 480 lines)
- CIF (352 pixels by 288 lines)
- QCIF (176 pixels by 144 lines)
- Analog (128 pixels by 96 lines)

A VIDEOPHONE IS...



H.261 VIDEO CODEC

- DCT
- Motion estimation and compensation
- Quantization
- Loop filtering
- Variable length coding/decoding

Slide 9—Implementation of Video CODEC

The current videophones typically implement the CODEC using 16-bit DSPs such as Texas Instrument's 320C30 or the Motorola 56 family. This is because the standards were still flexible at the time of design and companies still want to update their proprietary algorithms.

But videophones need to be cheap and using DSPs will always give as low a cost as hard-wired ICs for this task. We are already seeing this happen as companies such as LSI Logic bring out chip sets to support videotelephony.

As well as these core chips, a number of other peripheral chips are also required, such as 2 Mbits of memory and at least 256K of fast FIFO plus the usual array of glue logic.

Slide 10—Key Players

Who are the key players in the video telephony game? As a typical example of a Japanese company, I am taking Hitachi. All Japanese electronics companies that have some telecoms interests have programs on videophones. Some still in the labs and some outside. Hitachi is one of those which have launched a videophone in Japan, perhaps the best to date, and has met with some success. It also has the display and camera technology to be a major player in the videophone market in the years to come.

BT, the UK PTO, has been one of the major companies behind most of the videotelephony standards. It participates in all areas from infrastructure, research, through to designing the videophone. It has two major alliances, with IBM for PC videophones over ISDN, and GEC-Marconi on analog videophones.

GEC-Marconi has used its defense expertise and is trying to turn it into a commercial advantage. One of the areas it sees as fruitful is image compression, since it has much expertise in DSPs and so on. It is providing these for the analog videophones shown by BT at the Ideal Home Exhibition and Amstrad (the UK consumer electronics company). It also has several agreements with other, as yet unannounced companies and PTOs.

The AT&T analog videophone in contrast comes from chips developed by Compression Labs Incorporated (CLI) in partnership with ITT. CLI is one of the kings of the videoconferencing arena with PictureTel (which we will discuss later). CLI gets most of its current income from the high end of the videoconferencing arena from its Rembrandt range. It has also penetrated the PC videophone arena with its Cameo product for the Apple Macintosh.

PictureTel, in contrast, dominates the low end of the videoconferencing arena. It has a five-year agreement with Intel on videophone, conferencing and DVI chip sets. PictureTel is providing the compression technology; it has also supplied AT&T with products: the low-end videoconferencing product and probably a PC add-in card. The major reason AT&T took this over CLI is PictureTel's adherence to standards. PictureTel has also allied itself with several other PTOs and large companies of which the most important from the European viewpoint is the alliance with Siemens to produce a videophone matched to Siemens PBXs.

Finally the daddy of them all—AT&T. It produced its first videophone way back in 1964 and has been passionately in favor of them ever since. It is the first PTO to launch an analog videophone and to have the ability to coerce the market into buying them. It has the structure, research and product design of BT but also the silicon technology that BT has not.

Slide 11—Dataquest View of the Videophone Market

What do we think of the videophone market? I come from a facsimile background and am one of the industry analysts at Dataquest who covers it. It is interesting to see the contrasts between facsimiles. Let me explain. Back in the early 1980s the Group 3 fax standard that we know and love became ratified. Previously the cost was too high and the quality too low for people to want to buy a fax in big numbers. It was only when the first Group 3 machines appeared in 1984 that fax started to get moving. Yet it took Europe until 1988 to 1989 to really take off in terms of volume and revenue.

In the videophone market we are in a similar position. The standard was agreed last year and the first machines have started to appear which match the standard and can communicate with each other. However, there is still the problem of multiple standards since the analog videophones

IMPLEMENTATION OF VIDEO CODEC

- 16-bit DSPs (TI 320C30)
- Hardwired ICs
- Peripheral chips also required

DATAQUEST VIEW OF THE VIDEOPHONE MARKET

- Similar to facsimile
- Slow to start until price/quality acceptable
- Strong growth
- 1995-2000 time frame
- Potential of vast market

KEY PLAYERS

- Hitachi
- BT (and partners)
- CLI/IIT
- PictureTel/Intel
- GEC-Marconi (and partners)
- AT&T

have not got a standard—the AT&T one cannot talk to the Amstrad one, for example. None of the digital videophones can speak to the analog videophones. So in some ways the position is worse than fax in the early 1980s.

We believe that the screen display on the analog videophones is unacceptable to most consumers and the cost too high. Even if you buy one videophone on the assumption that the person at the other end already has one, then it is still 10 times the cost of an ordinary phone, even at the most generous of estimates. We therefore believe that the analog videophone will not take off in the short term and indeed that is our view of the whole videophone market.

However, when it does take off, as it surely will, there will be strong growth from the sorts of factors mentioned early. For example, from parental pressure of mothers wanting to look at children, grandparents at grandchildren and friends and families split across the world. In this increasing global village, we are becoming more aware of communications and video is a powerful form that people will surely want.

But we don't believe it will be soon. The ISDN infrastructure, quality of picture and costs of equipment will limit the market until the latter half of this century. We believe videophones will happen in the 1995 to 2000 time frame. This might seem strange to some, but I have learnt that the telecoms industry moves far slower than the PC industry.

There is, however, a potential vast market out there. There are about 260 million handsets in Europe connected to the phone system; if only 10 percent of these get transferred into a videophone then that is 26 million, or over five times the installed base of facsimile machines across Europe.

I leave you with this thought: potentially, the videophone market is a vast one, and it is up to you to exploit it.

By Jeffrey Goldberg

In Future Issues

The next issue of *Dataquest Perspective* will contain reports on:

- European Pricing Update
- State of the Industry
- European Semiconductor Vendor of the Year

For More Information . . .

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Dataquest Perspective

Semiconductors *Europe*
Conference Special, Part 1

SCEU-SVC-DP-9206 June 19, 1992

In This Issue...

Market Analysis

Semiconductor Market Forecast and Market Share Analysis

This *Dataquest Perspective* is part 1 of two special reports on Dataquest's eleventh annual semiconductor conference which was held on June 3 to 5 at the Jurys Hotel, Dublin, Ireland. This issue covers the first of Dataquest's speeches and the next issue will report on the Dataquest speeches that followed.

This speech covered the following areas:

Market Shares	*Page 1*
Products	*Page 2*
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Logic	*Page 14*
Applications	*Page 14*
Vendor Analysis	*Page 18*
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Global Investment	*Page 28*

By Jim Eastlake, Mike Glennon and Byron Harding

Market Analysis

Semiconductor Market Forecast and Market Share Analysis

This *Dataquest Perspective* is the first in two reports on Dataquest's eleventh annual semiconductor conference. The conference took place between June 3 and 5 at the Jurys Hotel, Dublin, Ireland. It was chaired by Bipin Parmar, Director of the European Semiconductor Group (ESG) at Dataquest. The first speech *Semiconductor Market Forecast and Market Share Analysis* was given during the session entitled *Dataquest's Forecasts and Analysis* by Jim Eastlake, Senior Industry Analyst and Manager of ESG, Mike Glennon, Senior Industry Analyst, ESG and Byron Harding, Industry Analyst, ESG.

The full text of this speech is reproduced here for the benefit of those clients who could not attend the conference. Copies of the slides shown accompany the text.

Introduction

Jim Eastlake

We are going to analyse the European semiconductor market, beginning with a review of our 1991 market share, and then talking about products and applications. Next, we will perform some vendor analysis to understand the possible direction of market shares. We will also look at that impact the product and applications trends will have on the regional markets. And finally, we will discuss world markets.

Market Shares

Slide 1—Preliminary European Market Share Rankings 1991

Let us begin our analysis by looking at 1991 in order to establish a base to look forward from. Here we see our preliminary estimate of the European semiconductor market share. While the big three European companies continued to hold the top spots, the headlines went to Intel which grew its European sales by 22 percent. This growth occurred through a substantial increase in microprocessor revenue as the PC migrated from the lower-priced 80286 to the more expensive 80386 products, and the 80486 established itself.

As Intel controls 60 percent of the European microprocessor (MPU) market, it is easy to understand why MPU was the strongest market in Europe, and indeed worldwide last year. Though I must note here that it was not alone, not surprisingly AMD more than doubled its European microprocessor sales. A review of the behavior of the various semiconductor product and applications markets last year provides a valuable guide to the reason behind the company's performance.

With the consumer market plagued with inventory problems, and the industrial market depressed by economic conditions, the discrete, microcontroller and analog markets achieved little growth. This we see reflected in the flat sales of Philips, SGS-Thomson, Motorola, and National Semiconductor.

In the EDP segment there were a few bright spots, but overall, a slowing PC market and continued restructuring among the big customers in Europe led to slow demand. This resulted in continued price erosion particularly in memory. We see this reflected in the sales of Siemens, Texas Instruments, Toshiba, and NEC, which rely on memory for a significant proportion of their revenue. Of the strong memory players, only Hitachi achieved significant growth doing very well in value-added memory modules. I would like to point out here that 7 of these top 10 vendors lost share of the European market—European, US and Japanese companies alike.

Slide 2—Preliminary European Market Share by Supplier Base Region

Here we see the European market share by vendor base. After a rare turn of events in 1990, when European and US companies gained share of the European market, 1991 saw a return to the more familiar pattern of the last decade. That time saw the combined sales of Japanese and now Korean companies (more specifically Samsung) gaining share at the expense of the European and North American companies.

The point I am making is: a company's market share depends on how well the product and applications markets in which it operates perform, particularly in the short term. However, in the longer term this alone does not determine market share performance. One major factor is that as new companies enter a market, they take share from the bigger, more established companies. This is balanced by the fact that the big companies with huge resources can "out-invest" their competition if they apply their strengths wisely and leverage their better developed routes to market.

I shall return to this theme in a little while to look at events over the next five years. But, in order to do this we must introduce and justify our thinking on the direction of product and applications markets.

Products

Mike Glennon

Slide 3—Market Product Share

I can analyse the European semiconductor market from three viewpoints. For products I shall examine the current status of the market; for applications I shall look forward and see which applications are likely to provide future demand for products, and for countries I shall see the impact of these trends on the regional markets. So, what do we expect to happen in these areas?

Let us turn first to products. Those products which are the most representative of the semiconductor market are memory, microcomponents and logic. These products represent over half of the semiconductor market in Europe.

The analog product segment is also significant, but while in 1991 it was larger than each of these categories, its expected growth is lower than for the others.

Slide 4—European Semiconductor Market

Here we have Dataquest's short-term and long-term growth forecasts for the products. It is clear that they show good growth, both in the short and the long term. First I shall look at the microcomponent market.

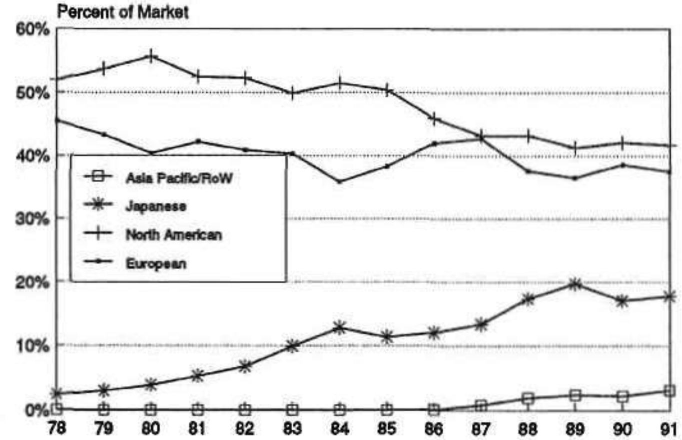
PRELIMINARY EUROPEAN MARKET SHARE RANKINGS 1991

(Millions of US Dollars)

1990 Rank	1991 Rank	Name	1991 Revenue	91/90 % Growth
1	1	Philips	$1,172	1.5
2	2	Siemens	958	-0.6
3	3	SGS-Thomson	887	-2.3
4	4	Motorola	770	0.7
6	5	Intel	760	22.2
5	6	Texas Instruments	629	-1.3
7	7	Toshiba	509	3.9
8	8	NEC	452	8.4
9	9	National Semiconductor	408	0.0
10	10	Hitachi	318	16.5

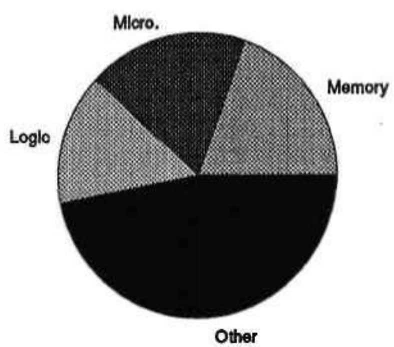
Source: Dataquest (June 1992 Estimates)

PRELIMINARY EUROPEAN MARKET SHARE BY SUPPLIER BASE REGION



Source: Dataquest (June 1992 Estimates)

EUROPEAN SEMICONDUCTOR MARKET PRODUCT SHARE



1991 Product Share

EUROPEAN SEMICONDUCTOR MARKET

(Millions of ECU)

	1991	1992	% AGR	1996	% CAGR
MOS					
Memory	1,787	2,000	11.9	3,584	14.9
Microcomponent	1,701	1,929	13.4	3,167	13.2
Logic	1,366	1,463	7.1	2,455	12.4

Source: Dataquest (June 1992 Estimates)

Looking at events over the past year, microcomponents have enjoyed high growth, in fact for the past two years, and this will continue for at least the next year. The major use of microprocessors is in personal computers, and the trend over the past 12 months has been towards 486-based PCs, and away from the 386.

Slide 5—European PC Shipments

While the upturn in 486 PCs is slight, it is significant, and the downturn in 386 products is very marked. This slide shows the consumption of PCs in Europe, but the shift in emphasis is also reflected in PC production. The 486 is higher in price than its 386 equivalent, so this move to higher performance increases the dollar value of the market.

Slide 6—Products, Microcomponent

In microcontrollers, growth has been slow. The weak consumer market mentioned by Jim earlier has reduced the consumption of these products. In addition, delays in the approval of GSM handsets, due to a bottleneck in testing of devices, has put back volume production of the phones, and hence the volume consumption of the high-value DSP controllers which are used in the handsets.

ISDN equipment is also a heavy user of DSP and microcontrollers, and the persistent delay in the volume use of the service has given a long-term postponement to consumption.

In the automotive industry, economic conditions across Europe have slowed new car sales, and hence the microcontrollers which are placed in them. However, the growing semiconductor content in automotive applications is offsetting this, and the market is still growing, albeit slowly. The peripherals market stalled in the past year.

Many component prices have declined severely. Maths coprocessors experienced dramatic price cuts, partly because of competition, and the PC chip set market is very competitive now and has many suppliers. Price pressure is very high in this area, resulting in low growth for the market.

Looking now to the future, the microprocessor market, especially in PC applications, is becoming more competitive as alternative sources appear. The size of the PC market has ensured companies are prepared to risk lengthy and costly litigation in order to gain a share of this lucrative market. However, it may not remain as lucrative for them. Intel's response to this frontal attack by a variety of companies has been to try to move the majority of the consumers upmarket to a well-protected area. The rise in 486 shipments indicates that it is succeeding. While the other suppliers are battling for a smaller share of a declining market, Intel has the high-end market to itself again. However, the effect of competition on processor prices has been noticeable.

Slide 7—Intel 386SX Pricing

The price in Europe of the 16-MHz 386SX processor, shown as the lines on this graph, has been relatively stable since December 1990. Prior to this, the high prices were related to shortages in supply, as the long lead times, shown as the bars, indicate. This decline in lead times may be due to the onset of competition in this market, which is reducing prices slightly, in spite of increases in lead time.

The result is the narrowing of the gap between the low-volume price and the high-volume price. There is now very little difference between them.

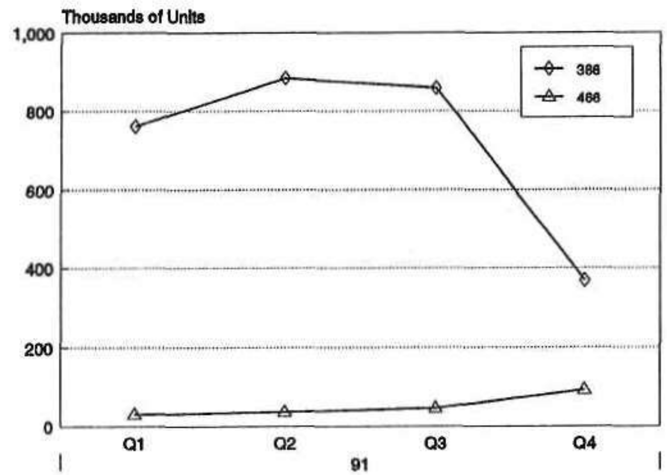
These price falls are small, as the only real competitor was AMD, but the arrival of more suppliers narrows the scope for differentiation, and lower prices become more tempting.

Slide 8—Products, Microcomponent

The other noticeable feature of the processor market, is the application of consumer marketing, in the form of brand image. We are now encouraged to buy a PC with "Intel Inside," even if we are not sure what it is. This is a reflection of a maturing market.

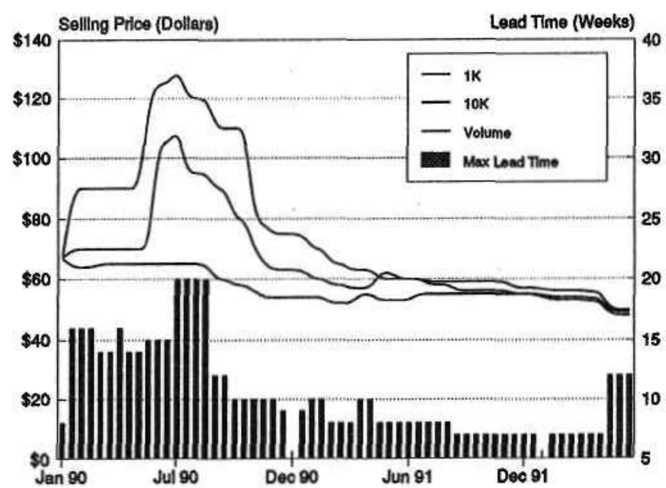
The RISC arena has been a little unsteady for the past year. There have been many announcements of new products which provide a major improvement in performance. However, many of these products have been delayed, with the consequential effect on their consumption.

EUROPEAN PC SHIPMENTS



Source: Dataquest (June 1992 Estimates)

INTEL 386SX PRICING



Source: Dataquest (June 1992 Estimates)

PRODUCTS - MICROCOMPONENT

- Microprocessor strengthened
  - Processor mix moved upmarket
- *Microcontroller*
  - Weak consumer market
  - GSM delays for DSP products
  - ISDN slower than expected
  - Transport segment slow
- Microperipheral
  - Significant price declines
  - Stronger competition than anticipated

PRODUCTS - MICROCOMPONENT

- Competition enters microprocessors
  - AMD, Chips & Tech, Cyrix, Texas, ST
  - Intel responding well
  - Consumer marketing comes to processors
- RISC
  - Step improvement in performance
  - ACE consortium weakening
  - ARM achieving success
  - IBM endorsing the transputer

The ACE consortium was to have provided a stimulus to the use of RISC and in particular the MIPS processor. However, the departure of many key members of the consortium, such as Digital and Compaq, has weakened it considerably, so the outlook is less optimistic. Europe's contribution to the RISC market has been subdued.

While the raging battle between SPARC and MIPS and Hewlett-Packard and IBM has received much attention in the press, a company called ARM has been quietly shipping its products, with very little fuss. Considering there are four SPARC suppliers, and five MIPS suppliers, ARM—until now only using VLSI Technology as its manufacturer—has maintained a creditable success in the top five installed base products. ARM has taken the unique approach of using RISC techniques to reduce die size and power consumption, rather than to deliver the ultimate performance.

At the same time, Europe's alternative processor, the Transputer, has been endorsed by IBM, for use in its disk drives—the serial link on the device giving the greatest benefit for IBM's application.

I just mentioned that the microperipheral market stalled last year, but one specific microperipheral deserves a more detailed analysis, mainly because of its impact on the semiconductor market. I am of course referring to memory.

Products—Memory

Byron Harding

Slide 9—1M DRAM Production in Europe

The memory market in Europe, and the industry supplying it, have seen some important changes since our last conference. I shall summarize these changes and their effect on the European market. To begin with, I will look at production of DRAM in Europe.

Siemens is the leader in the production of the 1M DRAM, followed at some distance by NEC and Motorola. Demand for the 1M has already peaked, so it is not surprising to see local production declining rapidly.

Slide 10—1M DRAM Production vs Demand in Europe

Total European production compared with demand indicates that a significant proportion of the market is being met by imports. Leading importers of the 1M are Samsung and Texas Instruments.

Slide 11—4M DRAM Production in Europe

4M DRAM production is beginning to ramp up, following the wave of investment in new European plants by the companies shown in the slide.

Mitsubishi and Hitachi are the most conservative in their production schedules, and my estimates for Texas Instruments only covers phase 1 of their fab plan. Of course, all these estimates are subject to changing market conditions and strategies.

Semiconductor companies around the world have pushed out their fab construction plans in reaction to the weakness in the world semiconductor market.

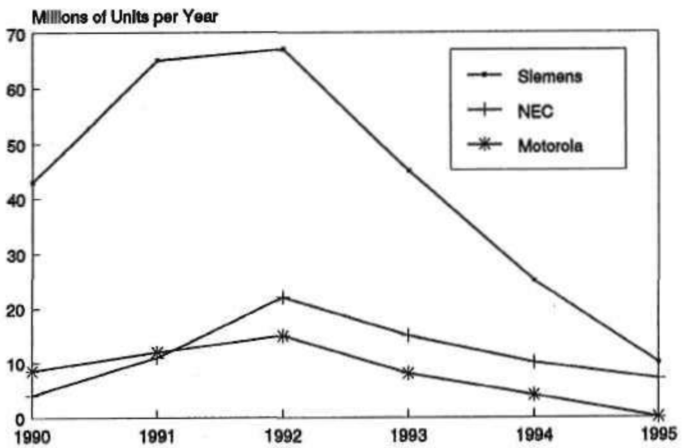
Fab plans in Japan have been affected more severely by this slowdown than fabs in Europe. In fact, the strategic importance of having a fab in Europe has probably saved these plants from more severe cutbacks.

Slide 12—4M DRAM Production vs Demand in Europe

A comparison of 4M production versus demand indicates that at least 30 percent of 4M DRAM will still be imported by 1995. This is even before taking into account exports from these plants to other world markets, and the use of these fabs to run other product lines. Nonetheless, Europe *will* become more independent in its supply of DRAM and other memory modules.

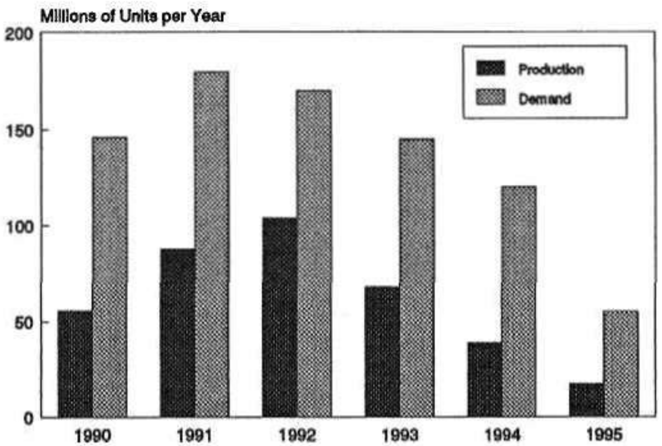
The question I raise is: can the European market provide an adequate return on investment? One indicator of this is the market price for memory.

1M DRAM PRODUCTION IN EUROPE
(PROJECTION)



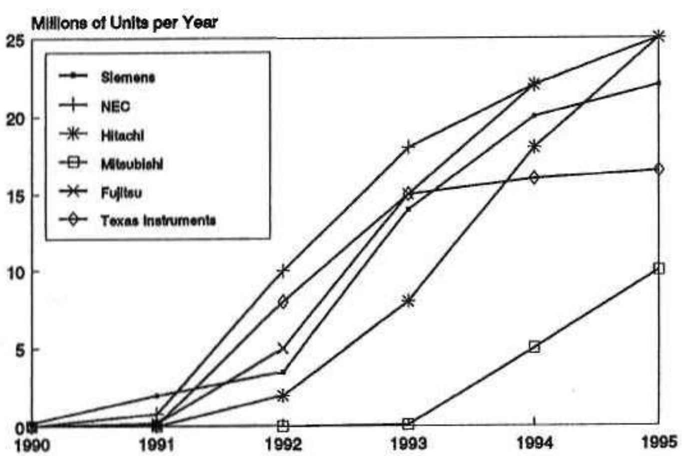
Source: Dataquest (June 1992 Estimates)

1M DRAM PRODUCTION vs DEMAND IN EUROPE
(PROJECTION)



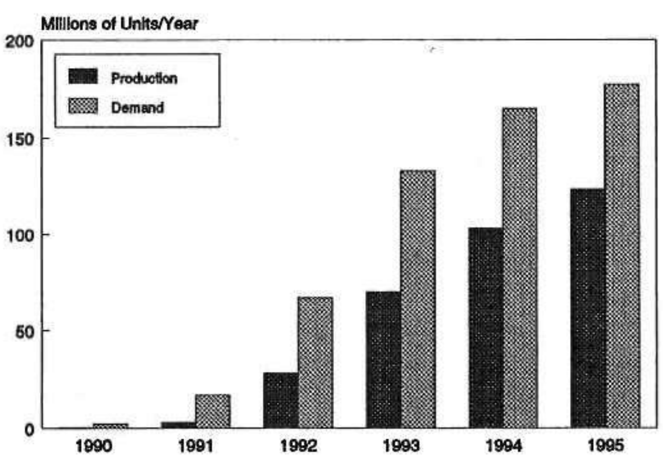
Source: Dataquest (June 1992 Estimates)

4M DRAM PRODUCTION IN EUROPE
(PROJECTION)



Source: Dataquest (June 1992 Estimates)

4M DRAM PRODUCTION vs DEMAND IN EUROPE
(PROJECTION)



Source: Dataquest (June 1992 Estimates)

Slide 13—Worldwide Market Prices, 1M (256Kx4) DRAM

This slide shows booking prices for 1M DRAM over the last nine months in five major world markets. These are the United States, Japan, Korea, Taiwan, and Hong Kong.

Europe is placed in perspective with these markets, and in a reasonably competitive position.

Slide 14—Worldwide Market Prices, 4M (4Mx1) DRAM

In the case of the 4M DRAM, there has been some price movement in Japan, making it the cheapest market overall. This is a continuing problem of overcapacity.

Europe fits firmly above price levels in the United States, Japan, and South Korea. This relatively high position is not entirely unrelated to certain trade controls, which I shall discuss later.

Slide 15—Worldwide Market Prices, Slow 1M (128Kx8) SRAM

The Japanese market price for the 1M slow SRAM has followed almost the same trend as the 4M DRAM. Again, overcapacity is to blame, pulling the price down below all other markets—except Europe.

In January this year, the 1M SRAM benefited from complete duty suspension, marked by the star in the slide. I believe that the sudden downward plunge in the price is mainly related to this suspension, and not just a result of ongoing price erosion.

This being the case, it clearly demonstrates the effect the tariff has on the market, and the likely consequence of its removal on other products.

[Dataquest has produced a reference report entitled *EC Semiconductor Tariffs and Related Issues: a Guide for Suppliers and Buyers,* which can be obtained by contacting Dataquest's marketing department.]

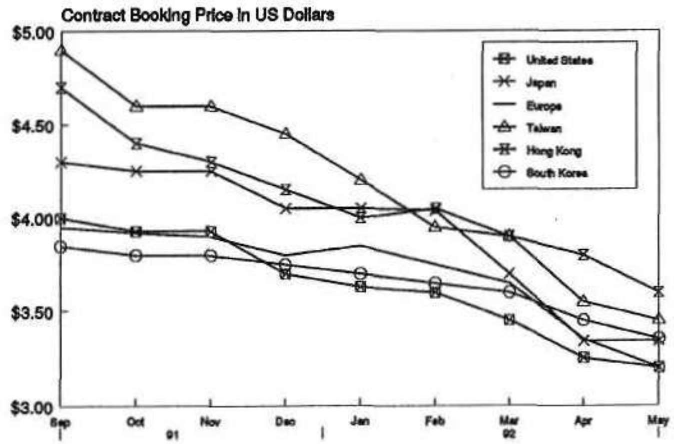
Slide 16—Worldwide Market Prices, 1M (128Kx8) EPROM

This is the case of 1M EPROM, which has hit rock-bottom prices in the Korean market. Cut-throat competition between US and European suppliers has driven the price down to a ridiculous $2.5.

Including European price trends shows that Europe is the next-cheapest market after Korea. Again, it is US and European suppliers that have driven the price down, not Japanese or Korean.

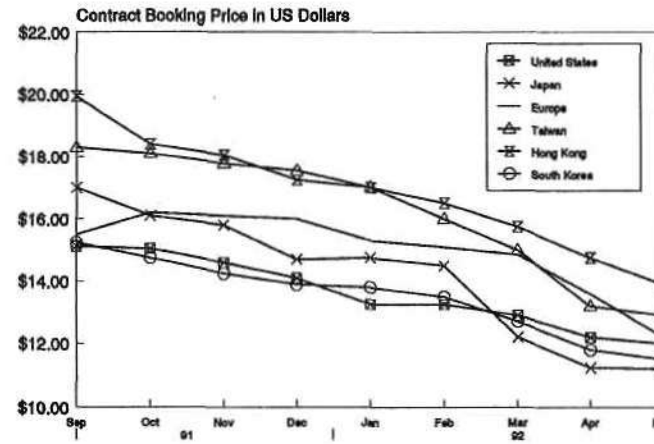
These slides demonstrate that Europe is world competitive in memory prices, and a reasonable return on investment for putting expensive DRAM fabs in Europe is not likely to be gained by selling the output from these fabs in Europe alone. Another solution is to run non-memory product lines in these fabs, for which profits are higher.

WORLDWIDE MARKET PRICES
1M (256Kx4) DRAM



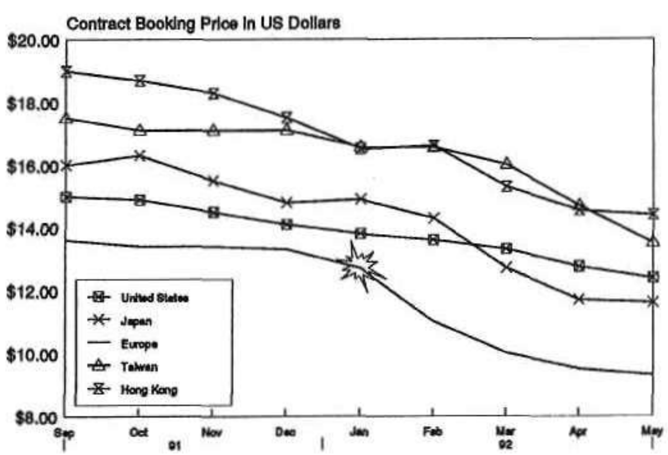
Source: Dataquest (June 1992 Estimates)

WORLDWIDE MARKET PRICES
4M (4Mx1) DRAM



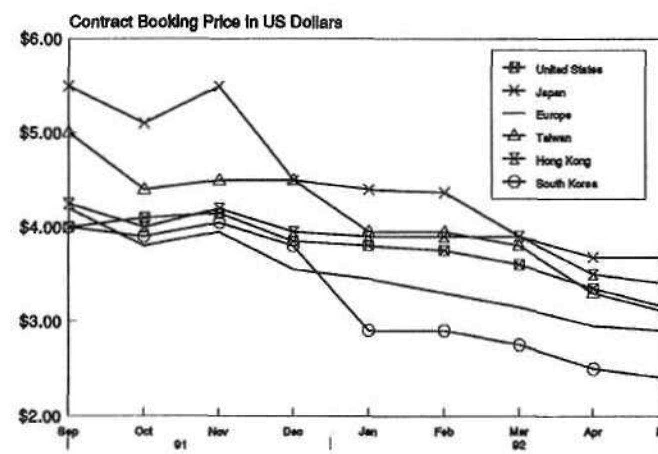
Source: Dataquest (June 1992 Estimates)

WORLDWIDE MARKET PRICES
SLOW 1M (128Kx8) SRAM



Source: Dataquest (June 1992 Estimates)

WORLDWIDE MARKET PRICES
1M (128Kx8) EPROM



Source: Dataquest (June 1992 Estimates)

Slide 17—EC Antidumping Action in Memory

This is a summary of EC antidumping action in the semiconductor field. But what is the effect of such measures on market prices?

As a case study, I will show you for the first time our estimates for Japanese DRAM reference prices compared with market prices.

Slide 18—Estimated EC DRAM Reference Price vs European Market Price, 256K DRAM

This the 256K DRAM. There is hardly any correlation between reference price and market price for this product.

The Japanese have moved out of this market and the major share is now held by Samsung, which is not bound by reference prices yet.

Slide 19—Estimated EC DRAM Reference Price vs European Market Price, 1M DRAM

The correlation is stronger for the 1M DRAM.

However, as the Japanese are moving out of this market too, the correlation is being lost again. Samsung and Siemens are now leading suppliers for this part.

Slide 20—Estimated EC DRAM Reference Price vs European Market Price, 4M DRAM

The closest link is found in the 4M DRAM, as products made in Japanese fabs still have the largest share of the market.

But with European production coming on line and strong imports coming from South Korea, this link will soon be lost, and a free market will prevail.

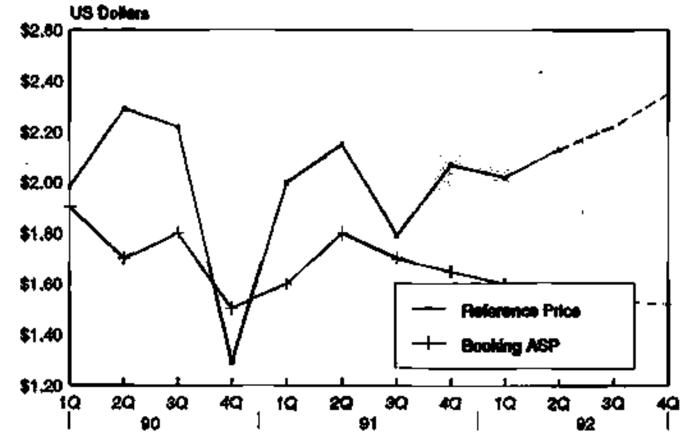
And so, on to our forecast for the European memory market.

EC ANTIDUMPING ACTION IN MEMORY

Japanese DRAMs:	Imposed January 1990
Japanese EPROMs:	Imposed March 1991
S Korean DRAMs:	Verdict expected in June 1992

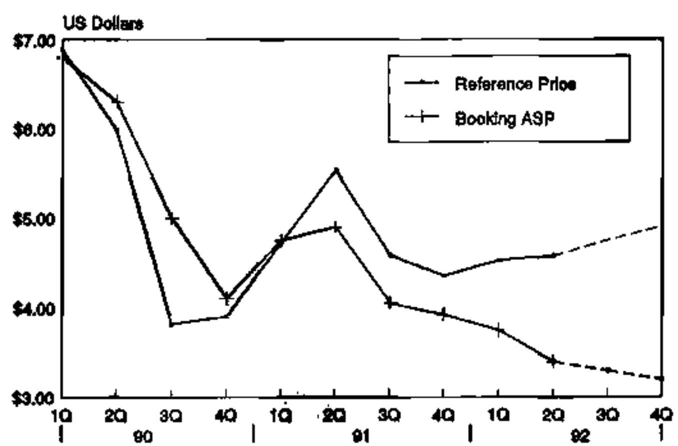
SRAMs next?

ESTIMATED EC DRAM REFERENCE PRICE vs EUROPEAN MARKET PRICE, 256K DRAM



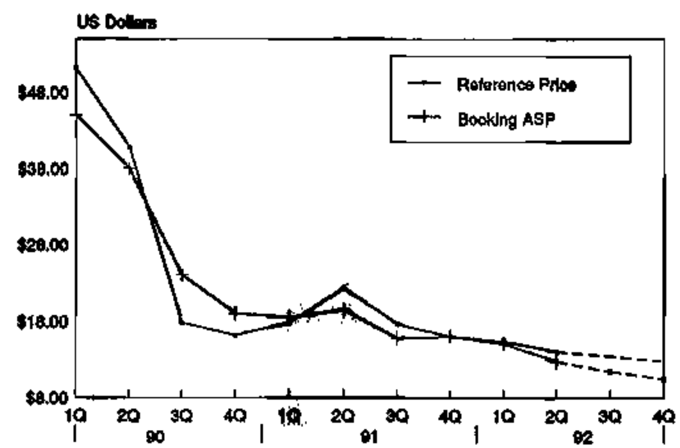
Source: Dataquest (June 1992)

ESTIMATED EC DRAM REFERENCE PRICE vs EUROPEAN MARKET PRICE, 1M DRAM



Source: Dataquest (June 1992)

ESTIMATED EC DRAM REFERENCE PRICE versus EUROPEAN MARKET PRICE, 4M DRAM



Source: Dataquest (June 1992)

Slide 21—European MOS Memory Consumption

Overall demand for memory in Europe in terms of megabits is expected to grow by 50 percent per annum out to 1995.

But there is a slowdown in this growth rate in the longer term. Although PC and workstation manufacturers are increasing their production base in Europe, we do not foresee any major new applications to sustain historical growth rates.

One exception is flash memory. It is getting implemented in many existing and emerging applications.

The success of flash memory has been helped by a worldwide standard on memory cards, the PCMCIA standard, which continues to evolve beyond its original charter for information storage.

Slide 22—European MOS Memory Price/Mbit

But the main differentiator in the memory market is cost, and this slide shows that flash memory suppliers, particularly Intel, are addressing this issue seriously.

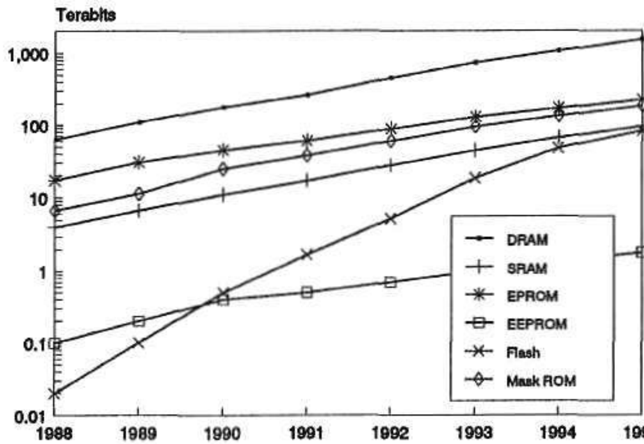
The market potential that flash memory presents has not gone amiss among those who envy Intel's 80 percent market share.

Slides 23 and 24—Flash Memory Product Announcements

This is a summary of some of those companies' plans, all the way from Intel through to TSMC.

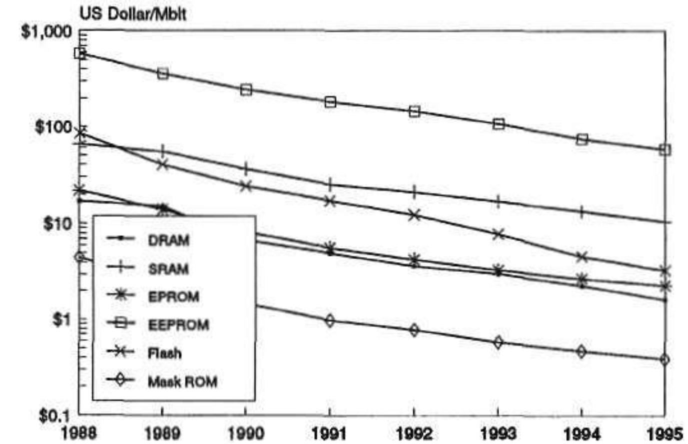
This is a market to watch over the next few years, as these companies start competing against each other for slices of Intel's market share.

EUROPEAN MOS MEMORY CONSUMPTION
(BIT SHIPMENTS)



Source: Dataquest (June 1992 Estimates)

EUROPEAN MOS MEMORY PRICE/MBIT
(AVERAGED ACROSS ALL DENSITIES)



Source: Dataquest (June 1992 Estimates)

FLASH MEMORY PRODUCT ANNOUNCEMENTS

	1M	2M	4M	8M	16M
Intel	4/89	6/90	1/92	4/92	4/93
AMD	9/90	4/91		1/93	9/93
Toshiba	11/90		9/91		6/93
Hitachi	9/90		3/92		
Atmel	9/90				
Samsung				3/93	
SGS-Thomson	1/92		9/93		3/93
WSI					
SEEQ	6/89		6/93		
Mitsubishi	9/90		1/93		8/93
Catalyst	3/91				

Source: Dataquest (June 1992 Estimates)

FLASH MEMORY PRODUCT ANNOUNCEMENTS

	1M	2M	4M	8M	16M
NEC	1/91		3/92		6/93
Fujitsu	1/93		6/93		12/93
Texas Inst.	1/91		1/93		1/95
NMB				1/95	1/95
Cypress	9/92		3/93		9/93
Sharp				1/95	3/95
Vitelic			9/93		
Hualon			9/93		
Macronix					9/95
Oki			3/93		3/94
TSMC				3/93	1/94

Source: Dataquest (June 1992 Estimates)

Products—Logic

Mike Glennon

The outlook is also for a respectable growth over the next five years, comparable to microcomponent and memory.

ASIC has been the strongest contributor to the logic market, but now a wider range of VLSI standard products is encroaching upon ASIC's domain.

Slide 25—Product Cycle Times

ASICs are often used early in a piece of equipment's life cycle, where standard products cannot provide the flexibility in the application.

As the equipment becomes more mainstream, and the volume increases, standard products take over from the ASICs.

These standard products are being developed earlier in the product life cycle, and this is compressing the early period in a product's life when ASICs are the preferred solution.

Many of these VLSI products are supplied by ASIC companies, as they attempt to break out of the ASIC market. The profitability of these products is high, despite the competition.

The price of a gate array may be low, but the price can rise significantly when it is sold as part of a SPARC chip set for example. The design expertise is being leveraged through the higher-priced silicon, raising the profitability of the product line.

Slide 26—Products, Logic

However, the factors which forced down prices in the ASIC market will also apply to these chip set markets.

There is only a limited number of high-volume applications, and many of these have already been identified by these ASIC companies. The PC chip set has had its day. The next application is now GSM, and already suppliers are fighting for these chip set sockets.

Image and data compression, high-definition TV, and cordless communications are other areas where we expect to see severe competition in the longer term.

No surprises are forecast for the general-purpose logic market, and it will maintain its steady level. The emphasis will move away from bipolar products towards CMOS and BiCMOS. The semiconductor market owes much to general-purpose logic, and there is still much to be learned from this market.

Finally, while bipolar is clearly showing a decline in logic, a place still exists in the highest-speed applications. These include very high-performance products such as digital testers or supercomputers.

Applications

Slide 27—European Semiconductor Market, Applications Share

Moving on now to applications, I shall look at EDP, communications, and consumer. As you can see, these represent about two-thirds of the market.

Slide 28—European Semiconductor Market

Here is the short- and long-term forecast for these applications.

You can see from this that:

- Data processing shows the highest long-term growth.
- Perhaps surprisingly, communications shows the lowest of the three.

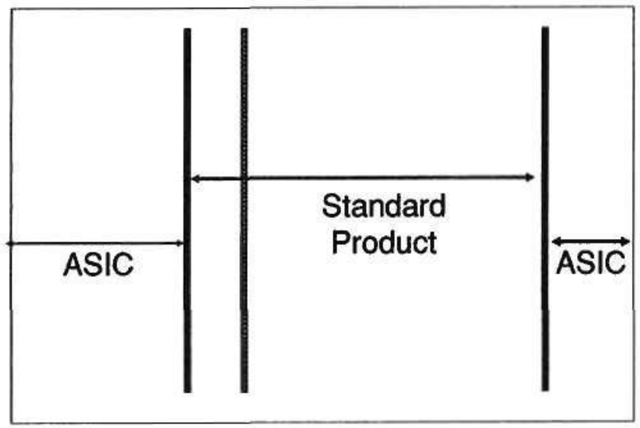
I shall explain the reasons behind this in the next few minutes.

Slide 29—Applications, EDP

Looking in more detail at EDP applications, manufacture of PC products is returning to Europe again, reversing the transfer of production to the Far East. The lack of control of production at these large distances, in a fast-moving market, has added to the cost of manufacture.

The total cost of delivering a product to a customer is now considered; offshore manufacture is not necessarily cheaper in this overall equation. PC manufacture is not alone in this, and other areas of manufacture, such as some consumer and telecoms products, are also being brought back to Europe.

PRODUCT CYCLE TIMES



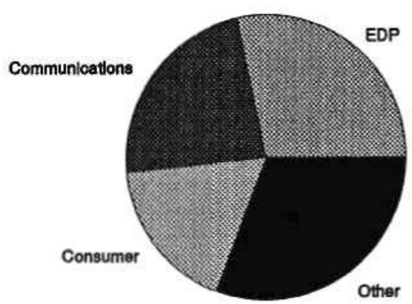
Product Lifetime

Source: Dataquest (June 1992 Estimates)

PRODUCTS - LOGIC

- Emphasis moving to standard products
  - ASIC is the loser here
- Fierce competition in GSM, HDTV, data compression, will axe chip prices
- General-purpose logic will move to CMOS and BiCMOS
- Bipolar still has a place in high-speed applications

EUROPEAN SEMICONDUCTOR MARKET APPLICATIONS SHARE



1991 Applications Share

Source: Dataquest (June 1992 Estimates)

EUROPEAN SEMICONDUCTOR MARKET

(Millions of ECU)

	1991	1992	% AGR	1996	% CAGR
EDP	2,594	2,837	9.4	4,392	11.1
Communications	2,123	2,240	5.5	3,225	8.7
Consumer	1,613	1,695	5.1	2,561	9.7

Source: Dataquest (June 1992 Estimates)

In addition to PC manufacture, workstation and mainframe manufacture is likely to increase, following the transfer of some production to Europe. Companies such as Bull and Olivetti are expected to increase their purchase of semiconductors, following a moratorium in purchasing to reduce inventories. These, however, are short-term changes. In the long term, multimedia-related products will be the driver for electronic data processing. Windows and other software will make significant demands on processor performance and memory needs.

Image management will also stimulate demand for peripheral chips; for image compression and decompression, and also network interface products. The complexity of these components is so high, they must be developed in multichip solutions. So, the outlook for multimedia applications is good, as the silicon demands are quite high at the moment.

However, there are many suppliers which are developing chip sets for this market now, while the high growth is still some time away. When the market does begin to take off, several suppliers will be ready to jump in at a moment's notice. The final result will be severe competition on price.

Slide 30—Applications, Communications

Communications is another major applications area in Europe, and is indeed Europe's greatest strength. However, the high long-term growth for the communications market is now past its peak, and we can expect lower growth in the long term. Much of the high growth is related to the digitization of communications within Europe, but this is nearing completion. But Eastern Europe still requires a digital infrastructure to be built, and the introduction of second operators into many countries will add to exchange and switch sales. The GSM network is still being built, but much of this work will be also completed in the near term. The market with the highest potential growth is cordless communications, although this does not require the same level of infrastructure.

So the potential decline in internal consumption of infrastructure products must now be balanced by exports of European telecoms products. Typically this would include exchange manufacture and mobile handsets.

The outlook for the communications sector of the semiconductor market is therefore related in the long term to the health of the world's communications market, as the export of equipment is dependent on the competitiveness of Europe's telecoms hardware suppliers.

These companies should maintain some success, however, as the world's top telecoms hardware manufacturers are European.

Slide 31—Applications, Consumer

In the consumer market, while the short-term demand has been weak, the longer-term outlook is much better. Fear of recession has slowed consumption of consumer products, and many suppliers built products in time for an expected boom, related to this year's Olympics, but this has yet to materialize, resulting in large inventories. There were some signs of a mini-boom in countries such as Austria and Switzerland prior to the Winter Olympics, but the summer boom is yet to come.

In the longer term, the outlook is better. Digital audio equipment will give consumers something new to spend their money on, when confidence returns to the market. Multimedia products provide another outlet for spending.

The negative factor is incompatiblity between vendors' formats, in both digital audio markets and multimedia. This may provide a brake on early take-up of the devices, until a clear winner is seen.

HDTV is a long time away, and the standards battle is yet to be finished. Resistance from both suppliers and consumers may hinder the success of this product, in spite of efforts by the European Commission:

- The Commission is trying to enforce a standard.
- But the suppliers have yet to be satisfied.
- The consumer as yet can only see an expensive TV, with little benefit in improved resolution.

I have shown you how we expect the market to behave for both products and applications, and this clearly will have an impact on how the semiconductor companies will perform over this period.

APPLICATIONS - EDP

- High growth again
  - PC manufacture returns to Europe
- Mainframe and workstation manufacture in France and Italy rises
- Longer-term multimedia will be the application driver

APPLICATIONS - COMMUNICATIONS

- Europe's greatest strength
- Internal consumption:
  - Digital communications
  - Mobile and cordless
  - Infrastructure in East Europe
- External exports:
  - Exchanges
  - Mobile handsets
- World's top hardware suppliers are European

APPLICATIONS - CONSUMER

- Short-term demand weak
  - Threat of recession in most countries
  - Excess inventory of all consumer goods
  - Olympics may not help
- Longer-term outlook is better
  - DCC and minidisk to stimulate demand
  - Consumer multimedia
  - HDTV: let's wait and see

Vendor Analysis

Jim Eastlake

Earlier, I established the principle that the behavior of product and applications markets affect company market share, though I acknowledged that there were other factors.

Well, I am now going to take the applications and product forecast that Mike and Byron have just presented and use them to do some portfolio analysis to see how market shares may evolve over the next five years.

Slide 32—European Product Split

This is a listing of the major product markets from bipolar digital, through MOS memory, micro, logic, and so on. On this we can plot the percentage share that each represents of the total European market.

So, bipolar digital represents 4 percent of the European market, MOS memory 20 percent and so on. The "average" line plots these shares giving an average for the European market. Note that analog, memory and micro represent the three largest markets. Though MOS logic and discretes are quite sizable too.

Take the long-range product forecasts and see which product categories contribute the most growth in dollars, or ECU, to the European market over the next five years. We can now plot what we call the "growth contribution" that a particular product area will make.

As you saw, we believe memory and micro will contribute most of the value of the growth to the European market, followed by logic and then analog. Note that discretes, opto. and bipolar products contribute little or nothing to Europe's growth.

So far then, the slide tells us that while analog is the biggest market in Europe, its growth contribution is somewhat less that MOS memory and micro, which by 1996 will be substantially bigger markets than the other five product areas.

Slide 33—European Applications Split

To cut a long story short, we can do a similar analysis with applications markets. Here we see the percentage share that the six applications markets show and the markets' growth contributions. The conclusion is that data processing is Europe's largest applications market though communications, industrial and consumer are quite substantial. Also, over the next five years, we believe data processing will contribute nearly 35 percent of the value of Europe's semiconductor market growth. The nearest other market will be communications which will contribute about 20 percent.

So, here we have a quantitative analysis technique based on size of current market and a market's growth contribution for products and applications. I am now going to use it to see if we can draw some conclusions about what US, European and Japanese companies' share of the European market will be like in five years' time.

In order to do this I am going to take the aggregated European sales in 1991 of the three big US, European and Japanese companies to look at how their combined market share may evolve. So, I have combined the European revenues of Philips, Siemens and SGS-Thomson; Motorola, Intel and Texas Instruments; and Toshiba, NEC and Hitachi. I have then calculated what percentage of the combined sales of these three groups is by product and applications market. Let us begin with the position of three European companies.

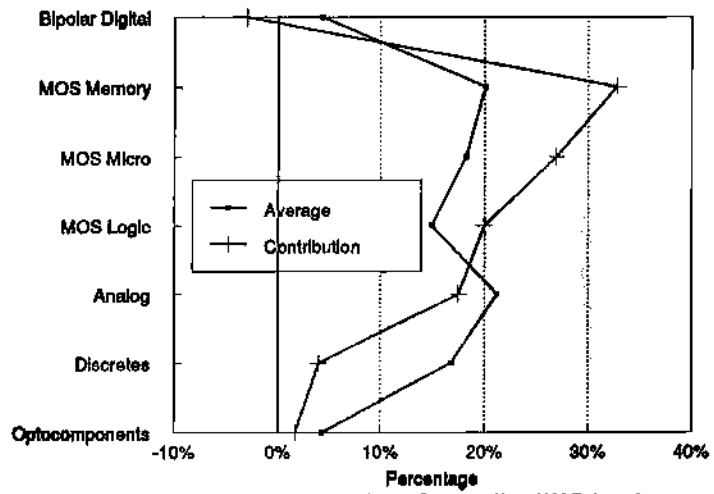
Slide 34—Top Three European Companies' Analysis, Product Split

This slide plots the top three companies' combined product portfolios on the share/contribution graph. The bars show the percentage of their total European sales, which fall into each of the main product markets. You can see that their combined sales are heavily weighted towards analog and discrete products which represent over half the business; whereas memories and microcomponents, the main contributors to growth, represent a relatively small part of combined business. Let us look at their combined position in applications.

Slide 35—Top Three European Companies' Analysis, Applications Split

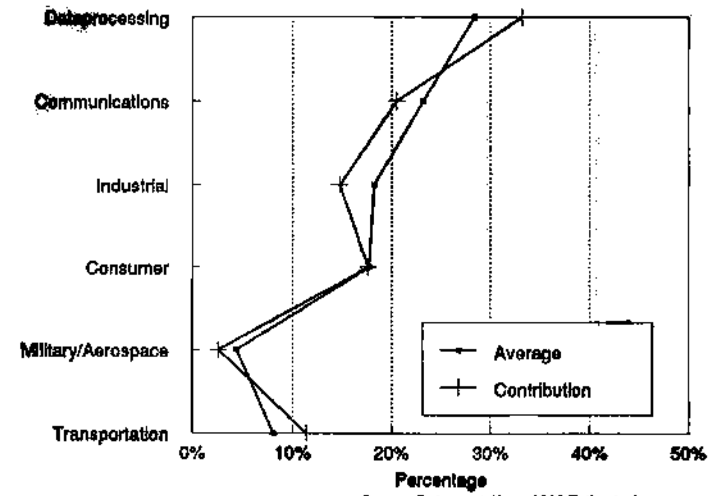
Again, the bars show the percentage of the three companies' combined European revenues which fall into the major applications markets. The analysis shows that nearly 35 percent fall into consumer, when consumer represents only 18 percent of the European market. Sales in

PORTFOLIO ANALYSIS
EUROPEAN PRODUCT SPLIT



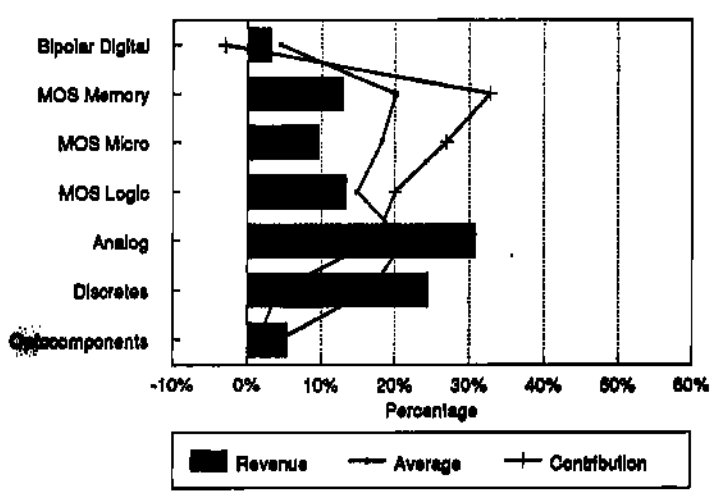
Source: Dataquest (June 1992 Estimates)

PORTFOLIO ANALYSIS
EUROPEAN APPLICATIONS SPLIT



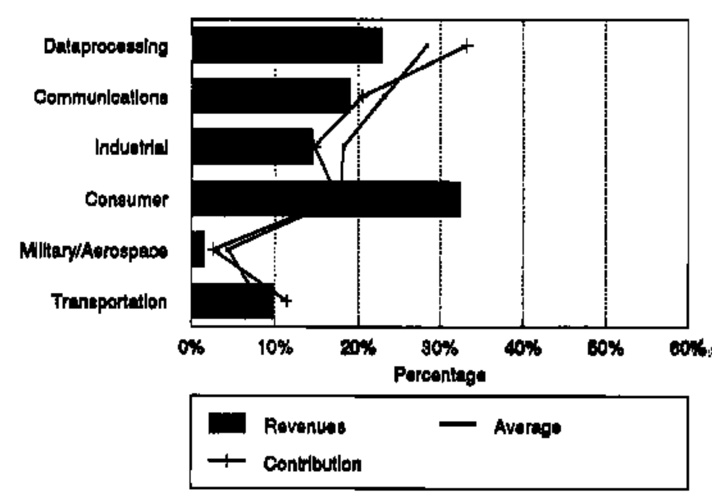
Source: Dataquest (June 1992 Estimates)

TOP THREE EUROPEAN COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



Source: Dataquest (June 1992 Estimates)

TOP THREE EUROPEAN COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



Source: Dataquest (June 1992 Estimates)

industrial and transportation are pretty much at market average. But, the percentage of their business, which falls in the two key growth segments of data processing and communications, is notably below average.

So we can conclude that the big European companies have dominance over the slower growth product and applications markets. With this in mind it becomes clear why the three companies have made certain strategic moves:

- Siemens has committed itself so heavily to DRAM, and has taken a license for MIPS RISC technology.
- Pasquale Pistorio [of SGS-Thomson] has voiced the need to enter the DRAM business; why he acquired Inmos to strengthen SGS-Thomson's micro and SRAM businesses; and why he is showing an interest in X86 processors.
- Philips has stayed in the PC business, and taken the license to Sun's SPARC, though it clearly needs to increase its presence in memories.

Slides 36 and 37—Top Three European Companies, Product and Applications Split

These are independent companies, So, their individual details differ considerably. In order to illustrate this I have included the next two slides in the conference binder which illustrate the individual products and applications portfolio details of the three. You can see for example, Siemens' significant sales in memories, and Philips' dominance in the consumer segment.

Slide 38—Top Three US Companies' Analysis, European Product Split

Now let us move on to look at North America. The combined product sales of the "big three" is shown here. It is certainly very different to the European companies' picture.

Nearly half of US companies sales to Europe fall into microcomponents: over twice the market average. By contrast, the combined portfolio of the three falls significantly below the market average in memory, logic, analog, discretes and optocomponents.

Companies with more than twice the market average share in a product tend to lose share with time. So, with such a presence in micros it seems highly likely that their combined market share will come under pressure. Though micros is one of the two big growth contributors.

Now we will look at how US companies' applications pan out.

Slide 39—Top Three US Companies' Analysis, European Applications Split

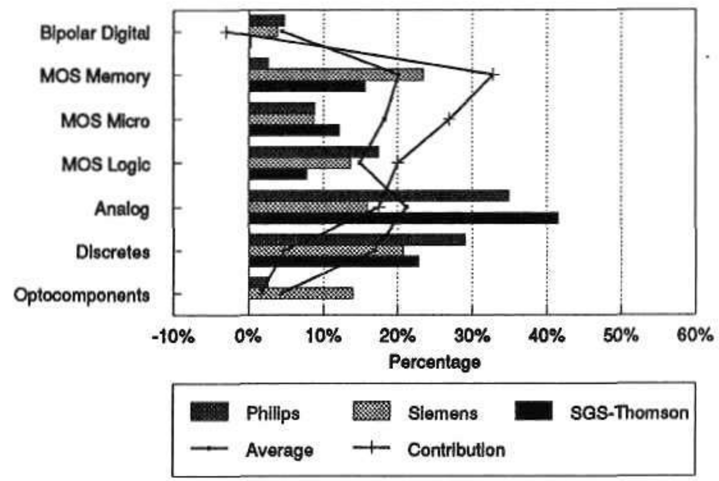
Well, not surprisingly with such a focus on microcomponents, an above-average percentage of their sales in Europe are into data processing applications. What this comparison reveals is a gap in the consumer segment.

So, among the major growth contributors in Europe, the three US companies are probably too heavily biased towards microcomponents, and data processing. In order to improve their likelihood of maintaining market share, they should strengthen their presence in memories, MOS logic and analog, and focus on consumer.

To this end we have seen:

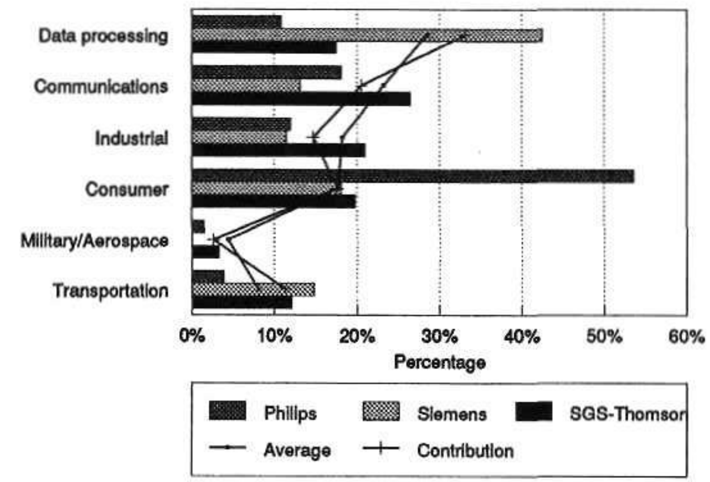
- Motorola develop a relationship with Toshiba over memory technology and products. It became involved with a number of companies in the field of consumer such as Philips, with which it is developing multimedia products.
- Intel perform pioneering work with flash memory, enter the DRAM business again through reselling Korean products, and develop its own DVI multimedia algorithm and product offerings.
- Texas Instruments blazes a trail of manufacturing and technology joint ventures in memories with its competitors, customers and even governments. It announced a re-emphasis on its consumer division, and is one of the most active participants worldwide in the various HDTV projects.

TOP THREE EUROPEAN COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



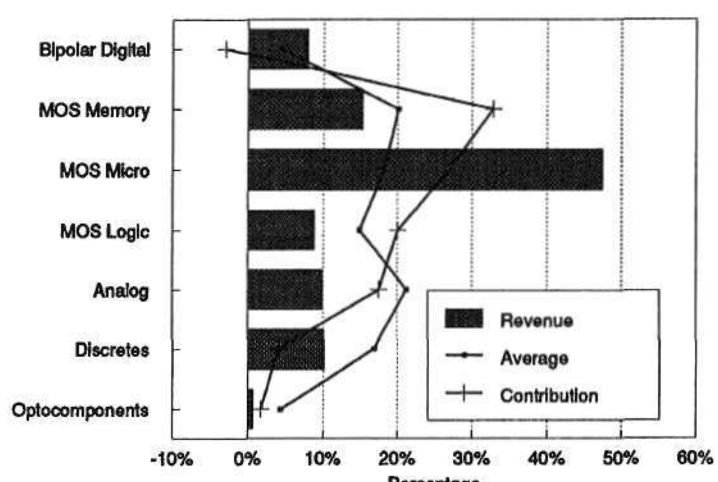
Source: Dataquest (June 1992 Estimates)

TOP THREE EUROPEAN COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



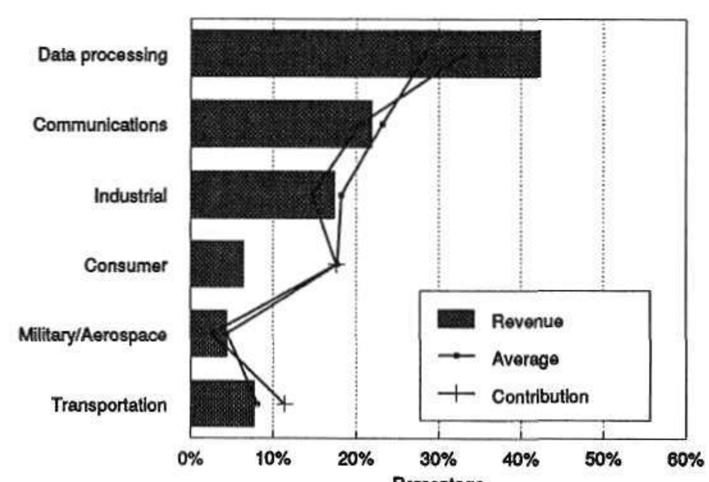
Source: Dataquest (June 1992 Estimates)

TOP THREE US COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



Source: Dataquest (June 1992 Estimates)

TOP THREE US COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



Source: Dataquest (June 1992 Estimates)

Slides 40 and 41—Top Three US Companies' Analysis, European Product and Applications Split

Again, US companies' individual details differ greatly. In order for you to study them in detail I have included these next two slides.

Slide 42—Top Three Japanese Companies' Analysis, European Product Split

Now to the big three Japanese. Well, no prizes for guessing which product area represents the biggest portion of their business—memories. Again, like the North Americans, the share of total sales that their biggest product area represents of their total European business is over twice the market average for that product. Unlike the North Americans, a big portion of their sales comes from the other high growth area, microcomponents.

Other than memories and micros, a study of the rest of their product profile reveals that their presence in bipolar, analog and discretes is well below the European average. This profile has left them vulnerable. With the flat memories business of the past couple of years they have found it difficult to maintain share, and profits have been under pressure. Let us look at their applications profile

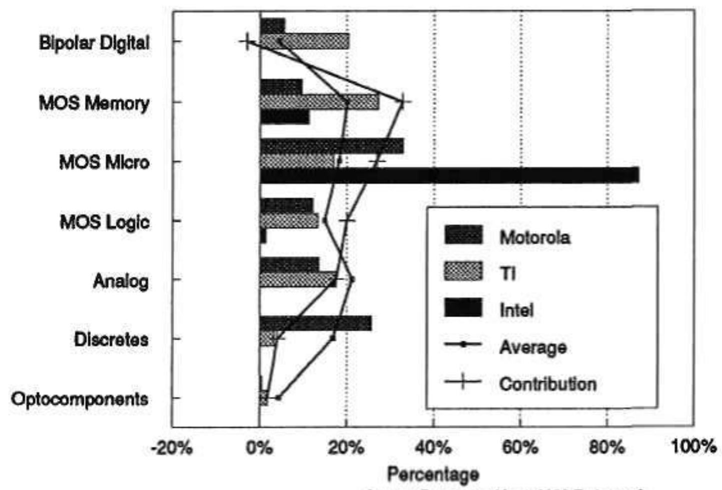
Slide 43—Top Three Japanese Companies' Analysis, European Applications Split

Here we see an interesting picture. Their combined sales reveal an applications profile that maps the European market very closely. The emphasis is clearly towards data processing and is memory-dependent, but unlike the North Americans they have a good deal of business in the consumer segment.

The conclusion I would draw is that Japanese companies' product portfolios *are* too memory-dependent in Europe. But knowing the products and technologies they offer in Japan, they have the ability to boost their European presence in the other areas quite considerably. Their weakness is in microcomponents, more specifically microprocessors and microperipheral chip sets.

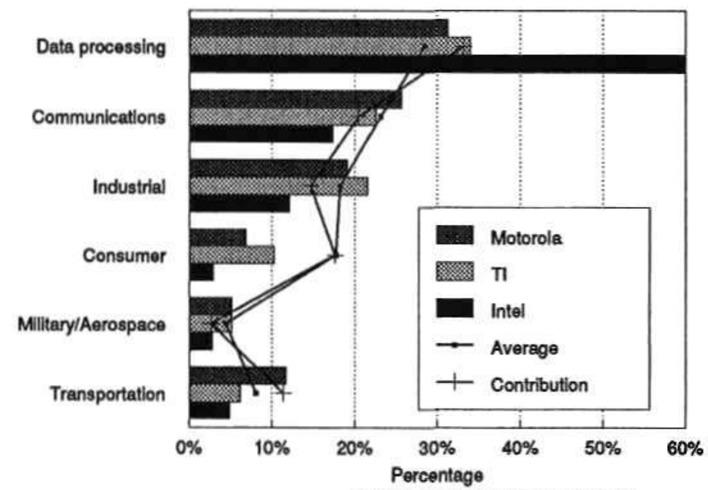
To this end we have seen Toshiba, NEC and Hitachi make a number of moves over recent years to rectify this. Most significant for me is the way in which they have embraced RISC. I see this as a possible route for them to break the North American hold over this area. The irony of the situation is that it is the North Americans who have given them the RISC technology.

TOP THREE US COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



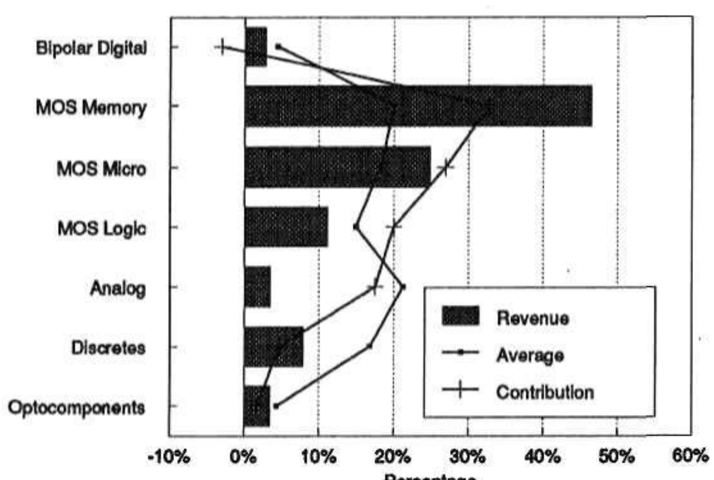
Source: Dataquest (June 1992 Estimates)

TOP THREE US COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



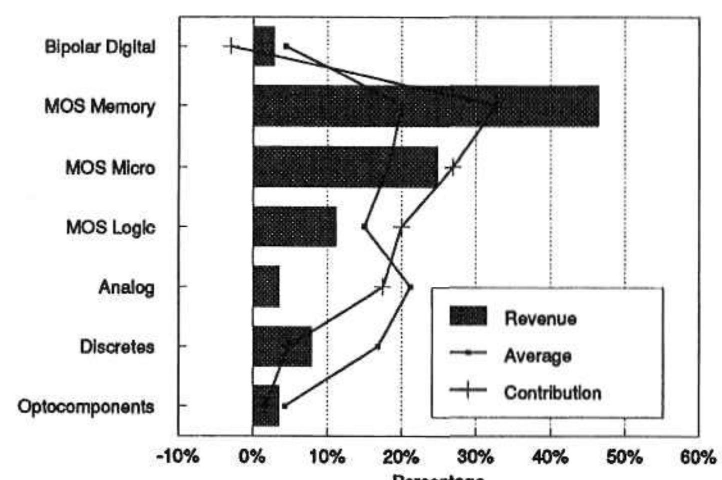
Source: Dataquest (June 1992 Estimates)

TOP THREE JAPANESE COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



Source Dataquest (June 1992 Estimates)

TOP THREE JAPANESE COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



Source: Dataquest (June 1992 Estimates)

Slides 44 and 45—Top Three Japanese Companies' Analysis, European Product and Applications Split

Again no one company is the same and I have yet again enclosed the individual companies' details in the conference binders for your reference.

I have shown how the evolution of product and applications markets have an effect on market share. To a lesser extent, the behavior of country markets can also play a role in determining vendor performance. So, next, we would like to give you our analysis of the main country markets in Europe.

Regions

Mike Glennon

We have now seen how we expect the markets for products and applications to behave, and examined the expected impact of these trends on the semiconductor companies which operate in the European market.

There now remains the regional analysis of the market, where we can see what we expect to happen at the country level.

Slide 46—European Semiconductor Market, Regional Share

For this I will again focus on three representative regions:

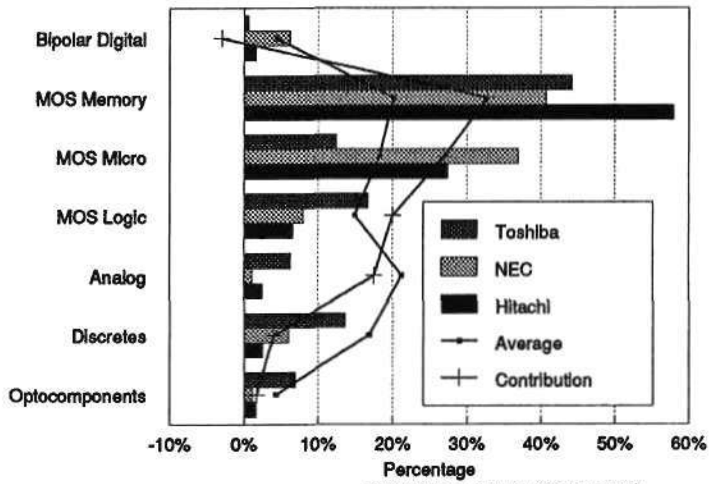
- Germany
- United Kingdom and Eire
- France

As you can see, these three countries represent over two-thirds of Europe's semiconductor consumption.

Slide 47—European Semiconductor Market, Consumption Forecast

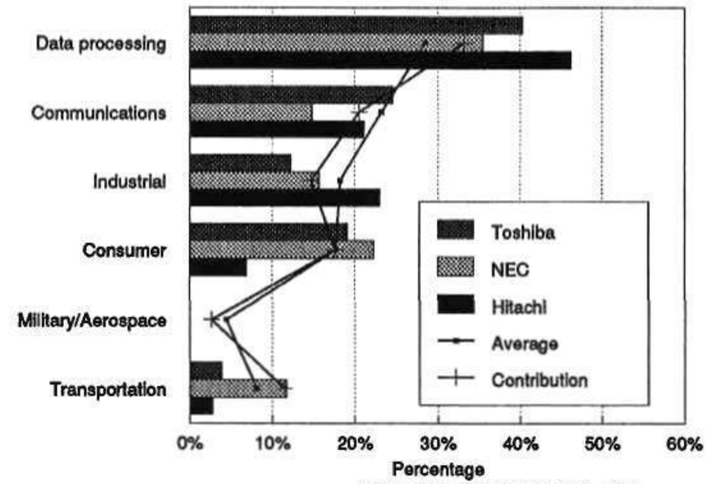
Again, this is Dataquest's forecast for the regions. From this you can see that we forecast the United Kingdom and Eire to have the highest growth of the three, and France to have the lowest. So now I shall look at the reasoning behind this forecast.

TOP THREE JAPANESE COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



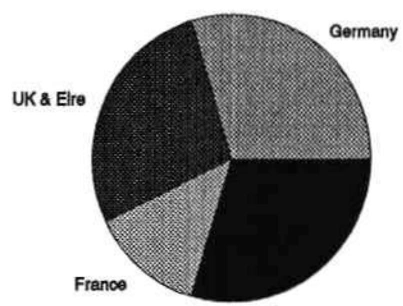
Source: Dataquest (June 1992 Estimates)

TOP THREE JAPANESE COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



Source: Dataquest (June 1992 Estimates)

EUROPEAN SEMICONDUCTOR MARKET REGIONAL SHARE



1991 Regions Share

Source: Dataquest (June 1992 Estimates)

EUROPEAN SEMICONDUCTOR MARKET CONSUMPTION FORECAST

(Millions of ECU)

Country	1991	1992	AGR 92/91	1996	CAGR 96/91
France	1,228	1,275	3.8%	1,844	8.5%
United Kingdom & Ireland	2,405	2,669	11.0%	4,310	12.4%
Germany	2,770	2,878	3.9%	4,294	9.2%

Source: Dataquest (June 1992 Estimates)

Slide 48—Countries, Germany

Turning first to Germany, the region's short-term outlook is poor, but the longer-term outlook is more positive. The cost of unification has had a big impact on the GDP growth, as we said it would at this conference last year. Higher wage demands are increasing costs and interest rates, giving Germans less money to spend on consumer goods. The result is some growth in consumer inventories, and a cutback in production. In addition to this, some consumer production is moving out of the region to areas such as Austria, which has stronger links into Eastern Europe.

The electronic content of cars is increasing, and this is compensating for the short-term decline in new car sales. Exports of cars, in particular to the United States, are growing again, so this sector will improve. To balance these negative factors, longer-term growth looks good. The telecoms business is strong, and the country's manufacturers benefit by being close to Eastern Europe.

Industrial production is also strong, and stable, and does not suffer the same swings in demand as consumer or EDP segments. PC manufacture is also rising, and this is a high-growth area. The longer-term outlook is therefore good, partly due to the size of the country, and the high demand as a result of this. The level of equipment manufacturing investment in Germany by foreign companies has not been massive; but big enough to have an impact on production in the region.

Slide 49—Countries, United Kingdom and Eire

The UK and Eire region also shows high growth, related very strongly to the presence of foreign companies which have invested in manufacturing in the region. However, the result of this foreign investment is that the design wins for the product are in the home market. The short-term outlook is for a recovery, following two weak years. This is related to the expected recovery in consumer consumption, and the knock-on effect on consumer equipment production. The growth in the manufacture of PCs is also contributing to the short-term recovery.

Presenting the conference here in Dublin means Eire should receive a special mention. The Irish market is a major contributor to the UK and Eire region. The location of manufacturers such as Apple, Digital and others means the market here is tied strongly to the PC market in Europe. We foresee this market to continue to show high growth, as the introduction of more advanced PC and workstation products stimulates EDP demand in Europe. The UK and Eire region has been particularly successful in courting foreign investment, perhaps the most successful region in Europe. This is a result of a continued policy throughout the 1980s.

Slide 50—Countries, France

Finally, France. The country is in a poor state of health, with some key French manufacturers in the process of transferring some manufacturing outside Europe to regions with low labor costs. This is at a time when many other countries are attracting manufacturing back to the home region.

But the telecoms business in France is good, and the country is benefiting from the telecoms market boom. The longer-term outlook is not so good, however, as the telecoms manufacturing business is moving past its growth peak.

The factor which is most likely to have an impact on semiconductor consumption is equipment manufacturing. The government appears to have made little effort to attract foreign manufacturers. Some local manufacturers are now transferring production overseas, and there are few new ones to replace them. The French semiconductor market may suffer as a result.

So I have shown you our expectations of performance both in the short term and the long term for the key areas of: products, applications and regions. But how will the European region as a whole perform when compared with the other worldwide regions?

Slide 51—Worldwide Semiconductor Forecast, Actual Market Share by World Region

This is Dataquest's latest forecast for the world regions, out to 1995. Europe lost its position as the world's second-largest semiconductor market as long ago as 1980. The United States lost its leading position in 1985. If the picture is not clear, the next slide shows the underlying trend.

COUNTRIES - GERMANY

- Short-term demand weak
  - Cost of reunification is high
  - Excess consumer inventories
  - Automotive market is soft
- Positive factors are:
  - Telecoms business is strong
  - Industrial production is stable
  - PC manufacture rising
- Longer-term outlook good - due to size
- Attraction for foreign investment - medium

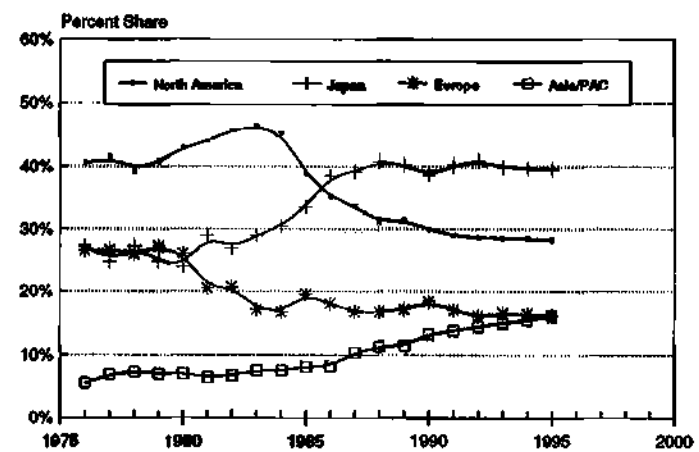
COUNTRIES - FRANCE

- Country close to recession
- Local manufacture moving outside Europe
- Good telecoms business
  - Alcatel No.1 telecoms manufacturer
- Attraction for foreign investment - poor

COUNTRIES - UK & EIRE

- High investment by multinationals
  - Strong manufacturing economy
  - Design wins are outside Europe however
- PC manufacture is concentrated here
- Longer-term outlook good
  - Due to foreign investment
- Attraction for foreign investment - good

WORLDWIDE SEMICONDUCTOR FORECAST ACTUAL MARKET SHARE BY WORLD REGION



Source: Dataquest (June 1992 Estimates)

Slide 52—Worldwide Semiconductor Forecast, Market Share Trend by World Region

From this slide you can see that Western Europe is in danger of becoming the smallest semiconductor market in the world, as the growth in the Asia/Pacific region outstrips that in Europe. The transfer of equipment production to that region is reducing the equipment production in Europe, and hence the semiconductor consumption.

If this is the case, Europe may lose its high technology to other regions, as the worldwide semiconductor suppliers focus their attention in areas where much of the world's manufacturing is located. If this occurs, European equipment manufacturers may not have access to the latest technology, and will therefore lose a competitive edge for their equipment.

Global Investments

Jim Eastlake

Slide 53—Investment

I would like to finish this market analysis with a few observations on the global investment environment.

Between 1986 and 1991 worldwide capital spending on semiconductor plant and equipment grew from $5.1 billion to $14.4 billion. We attribute this incredible surge to a capital investment boom in Japan fuelled by cheap money, and spurred on by a double-digit growth in the worldwide PC market. This has left the industry with significant excess capacity that is going to take time to work off. There are several signs which point to this:

- IC prices are flat or declining, particularly memory products.
- The profits announced by particularly the big Japanese corporations have slimmed.
- The level of foundry activity is increasing, which suggests that some companies are scrambling to sell excess wafer fab capacity in order to attain higher utilization.
- The rate of closure of older fabs is picking up and the speed with which new lines are being brought forward has slowed.

Slide 54—Delayed 200 mm Fab Plans in Japan

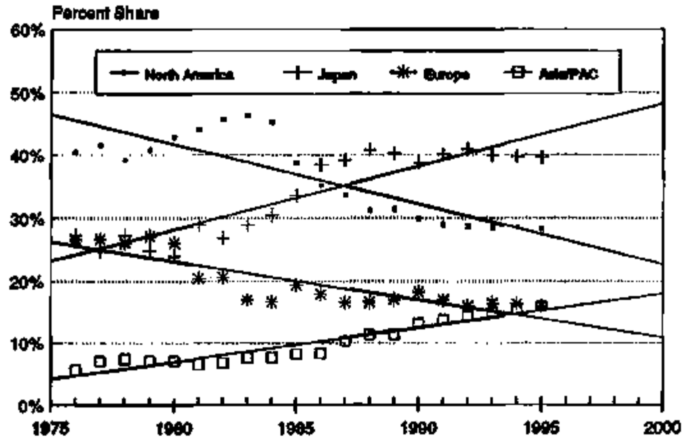
This slide shows the number of 200 mm mainly memory fab projects that have been delayed or scrapped recently in Japan. There are 12 here but outside Japan there are even more. Byron already indicated that Europe has not escaped.

Slide 55—Worldwide Forecast of Production, Capital Spending and Wafer Fab Equipment

Against this background we do not expect the current levels of capital spending to be maintained. This table summarizes our latest projection for semiconductor production, capital spending and fab equipment revenues.

You will see that we expect global capital spending to shrink by 3 percent this year and that wafer fab equipment sales will decline by 8 percent. The projected growth of 14 percent in the value of semiconductor production may then seem contradictory, but this is possible because of the excess capacity. In the longer term, we forecast the compound annual growth rates for capital spending and fab equipment as being only single-digit across the period 1990 to 1995. This is to be compared with the solidly double-digit growth through the 1980s.

WORLDWIDE SEMICONDUCTOR FORECAST MARKET SHARE TREND BY WORLD REGION



Source: Dataquest (June 1992 Estimates)

INVESTMENT

- Investment grew from $5.1 billion to $14.4 billion from 1986 to 1991
- Reason: investment boom in Japan
- Result: excess capacity
- Evidence:
  - Memory prices
  - Japanese profit margins
  - Increase in foundry activity
  - Increased fab closures/delays

DELAYED 200 mm FAB PLANS IN JAPAN

COMPANY	PRODUCTS	FAB TYPE
Fujitsu	16Mb DRAM	Production
Hitachi	4Mb/16Mb DRAM	Production
KTI	ASIC	Production
Matsushita	16Mb DRAM	R&D
Matsushita	16Mb/64Mb DRAM	Production
NEC	16Mb DRAM, MPU	Production
NEC	4Mb/16Mb DRAM, EPROM	Production
NKK	4Mb SRAM, ASIC, MPU	Pilot
Oki	16Mb DRAM	Production
Sanyo	16Mb DRAM	Production
Sharp	4Mb DRAM, ROM	Production
Toshiba	16Mb DRAM	Pilot

WORLDWIDE FORECAST OF PRODUCTION, CAPITAL SPENDING AND WAFER FAB EQUIPMENT

(Millions of Dollars)

	1991	1992	AGR	1995	CAGR 95/90
Production	69,231	78,769	14%	110,352	11.9%
Capital Spending	14,372	13,970	-3%	19,090	8.8%
Fab Equipment	6,026	5,568	-8%	8,883	8.7%

Source: Dataquest (June 1992 Estimates)

Slide 56—Investment

What do we consider to be the implications of the end of this Japanese-led boom.

Firstly we can expect Japanese semiconductor companies to slow down their plans for foreign investment. There are clear signs of this happening now. Secondly, we see a slowdown in the flow of capital from Japan. The migration of Japanese equipment and materials companies set to follow their customers abroad will slow. This will result in fewer acquisitions and investments abroad which in turn will cut off a vital flow of investment to, in particular, US companies, given the importance Japanese capital has played in funding start-ups. Thirdly, Japanese companies will increasingly move away from commodity products towards offerings with added higher value; as a result, chip design and manufacturing flexibility will grow in importance. Finally, there is the spectre of increased trade friction.

The silver lining to this dark cloud rests on the simple fact that the increasing use of semiconductors across a bewildering array of applications will continue at a steady pace. Several new areas promise to kick the industry back into high gear over the next four or five years. We have mentioned some already. But, we must be vigilant for there is a clear analogy with market conditions of the past, if capacity is cut back too far at the wrong time.

Slide 57—Summary

We explained how we believe memory reference prices will be less influential in the future as production in Europe increases. We then indicated that we see semiconductor demand from the communications segment in Europe starting to slow, as the digitization of exchanges nears completion. Germany is experiencing a short-term slowdown as the cost of unification slows economic growth. But as the country recovers, we will see the semiconductor market improve within the window of this forecast.

I indicated that, *combined*, the big three Japanese companies seem best positioned in Europe's product and applications markets to maintain or grow market share over the next five years. And finally, the current overcapacity in the industry is going to take time to work off with the inevitable consequences on prices.

INVESTMENT

- Slowdown in Japanese foreign investment
- Slowdown in transfer of capital
- Migration from commodity to value-added products
- Spectre of increased trade friction
- Pervasiveness of semiconductors will restore balance

SUMMARY

- Memory reference prices less influential
- Telecoms growth slowing
- Germany's slowdown short term
- Japanese companies well positioned
- Overcapacity will take time to work off

In Future Issues

In *Dataquest Perspective,* Semiconductors Europe, Conference Special, Part 2 we will be looking at the speeches given by the other Dataquest speakers. Their topics will cover:

- End-user strategic trends
- Personal communications
- Videophones

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9205 May 29, 1992

In This Issue...

Pricing Analysis

European Pricing Update

The memory reference prices are due in June, and these may hold back a few large memory orders. In standard logic, prices are remaining firm, and lead times are lengthening, which is typical for this time of the year. Intel has announced massive price cuts in its 486SX products, which should have a rippling effect through to 386 prices, forcing them down in the near term.

By Byron Harding and Mike Glennon *Page 2*

Market Analysis

State of the Industry

The SIA European book-to-bill ratio for April was 1.02, lifting slightly from March's 0.99. While bookings have shown little growth, billings have declined dramatically. If this trend continues, the outlook for the year is very bleak indeed. The actual data is now running well below the forecast model data, and as the booking data has yet to show an upturn, the billing data is unlikely to lift for at least the next three months.

By Jim Eastlake and Mike Glennon *Page 4*

The Balance of Power in the European EDA Industry

The EDA industry has seen much structural change over the past few years. Many small companies have combined to produce a much larger organization, ideally giving this new organization much greater influence in the market. This article looks at the bargaining relationships between suppliers and vendors, and recommends strategy options to these suppliers, whether they are large, newly formed, or small vendors.

By Jim Tully *Page 8*

Technology Analysis

On the Verge of 3 Volts

The introduction of many portable products, requiring battery power rather than mains, has accelerated the need for ICs that consume lower power. This article adresses many of the issues surrounding the transition of ICs from the current 5V standard to a new low-voltage standard.

By Gerald J. Banks and Patricia Galligan *Page 17*

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File inside the *Dataquest Perspective* binder labeled Semiconductors *Europe*

Pricing Analysis

European Pricing Update

Table 1 shows European semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Standard Logic

There are no changes in the prices for standard logic, but lead times are lengthening, which is typical for this period of the year. The lead times are hitting 24 weeks on some products from certain suppliers. These lengthening lead times are relieving pressure on the prices, but the prices have not actually increased. Philips' announcement about dropping a range of its bipolar products is driving longer-term business towards other suppliers, also adding stability to the prices.

Analog

The mono operational amplifier arena in Europe is fairly stable, with no price changes.

Microcomponents

The 386 products are showing their typical price declines for this period. The large price reduction announced by Intel for its 486SX is increasing its battle for market share. AMD has announced a competing product, but has yet to give an indication of price. In the meantime, Intel is taking the initiative, and pushing the entry cost higher.

Memory

DRAM

Prices continue to slip downwards in many cases, although it is the 4M part that is dropping the fastest. This has a direct effect on the 1Mx9 SIMM, which is increasingly being sold in a three-chip format, using 4M. The question being asked in the industry is whether demand for the 4M DRAM will pick up faster than expected, so that the conservative ramp-up in Japan announced by MITI earlier this year would give rise to a shortage in the summer. The impending announcement of new reference prices in June is probably holding back a few large orders. Will the 4M reference be going up, or down?

The average contract price per Mbit is as follows:

- 256K = $6.08
- 1M = $3.15
- 4M = $3.00
- 1Mx9 = $3.33
- 16M = $8.75

EPROM

European prices for UV EPROM are very attractive, and erosion continues at most densities. The average contract price per Mbit is as follows:

- 1M = $2.90
- 2M = $2.20
- 4M = $2.75

SRAM

European prices for slow SRAM continue to be very competitive. Price erosion has held off somewhat now. However, Europe continues to lead the world in bargain-basement prices on the 1M slow SRAM. The average contract price per Mbit is as follows:

- 64K = $26.00
- 256K = $13.00
- 1M = $9.30

Current Exchange Rates

1 US dollar =
0.550 UK pounds
1.613 deutsche marks
5.425 French francs
0.786 ECU

By *Byron Harding*
Mike Glennon

Table 1
European Semiconductor Pricing May 1992
All Prices in US Dollars (including import duty where relevant)

Device Family	Product	Package	Mean 1K Price	Mean 10K Price	25K+ Contract Price	Lead Time in Weeks
Standard Logic	74F00	PDIP	0.12	0.10	0.09	12–18
Fast TTL	74F74	PDIP	0.14	0.13	0.12	12–18
	74F138	PDIP	0.18	0.17	0.15	12–18
	74F244	PDIP	0.25	0.24	0.21	12–18
Standard Logic	74AC00	PDIP	0.19	0.17	0.15	12–16
Advanced CMOS	74AC74	PDIP	0.24	0.21	0.20	12–16
	74AC138	PDIP	0.35	0.30	0.26	12–16
	74AC244	PDIP	0.43	0.37	0.35	12–16
Analog	741 Op. Amp.	TO92	0.17	0.12	0.11	4–6
	CODEC/Filter 1	[1]	2.90	2.65	2.50	6–10
	CODEC/Filter 2	[2]	5.75	5.45	5.00	6–10
Microcomponents	80386SX-16	PQFP	49.00	48.00	47.50	8–12
	80386DX-25	CPGA	103.00	98.00	95.00	8–12
	80286-16	PLCC	11.70	11.00	10.00	4–6
	68020-16	PQFP	31.00	28.00	26.00	4–6
	R3000-25	CPGA	135.00	120.00	110.00	4–10
Memory						
DRAM	256K-8 (256K×1)	PDIP	1.80	1.60	1.52	2–8
	1M-8 (1M×1)	SOJ	4.00	3.40	3.15	2–6
	1M-8 (256K×4)	SOJ	4.00	3.40	3.15	2–6
	4M-8 (4M×1)	SOJ	14.50	13.90	12.00	2–8
	9M-8 (1M×9)	SIMM	32.00	30.50	30.00	2–4
	1M-7 (1M×1)	SOJ	4.00	3.40	3.15	2–8
	1M-6 (1M×1)	SOJ	4.16	3.54	3.28	4–10
	4M-7 (4M×1)	SOJ	14.20	13.00	12.00	4–8
	4M-6 (4M×1)	SOJ	15.20	13.60	12.50	6–10
	16M-8 (4M×4)	SOJ	140.00	140.00	140.00	8–14
UV EPROM	1M-17 (128K×8)	CDIP	3.50	3.15	2.90	2–6
	2M-17 (256K×8)	CDIP	6.40	5.10	4.40	2–8
	4M-17 (512K×8)	CDIP	15.50	12.50	11.00	4–10
SRAM	64K-85 (8K×8)	PDIP	2.10	1.85	1.65	4–10
	256K-85 (32K×8)	PDIP	3.80	3.50	3.25	4–8
	1M-85 (128K×8)	PDIP	11.00	9.80	9.30	2–10

[1] Group 1: Commercial temp, serial, PDIP, A/μ law
[2] Group 2: Commercial temp, serial, PLCC, A/μ law, programmable
Source: Dataquest (May 1992)

Market Analysis

State of the Industry

The WSTS flash three-month average book-to-bill ratio for April was 1.02, an increase from April's 0.99, as shown in Figure 1. Three-month average orders booked totalled $909.5 million, a meagre 0.5 percent increase on March. However, three-month average orders billed totalled $889.5 million, a 2.9 percent decline on the previous month, resulting in an increase in the book-to-bill ratio. WSTS's estimate for the actual month's billings in April was $789.5 million, a 21.9 percent decrease from March's restated estimate of $1,010.5 million.

A decrease in billings in April compared with March is to be expected, as April is the first month of a quarter, but a decrease of this magnitude is unusual. With the first four months of 1992's billing data available now (in effect the first third of the year), the period has grown by 1.4 percent over the same period last year. In Europe we have come to expect most market growth to take place in the first five months of the year. With this in mind, Europe looks set for single-digit growth again in 1992.

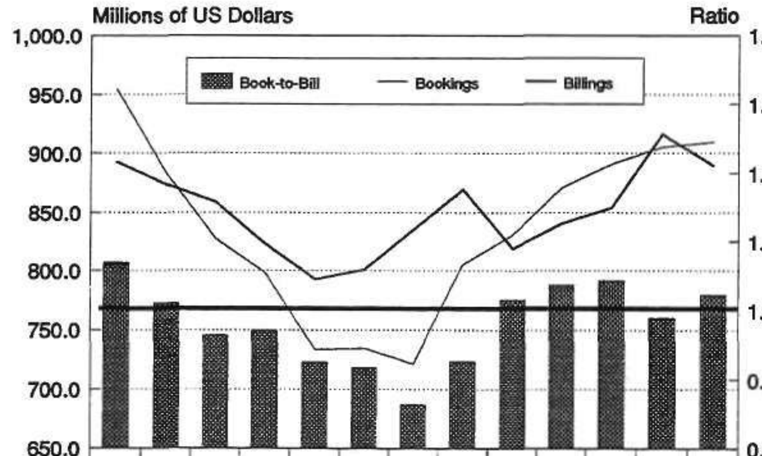
The US picture is somewhat different from Europe. April's three-month average bookings increased by 4.8 percent to $1,571.3 million from March's $1,499.6 million. Three-month average billings also increased, by 2.1 percent, from $1,402.6 million to $1,432.0 million. This resulted in a book-to-bill ratio of 1.10, and it marks the sixth consecutive month that the US ratio has been above unity.

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trend and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billing and three-month average booking figures. These figures represent an "average" year. When the actual figures are compared with the forecast, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

Figures 2, 3 and 4 show the forecast and actual three-month average bookings, actual monthly

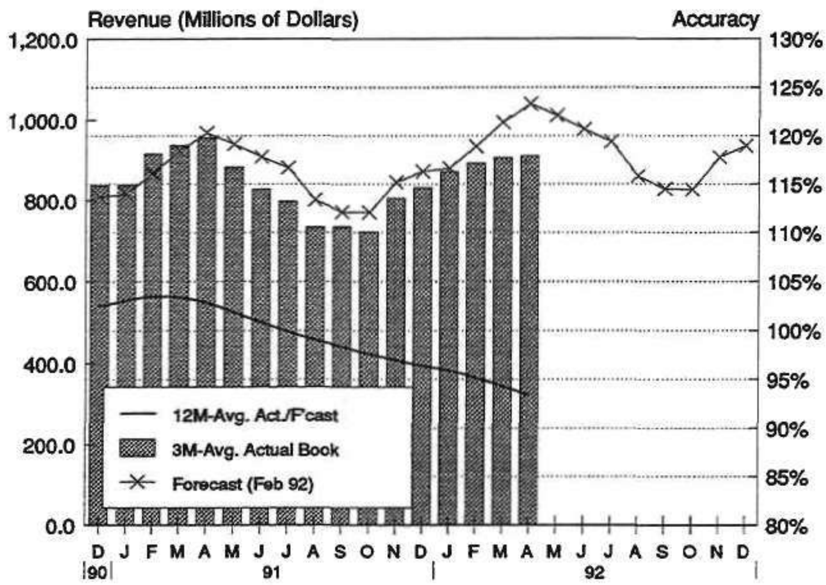
Figure 1
European Total Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Apr	May	Jun	Jul	Aug 91	Sep	Oct	Nov	Dec	Jan	Feb 92	Mar	Apr
Book-to-Bill	1.07	1.01	0.96	0.97	0.93	0.92	0.86	0.93	1.02	1.04	1.04	0.99	1.02
Bookings	954.6	882.4	827.3	798.3	733.5	734.6	721.4	805.1	831.0	871.0	891.0	905.4	909.5
Billings	893.0	873.5	858.7	823.0	792.7	800.8	835.2	869.4	818.7	840.5	854.0	915.9	889.5

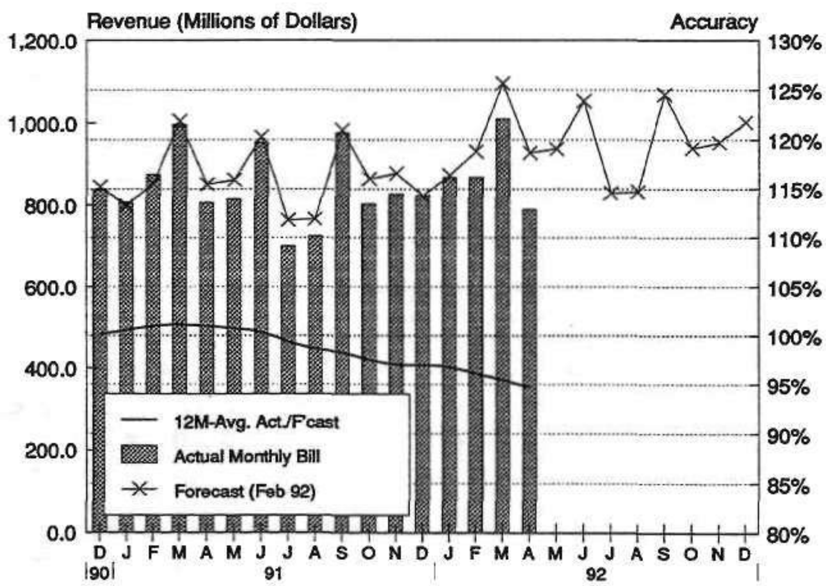
Note: Last two months are preliminary.
Source: WSTS, SIA

Figure 2
European Total Three-Month Average Bookings



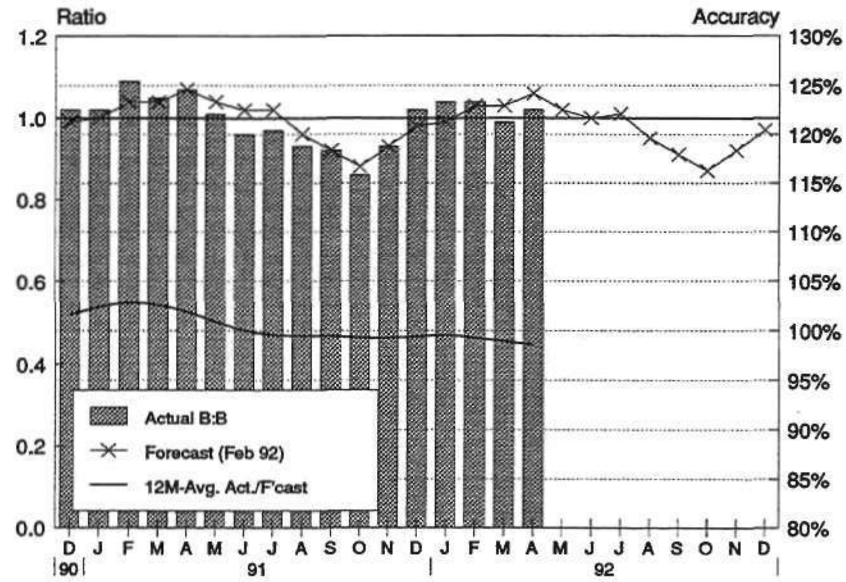
Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (May 1992)

Figure 3
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (May 1992)

Figure 4
European Total Semiconductor Book-to-Bill



Note: Last two months are preliminary.
Source: WSTS, SIA, Dataquest (May 1992)

billings, and book-to-bill ratio from the Dataquest forecast model.

The actual data is showing little growth, and the gap between the forecast model output and the actual data is widening. The actual billing figure for April is well below the forecast model expectations, and out of line with the indicated trend. This would suggest the data is weak, and it is likely to be restated upwards.

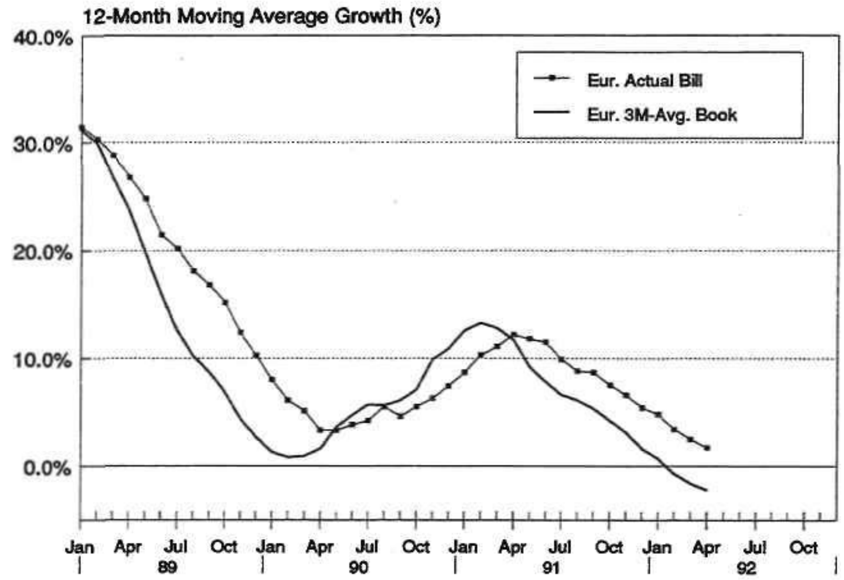
The forecast model for billings calculates a growth for the year of 8.8 percent, based on its calculated value for 1991. However, the actual value for 1991 was lower than that calculated by the forecast model, so the forecast growth for 1992 over the actual 1991 value is 12.7 percent. The underlying trend apparent from the data we have so far indicates that growth for 1992 is likely to be nearer 1 percent over the actual figure for 1991. The booking model calculates a growth of 7.5 percent over its calculated value for 1991, and a growth of 12.0 percent over the actual value for 1991. The underlying trend here indicates this growth will also be close to 1 percent over the actual 1991 value.

The 12-month moving average growth in bookings for Europe is continuing its decline. Average growth for the past 12 months is now minus 2 percent. The 12-month average bookings growth curve is an excellent leading indicator for 12-month average billings growth, as can easily be seen in Figure 5. The indication from this is that the decline in bookings has not yet reached a turning point, so billings are unlikely to show any sign of improvement for at least two months, and possibly as long as four months.

Dataquest Perspective

On the streets the biggest news over the past four weeks has been Intel's decision to reduce considerably the prices for its 80486SX products. The facts are that Intel has reduced the price of the 25-MHz 486SX from $282 to $119, and the 16/20-MHz parts to $99. This is for plastic-packaged devices in quantities of 1,000 pieces. We believe that while Intel may gain significant penetration into the mass merchant channels, this price change was most definitely driven by encroaching competition. However, the most

Figure 5
US and European Total Semiconductor 12-Month Average Growth
(Three-Month Average Bookings)



Source: WSTS, SIA

important issue is the net impact this will have on the following areas:

- **PC Demand Mix:** Over the next two quarters, worldwide PC demand will shift to the 486SX, primarily from the 386DX. To a lesser extent this will impact 386SX sales, which will move further downwards and become focused at the home/consumer markets. The 486DX volumes will continue their slight growth until the first quarter of 1993, then take off rapidly.
- **Competitive Shares:** Intel will gain unit share over the next two quarters, going from a combined 386DX plus 486SX volume of 1.2 million units worldwide in the second quarter to more than 2 million units in the fourth quarter because of the shift in demand mix. Most of these gains will come at the expense of AMD's 386DX and will inhibit penetration by Cyrix, Chips & Technology, and Texas Instruments.
- **Intel's Revenue:** During this transition, the average selling price for the 486SX will take the position of the 386DX at the $100 to $110 mark. Taking the unit shift into consideration, the company's sales from these two products will increase from $180 million in the second quarter of 1992 to $220 million in the fourth quarter.

In conclusion, we see this as Intel taking aggressive steps to continue revenue growth and avoid losing market share. However, competitive pressures are forcing it to accept more moderate profits. In turn, AMD and other new entrants will have a more difficult time penetrating the market and self-funding R&D for the next-generation 80X86 on the reduced profits available.

By Jim Eastlake
Mike Glennon

The Balance of Power in the European EDA Industry

Introduction

The electronic design automation (EDA) industry is characterized by much technological change, high research and development expenditure, high product support costs and a great deal of industry concentration in both user (buyer) and vendor (supplier) organizations. Clearly, users and vendors need each other, but which party wields the greater bargaining power when determining price, functionality and purchasing terms? Using a Porter-style analysis, this report undertakes to:

- Explore the bargaining relationship (the power balance) between buyers and suppliers in the European EDA industry
- Project several future scenarios
- Recommend strategy options to each party

Forces Affecting the Power Balance

The power balance between supplier and buyer in the European EDA industry is a dynamic relationship which changes over time. It is driven by a number of forces including:

- Customers' costs of switching between one supplier and another
- The number of suppliers serving the industry
- Buyer size
- Local economic conditions
- The viability of using substitute or alternative means of designing electronic systems
- Entry barriers to new supplier companies
- The possibility of backward integration by the buyer (that is, buyers acquiring suppliers)

Each of these factors affects the power balance in varying degrees, as explored below.

Switching Costs

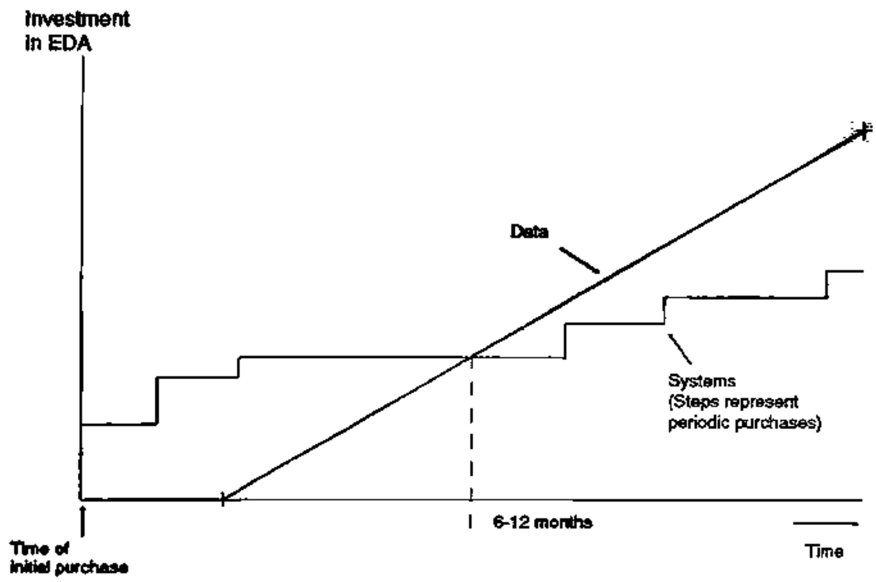
Switching costs are the costs that a customer (a buyer) will incur when switching from one vendor of EDA tools to another. They are usually high and are primarily determined by:

- New-system purchase costs
- Personnel retraining costs
- Costs of transferring data from the old system to the new

New-system purchase costs are the most visible and easily measured, but depending upon the scale of purchase, can often be the least significant cost. Personnel and data-related costs mainly result from system incompatibilities between different vendors' systems. The greater the dissimilarity, the greater the switching costs. Different players in the industry have different perspectives on intervendor compatibilities, resulting in an underlying conflict of interest as follows:

1. Users: Users want all vendors' systems to be identical in terms of user interface and data formats in order to:
    - Better allow purchasing choice
    - Minimize retraining costs
    - Allow all designs created on the old system to be electronically transferred to the new system. This is especially important for companies involved with long product life cycles such as in military and aerospace fields. This data is a key investment of the user company and can easily exceed the purchase costs of the EDA system over time (see Figure 6).
    - Allow in-house manipulation and archiving of data, perhaps in a multivendor environment
2. Newly emerging vendors: These vendors are trying to establish a position in the EDA market. They require data formats and programming interfaces to be standardized to better enable them to offer products integrated with existing vendors' products. These companies pose no threat to established vendors at this stage in their development, wishing instead to work in partnership. In this, they have the backing of the user community.
3. Newly established, fast-growing vendors: These companies have passed through the newly emerging stage and have established a presence in the market. They require standard data formats in order to better allow them to grow by attacking competitors' user bases through a migration strategy. In this respect they are predators, looking to gain market share from the established players.

Figure 6
A Company's Investment in Data Can Exceed System Investment in Only 6 to 12 Months



Source: Dataquest (May 1992)

They often team up with new entrants in order to offer excellent solutions to users.

4. Established, slower-growing or declining vendors: The primary asset of these companies is their user base. Standardization could place this user base at risk from competitors and therefore offers more threat than opportunity to these companies, resulting in a more wary approach to standards. In many cases, these companies are fundamentally opposed to standards—especially to standardization of data formats.

The above situation is illustrated in Figure 7.

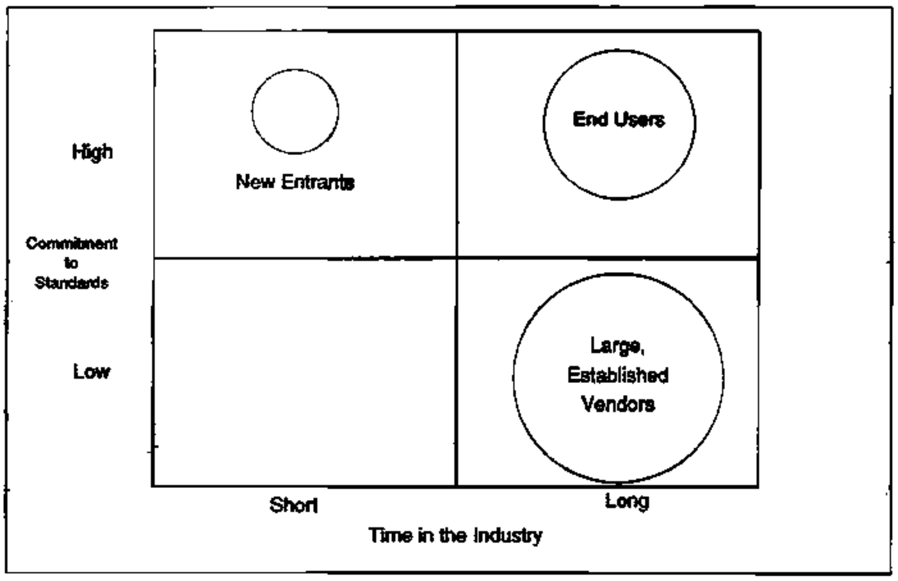
The combined interests of the above industry participants led to the development of electronic data interchange format (EDIF) and (later) of frameworks to facilitate easier integration of EDA tools.

In spite of a promising beginning, EDIF never truly developed into a universal interchange mechanism. In practice, vendors have been keen to provide facilities to convert from EDIF into their internal formats, but few have provided the reverse facility in fear of predative action by competitors. The most cautious response has come from the established (category 4) companies who have the most to lose from attacks on their user base.

At this time, frameworks are beginning to facilitate the integration of products from new (niche) entrants with broad-line EDA product lines from established vendors. Other standardization initiatives are leading to a greater commonality in the style and appearance of user interfaces, leading to a slight reduction in retraining costs. However, a universal framework is proving to be elusive as a myriad of proprietary frameworks now exist within the overall guidelines of the CAD Framework Initiative.

In fact, EDIF and frameworks were designed for different purposes. EDIF attempted to provide a data interchange mechanism between EDA systems, while frameworks were primarily a set of tools to integrate EDA products into a common environment (encapsulation, user interface and data management). We believe that the focus on frameworks over the past two years has defocused the EDIF initiative to a point where the major switching cost (migration of design data from old to new system) is still far from a total solution.

Figure 7
Approaches to Standards



Note: Circle size indicates relative power.
Source: Dataquest (May 1992)

In summary, systems have become *slightly* more open but switching costs remain very high, mainly for technology and marketing reasons. Therefore, customers become locked in and established vendors gain larger relative power.

The Number and Concentration of Suppliers

Several hundred suppliers operate in the European EDA market. However, most are small, geographically limited suppliers offering a narrow range of EDA products. The major pan-European suppliers are mostly US companies. Only one major vendor is fully European-owned (Racal-Redac). The other major European EDA company (Siemens Nixdorf Information Systems) is showing signs of pulling out of the market.

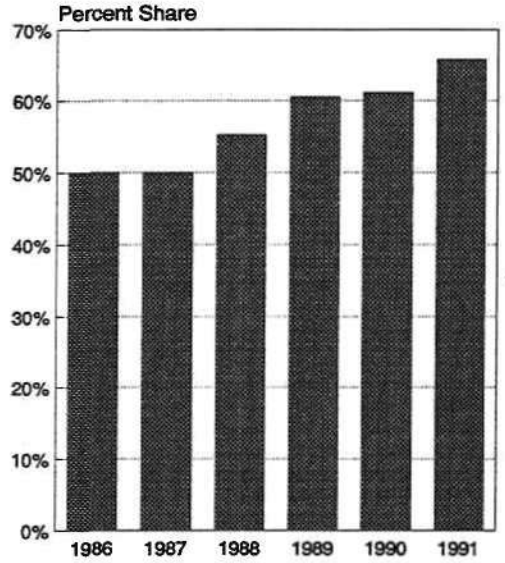
Two driving factors apply to the number of suppliers:

- The total number of suppliers is increasing as systems become (slightly) more open following the framework initiatives mentioned above. Many new niche suppliers have entered the market over the past two or three years.
- At the same time, the industry is becoming more concentrated due to merger and acquisition (M&A) activity. This can be seen in relation to the market share captured by the top 10 vendors in Europe over the past several years (Figure 8).

We expect this trend to continue, as the industry becomes further divided into two types of companies—broad-line and niche suppliers. We further believe that concentration was originally the result of major EDA companies acquiring each other. In the future it will be mainly larger broad-line players acquiring smaller niche companies in an attempt to capture critical new technology and provide total systems solutions.

Supplier concentration is illustrated by the M&A activity of the leading EDA vendors over the past few years (Table 2). This represents a significant concentration of vendors. This supplier concentration reduces the overall number of suppliers, tending to increase their relative power as a result. This is also increasing the stability of the industry as demonstrated by the consistent positions of the major EDA companies in the market share leadership rankings over the past few years. Only one new company, Cadence, has joined the top 10 list in the past 7 years.

Figure 8
Market Share of Top 10 Vendors in Europe



Source: Dataquest (May 1992)

Table 2
EDA Supplier Concentration

EDA Vendor	Merger and Acquisition Activity
Mentor Graphics:	Trimeter (1989); Caedent (1987); Silicon Compiler Systems (1990); Contour (1988); CADI (1983); SDL; Tektronix CAE (1988); Synergy DataWorks (1984); Descartes (1989); Performance CAD (1989); Silvar-Lisco/DSP (1989)
Cadence:	SDA (1988); ECAD (1988); Tangent (1988); ASI (1989); Gateway Design Automation (1989); OmniCAD (1987); ES2 (1990, joint venture); Siemens Nixdorf (1991, joint venture); Valid Logic (1991); Telesis (1987); Calma (1988); IMS (1988); ADT (1988). [Note: Cadence was formed by the merger of SDA and ECAD in 1988]
Racal-Redac:	HHB Systems (1989); Silc Technologies (1990); Thom '6 (1989)
Intergraph:	Dazix (1991); Cadnetix (1988); HHB Systems (1988); SimuCAD (1988)

Source: Dataquest (May 1992)

Some of this merger and acquisition activity is complex to describe. The companies on the left of Table 2 did not always directly acquire each company on the right. M&A activity among the companies on the right may already have taken place before the ultimate acquisition by the company on the left. For example, Daisy Systems acquired Cadnetix to form Dazix. Cadnetix had previously acquired HHB Systems which was later sold to Racal-Redac after the formation of Dazix. Later, Dazix was itself acquired by Intergraph. In each case, the reasons for acquisition were one or both of the following:

- To acquire technology and products in an adjacent and related sector
- To increase market share

Since much captured market share has been as a result of merger and acquisition, companies often produce wider than necessary product lines, requiring considerable resource allocation for their ongoing development and maintenance. We have no doubt that the effort needed to integrate diverse products following acquisition has been a major impediment to the underlying growth and development of most of the EDA industry leaders.

Cultural integration is another factor in the success of acquisitions. Fortunately for the companies involved, the acquisitions have usually been in highly related and synergistic disciplines. Some form of cultural synergy therefore already existed. Nevertheless, culture is a subtle concept which is difficult to analyse and predict, and has been a contributory factor in post-acquisition failure in at least one EDA example—that of Daisy's acquisition of Cadnetix.

Most EDA acquisitions have been examples of one US company acquiring another US company. Some of the "trickiest" acquisitions from a cultural viewpoint could be expected to be cases where foreign acquisitions have been made. However, the few cases of such acquisitions—for example, Racal-Redac's acquisitions of Thom '6 (France) and of HHB Systems (USA)—appear to have been generally successful. A major reason for this success is no doubt the continuity in personnel and the gradual "conversion" to parent company culture.

Supplier Rivalry

Buyer power is enhanced in situations where suppliers exhibit intense rivalry, since suppliers are more likely to try to "get the business at any cost." Since most EDA vendors set up a separate company for each country, rivalry must be considered at the country level rather than at the overall European level. One indicator of rivalry is the closeness in market share of two suppliers. Consider the two market leaders, Mentor Graphics and Racal-Redac. Their relative market share differs considerably among countries. For example (1990 figures), in Benelux, Mentor's $7.1 million compared with Redac's $2.9 million while in Germany, Mentor achieved $16.5 million against Redac's $14.2 million. This indicates that, everything else being equal, Germany will see the fiercer competition between the two. Our research indeed shows this to be the case.

Increased supplier rivalry can also be expected where a fast-growing competitor is gaining market share. This is especially true in Europe in the case of Cadence, which is upsetting the established order of the past few years and should expect a tough fight.

Relative Buyer Size

The changing vendor situation was discussed above, but vendors are not the only companies engaged in consolidation. Table 3 shows examples of key M&A and joint-venture activity of the leading European electronics systems companies over the past several years. These are some of the major EDA system buyers in Europe. The table shows a significant consolidation on the buying side of the industry. Most of the acquisitions were of companies in a very closely related business. It is therefore to the benefit of the companies involved to attempt some kind of rationalization of EDA systems in order to better allow the sharing of designs and libraries around the enlarged organization. This may be good news or bad news to vendors. We believe that the EDA market leaders will strengthen their position, while small and medium-size companies will lose ground as the newly enlarged buyer companies become more conservative in their buying policies as their size increases, leading these companies to favor larger vendors which can demonstrate greater financial stability.

Table 3
End-User Consolidation

EDA Buyer	Companies Acquired
Alcatel:	FACE/Telettra, National Telecom, AME Space
Ericsson:	Orbitel
Nokia:	NKF Holdings, Technophone, ITT Consumer
Thomson:	Ferguson, Philips Defence, British Aerospace (joint venture)
Olivetti:	Acorn Computers, Triumph-Adler, ISC Systems
Siemens:	Rolm, Nixdorf, Plessey Defence, Bendix Electronics
Bull:	Zenith Data Systems
STC:	ICL, Datachecker, Northern Telecom Data Systems
GEC:	Ferranti International, National Nuclear Corporation
Racal:	Decca, Chubb
ABB:	(Formed by joint venture in 1987)
Bosch:	Blaupunkt

Source: Dataquest (May 1992)

Another factor related to buyer size is the *ease of backward integration by the buyer.* Historically, many large end users developed their own EDA tools, for example Philips, British Aerospace, Northern Telecom, AT&T and NTT; scores of other examples exist. However, in recent years, the sophistication required of EDA tools has led to high development costs. Dataquest estimates that EDA vendors spent more than $330 million on R&D in 1991. End users cannot compete with this level of spending and no longer have any real need to, as they can now buy sophisticated merchant tools from a number of vendors. Several end-user companies are attempting to sell their internally developed tools on the open market but face an uphill task competing against sophisticated products, established distribution channels and competitive marketing organizations. British Aerospace and Dassault (France) fall into this category. Dassault has recently assigned marketing and distribution rights to Teradyne in order to overcome this problem.

The last bastion of tools developed in-house is Japan, where EDA tools were traditionally produced in-house and executed on mainframe computers. Large Japanese companies are now migrating to merchant tools in large numbers.

In view of this strong trend away from in-house EDA tools, we believe that, in general, it is unlikely that large end users would wish to backward integrate and acquire an EDA vendor. The end user's business would be fundamentally different to that of an EDA vendor and would be difficult to integrate post-acquisition. Such acquisitions would probably be doomed to failure. A more common, and realistic, approach is for the end user to take a minority equity stake in the EDA vendor (for example, IBM's 6 percent stake in Cadence).

Local Economic Conditions and Market Growth

In general, poor economic conditions or flat market growth will result in reduced buyer activity and greater pressure on vendors. It follows that this directly impacts bargaining power. If the local economy is in a poor state, possible effects may be:

- High costs of capital, thereby reducing the spending ability of buyer companies. This will reduce the number of EDA systems sold, leading to greater supplier rivalry.
- High inflation, causing upward pressure on salaries. As salaries are one of the major cost elements of EDA vendors, the vendors will try to pass this cost to the customer in an attempt to maintain margins.

The majority of an EDA vendor's costs are fixed. The incremental costs to the vendor of a new sale can therefore be quite low, especially to a repeat customer. Local business managers may (if allowed) discount heavily if local conditions warrant it, particularly where poor economic conditions have been forecast in advance and income targets set accordingly. The precise dynamics of this situation will be affected by the way in which local business managers are measured and by the vendors' transfer pricing method.

Substitutes

The basic question of substitutes is: Is there an *alternative* to EDA products? The only current alternative is for user companies to revert to the situation which existed pre-EDA and undertake purely manual design. However, EDA tools are universally acknowledged by large end-user companies to offer considerable reductions in the time-to-market of their products (especially over several product revision iterations) and are therefore viewed as indispensable. In this context, no viable substitutes exist at this time.

Buyer company decision makers may elect to spend budget on other budget "substitutes" such as people, test equipment, and so on. Substitute technologies may also arise, such as new semiconductor or printed circuit board technologies; in extreme cases, these may render a particular EDA system obsolete. In general, however, substitutes for the buyers' products are the most likely to emerge (for example, facsimile replacing telex systems). In some cases, this will trigger a change of strategic direction in the buyer's company and may have a follow-on effect on EDA policies.

Threat of New Entrants

Industries in which it is difficult for new companies to enter tend to produce a relatively small number of powerful "protected" competitors. The likelihood of new entrants depends upon several factors, including:

- Economies of scale: Some industries are difficult to enter because the relatively low sales levels achieved around the time of market entry are extremely unprofitable. This mainly affects manufacturing companies which can drive unit costs down over larger production runs and is only marginally important in most software industries—including EDA. Economies of scale are, therefore, not a barrier to entry.
- Capital requirements of entry: These are very low for niche companies—an EDA company can be started with only a few personal computers for product development purposes. Compare this with broad-line vendors, which must invest large sums in research and development.
- The experience curve: This relates to the difficulty (and time delay) associated with a company becoming familiar with a new technology before it becomes fully competitive. This is a major impediment to entry in some industries, but EDA company founders usually gain their experience from other companies before the new company is started.
- Legislation and deregulation: This has not occurred in the EDA industry and is unlikely to do so, unlike the situation in

some end-user industries such as telecommunications.

- Access to distribution channels: Distribution is a major issue in the European EDA industry since each country is a separate market having its own language and style of business. Most new entrants are small companies operating in narrow niche areas and, as outlined above, the number of companies falling into this category is increasing due to the development of frameworks. European-based new entrants tend to enter the market in a limited geographical area around their home territory, then expand later. Non-European companies usually attempt to enter multiple markets simultaneously. In both cases, companies have three options available to them:
  - Attempt sales and support by company's own personnel
  - Utilize a third-party distribution company (usually on a per-country basis)
  - Distribute via a broad-line EDA vendor

  Since the advent of frameworks, most niche companies choose the third option above, since the niche tools are usually designed to be used alongside an existing widely distributed EDA tool. In this case, small companies must constantly ensure that they do not become *controlled* by the larger vendor.
- Differentiation: The primary threat from new entrants is related to the differentiation of their products. Usually, these products perform a particular task uniquely well, leading to pressure from end users onto larger vendors to allow the niche product to be integrated with their system. Synopsys fell into this category when it started to enter the market.

Instead of new entrants tending to reduce the bargaining power of established vendors, the opposite is usually true. Large vendors distribute niche tools on behalf of new entrants with the effect that the large vendor's product range becomes more attractive to end users. Therefore, the concept of OEM products being sold by established vendors is now quite common in EDA for products based upon technology which is *non-strategically important* to the broad-line vendor, and we believe this trend will continue. Where a particular technology is considered to be "core," the broad-line vendor will insist upon owning it through either development or acquisition.

Perception of Buyers' Customers

Bargaining power can also be influenced by the buyers' customers' perception of the EDA system. For example, the defense ministry in a country may be more impressed with the integrity of a final product, such as a missile guidance system, if it has been designed using a leading and well-proven EDA system. The desire to prove the effectiveness of the EDA system in these circumstances leads to an increase in competitive rivalry between vendors.

Dataquest Perspective

The forces affecting the balance of power at this time are aligned principally in favor of the EDA vendor because:

- Customers are locked in, making switching costs very high.
- The products are indispensable, with no known substitutes.
- Buyers cannot develop their own EDA tools because of prohibitive R&D costs.
- The industry is dominated by a small number of powerful suppliers.

Clearly, this situation is not stable, because of the many forces acting on the power balance. Our research shows that the locked-in effect is a cause of some considerable frustration to large customers. We believe that those vendors which form close partnerships with customers and fully open their systems to them will be best positioned for long-term growth.

The situation could therefore change in the future. Clearly, a precise view into the future is not possible but the likely possibilities which may impact bargaining power are limited in number and may conveniently be explored in a number of scenarios as follows.

Scenario 1: Major New EDA Companies Enter the Market

This would most likely be caused by the merger of multiple niche companies, each having reasonable financial backing. Each may have already developed a reputation in the market, probably via a broad-line EDA company distributing the companies' products. The companies will therefore possess knowledge of how best to integrate their products with the broad-line company because of their previous partnership with them. Their task now is to change from partner to predator, entering new accounts from a niche position and expanding their position from inside.

In order to achieve this, the company must possess highly differentiated products within its niches. These must have existed anyway for it to have been successful in a number of niche areas before merging.

When the bigger EDA companies detect the intentions of the new entrant, they will move quickly to stop distributing the products (assuming they were selling them on an OEM basis previously). Where necessary, the larger companies will then fill the gap by:

- Forming a relationship with another niche company offering similar products.
- Developing similar products themselves.
- Attempting to acquire the new entrant; however, at this stage in its development, the company may still be privately held and may not wish to be acquired, or may be too expensive.

It is interesting to consider how such a company could overcome the switching costs which were shown to be so important earlier in this discussion. This is achieved in one of two ways as follows:

1. The new entrant could use its knowledge of the bigger EDA companies products to produce effective data translation facilities in order to devise a workable migration strategy, or ...
2. Sidestep the issue completely. This is only possible if the new entrant's products represent a far better and more productive way of working. Buyer companies may then be willing to operate the old and new systems in parallel until the old systems become obsolete, gradually migrating to the new. This is an expensive option for the buyer, but could be worthwhile if the rewards were sufficiently great.

In this scenario, the entry of a new broad-line company will tend to reduce the relative power of the other established EDA vendors. The growing company will also probably offer attractive financial benefits to buyers, thereby destabilizing the existing order. Niche companies will always pose this kind of threat because of their highly differentiated products and their ability to respond quickly to market conditions in view of their minimal user bases, which tends to slow companies down.

Scenario 2: Systems Become More Open

Pressure from end-user companies could gradually lead to a further "opening" of EDA systems. This means the publishing of all interface data formats and the development of comprehensive data interchange formats which would allow users to exchange design information between different vendors' systems and between merchant EDA systems and in-house software and database systems.

Much progress has already been made towards this situation with the development of EDIF. However, while many vendors claim to support EDIF, they usually only support a subset of the standard or only provide EDIF *input* facilities. (The lack of an EDIF output facility prevents the vendor's customers from extracting their design data from the EDA system and therefore prevents them migrating to another vendor's system.) In other words, many vendors only pay lip service to the standard today.

End users urgently demand open systems. At the same time, vendors desperately need sales into new accounts. The new account sales possibilities following end-user mergers and acquisitions could be used as a lure by end-user companies to persuade broad-line vendors to open their systems. Those vendors in a competitively strong position—that is, those with competitive products and a satisfied user base—may do so.

The availability of a few broad-line vendors offering genuinely open products would stimulate the EDA market in a number of areas. These would be centered around the consumer electronics and related sectors in which short end-user product lifetimes are typical. Consider, for example, a consumer TV company in relation to an aerospace company. The TV company may change TV models every six months, as designs rapidly become obsolete for marketing reasons. The aerospace company will maintain "active" designs, perhaps of a jet aircraft, for up to 30 years. In this scenario, if the aerospace company wishes to switch to another EDA system, it is essential that existing designs can be transferred to the new system. However, the consumer electronics company may elect to start new designs on the new system and maintain the old EDA system for six months until existing designs become obsolete, then dispose of the old system. Even in the consumer electronics case, some information *will* need to be transferred to the new system (for example, libraries). However, this is usually a much simpler transfer than that of design information.

This shows that aerospace companies (and similar) will find more difficulty switching vendors than consumer electronics companies unless their specific vendor operates an open systems policy. Ten years ago, a large proportion of European EDA sales were to military and aerospace sectors. Over the past four to five years the balance has been swinging away from defense towards commercial sectors and it is these commercial sectors which will probably be of greatest significance in the future. Therefore, the existence of only one or two broad-line EDA vendors opening their systems could stimulate the market in a major way.

The impact of this on bargaining power is that the first vendors to offer genuinely open systems will be in a powerful position and will be able to place premium prices on their products. However, this situation is likely to be short-lived as other vendors start to offer similar capabilities.

While the opening of systems will stimulate the market, those vendors presently strong in military, aerospace and automotive sectors may elect to remain closed, thereby following a strategy of milking those accounts. As a result, these vendors may, over a long period of time, exit from the EDA business.

Scenario 3: Situation Remains Unchanged

This requires no explanation, as this scenario is the current situation as analysed throughout this report.

Enhancing Bargaining Leverage

The above analyses lead to a small number of recommendations to both parties in order to best improve their relative bargaining positions.

Buyers

In view of the considerable levels of concentration in buyer industries, end-user companies have an opportunity to rationalize their EDA systems in such a way that they can achieve compatibility between EDA systems in the acquired or merged companies. This will allow an organization-wide EDA policy to be developed and the combination of purchases with sister business units. This is also an opportunity for the vendor, as rationalization following acquisition is now one of the major motives for EDA system purchases. However, there is a risk that the end-user company may become locked into a single supplier. Where this is judged to be undesirable, it will be safer to operate with a few vendors' EDA products and invest the necessary resource in the development of communication links between them. This approach has been adopted (for example) by LM Ericsson in Sweden.

The buyer should buy from a sufficient number of vendors to ensure competition, but not too many, or it will cease to be an important buyer to each vendor. The buyer should select suppliers which are especially competitive with each other and divide purchases among them (for example Mentor Graphics and Racal-Redac in Europe). This was not possible previously, but it may become possible as frameworks and open systems begin to play a part in the industry.

Purchasing leverage can be enhanced through phased purchases of an annual contracted volume, rather than ad hoc purchases from individual departments or business units.

Suppliers

The main effect of a reduction in vendor bargaining power is a reduction in margins. When determining what vendors must do to enhance their bargaining power, and therefore their margins, it is useful to consider the vendors in the following categories.

New Entrants: These companies must demonstrate excellence or uniqueness in their products. This suggests that they should concentrate on technology which is at an advanced stage of experimentation, but not yet fully exploited. The competitive impact of such technology is likely to be high but able to be exploited at relatively low cost without a great deal of speculation and uncertainty. They must also demonstrate an ability to integrate with customers' existing EDA systems. Perceived financial instability is a major negative point of the new entrant, especially in the eyes of large buyer companies. Financial backing from venture capital or other sources is therefore another key point in enhancing bargaining leverage. The new entrant must also demonstrate an ability to support the products over a wide geographical basis. This can be achieved through a network of support offices (expensive), through a broad-line EDA vendor, or via independent distributors.

Established Vendors: In view of the consolidation of these vendors, they are in a position to offer a wide range of products and can therefore supply complete turnkey solutions to larger customers, thereby adding value. Their size and stability adds credibility to their case, as does their worldwide support networks. Both of these factors enhance the leverage of the larger suppliers considerably.

These vendors must form close partnerships with buyer companies and fully open their systems to them. They should also undertake joint development projects with large customers. In this way, both sides gain, in spite of the difficulty of managing such projects. In such situations, the buyer is much more likely to approach the partner vendor first when searching for a new product. The vendor gains additional sales and gains access to the considerable user expertise of the buyer in order to optimize and enhance the product line through a "friendly" test market.

These vendors should invest moderately in technologies of a speculative, and potentially high-payback, nature through internal development, since this best ensures that resulting products are most easily integrated with the vendor's existing products.

By Jim Tully

Technology Analysis

On the Verge of 3 Volts

A host of battery-powered, handheld systems has heralded the advent of low-voltage ICs. The 5V standard has reigned for more than two decades, and the transition to a new standard will not be a trivial task. Companies will have to contend with many complex issues as they formulate their strategies to migrate products to the new standard. This article attempts to put the various issues relating to this topic in perspective by addressing the following elements:

- Technical considerations regarding migration to 3V
- Standards
- Issues
- Driving applications
- Dataquest's perspective

Technical Considerations

Components of Power Consumption

The question of what is driving low voltage raises two main technical considerations. These considerations relate to lithography and to power consumption. Companies say that the driving force to low voltage is customer requirements that specify battery operation of portable equipment. Some of the major benefits incurred from a lower operating voltage include the following:

- Systems will have a longer battery life.
- ICs can still be packaged in inexpensive plastic packages.
- Small handheld devices do not need fans or other expensive thermal management schemes.

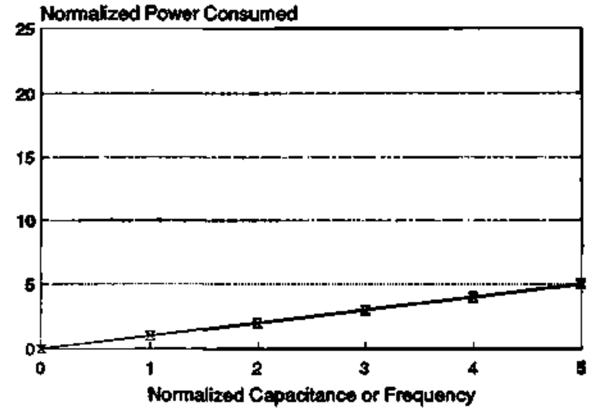
Nevertheless, although power consumption is mostly referenced as the driving force toward lower-voltage operation, an equally compelling reason relates to device physics. It just so happens that the applications are emerging at a time when lithography would soon have forced the issue.

Options for Reducing Power Consumption

The power consumption of a CMOS transistor is primarily a function of capacitance, frequency and voltage. Over the past several years, capacitance and voltage have been held relatively constant while frequency (driven by system clock rates) has steadily increased. Concurrently, ever-increasing transistor count means that with each new product generation there are more transistors, each of which consumes more power. Thus, each new generation of products consumes more power than the last. Consequently, system power consumption has increased dramatically. This increasing power consumption places a greater load on the power source and requires more efficient thermal management, in terms of both an IC package's ability to conduct heat away from the die and the heat being removed from within the system.

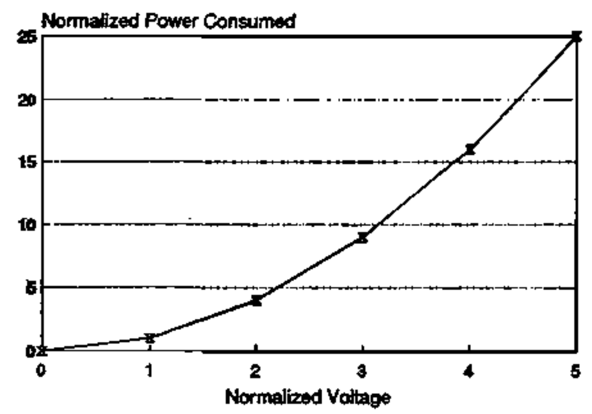
In a battery-operated system, increased load shortens battery life and increased heat adversely affects system reliability. As frequency and performance are interdependent, reducing operating frequency is not usually considered a viable option to power reduction. Capacitance is inherent in the manufacturing process; therefore, it is difficult to reduce. Reducing the number of transistors decreases the functionality of the system, which is also an impractical solution. While capacitance and frequency contribute linearly to power consumption (see Figure 9), voltage is a square relationship (see Figure 10). Because of the square relationship of voltage, a small reduction in voltage significantly reduces the power consumed. This fact is the primary motivation behind the move to a lower-voltage standard.

Figure 9
Linear Relationship



Source: Dataquest (May 1992)

Figure 10
Square Relationship



Source: Dataquest (May 1992)

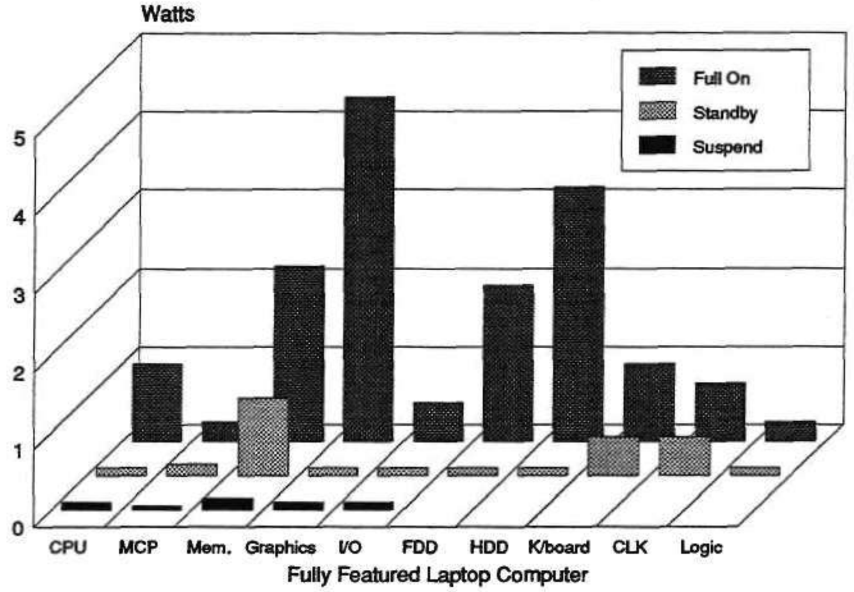
Other Forces Driving Low Voltage

As lithographies continue to shrink, the channel width of the transistors also continues to shrink. As these channel widths approach 0.5 µm, the voltage placed across the channel must be reduced. Placing 5V across a 0.5-µm transistor causes a permanent drain turn-on, which is effectively a short circuit rendering the transistor useless. To eliminate this drain turn-on condition the voltage applied across the transistor must be reduced. Although voltage reduction can be performed on-chip with a simple voltage divider without requiring an external low-voltage power source, such an approach not only increases the size (and hence the cost) of the die, but also it does not address the applications needs of portable systems.

Conservation

Figure 11 shows where power is consumed in a full-featured laptop computer. Mechanical peripheral devices consume most of the power—especially the display subsystem, hard disk, and floppy-disk drives. Main memory is the next major power consumer, while other electronic components account for the rest.

Figure 11
Estimated System Power Consumption



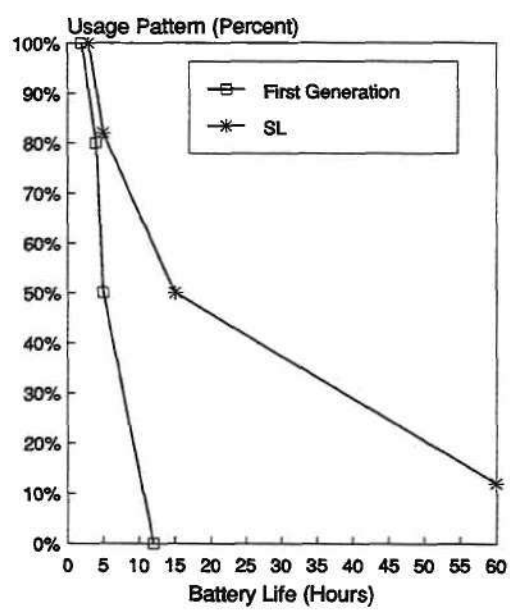
Source: Intel Corporation

Unfortunately, most of the power consumed by a fully energized PC under typical operating conditions is wasted. Idle PCs may do no useful work for an extended period of time, yet power continues to be consumed. In battery-operated equipment, such a power drain is intolerable. Low-voltage operation as a means of extending battery life goes hand in hand with power management or conservation, which is a critical ingredient in maximizing battery life. Power management techniques focus on minimizing the active operating power in particular when a system is not in full use.

To illustrate how significant the improvement in battery lifetime can be through effective power-management schemes, we present here data sourced from Intel based on the Intel386 SL SuperSet (see Figure 12). This device currently operates on the 5V standard, although all ongoing SL product development is being undertaken in the context of 3.3V operation.

In addressing the problems of power optimization, Intel defined its approach as threefold: System components must be designed to reduce power demands or let power be removed entirely; control logic must monitor peripheral usage to determine when to disable or re-enable power to the peripheral subsystems; and power-management facilities must preserve full compatibility with all existing software. Intel's objective in introducing its Intel386 SL product was to provide systems

Figure 12
Power Management Aids Battery Life



Source: Entry Level Products Group

integrators with transparent power management for the CPU as well as other system elements.

Standards

Standards represent an area of prime importance and, currently, something of a dilemma. Standards involving supply voltage, supply voltage tolerances, input/output (I/O) voltage thresholds, and issues such as regulated versus unregulated power are a source of confusion and debate.

The original JEDEC standards that most companies claim as their references—JESD8.1 and JESD8.0—date from 1984. The former targets higher-performance applications, with a regulated power supply and transistor–transistor logic (TTL) interface. The latter was intended to address battery users' needs for low power to enable unregulated 2.0V to 3.6V operation as well as regulated 3.0V to 3.6V operation.

All the companies interviewed claimed adherence to the JEDEC standard for 3.3V; nevertheless, it became increasingly obvious that companies seemed to be implementing I/O voltage thresholds differently. Although agreement existed with regard to the supply voltage being specified as 3.3V ±0.3V, direct current specifications between individual suppliers seem to be inconsistent with those specified in Table 4.

Research into the JEDEC standard revealed that its low-voltage and electrical-interface standards committee, JC16, is feverishly working on updating the existing standards. Ballots have been distributed to its members and will affect JESD8.1, referred to as the LVTTL (low-voltage TTL) standard. The intention is to bring the standards in line with the limitations of technology as well as supporting practical systems requirements. Although JESD8.0—otherwise referred to as the low-voltage CMOS standard—is currently under review, it is not certain that a revision will be required. However, as most systems are still designed to TTL interface specifications, JESD8.1 is the most critical standard to be addressed at this time.

The LVTTL standard proposal is expected to be completed early in 1992 with a companion proposal for battery-operated systems expected to be completed a few months later. However, until standards are solidified and adhered to, the onus rests with the system designer to ensure that the various components of the system can interface together under worst-case operating conditions. Given the differences in existing data sheet specifications, it may be necessary for systems manufacturers to require special testing to ensure compatibility. Once JESD8.1 has been updated, we may begin to see consistency between the various IC suppliers.

Issues

Performance

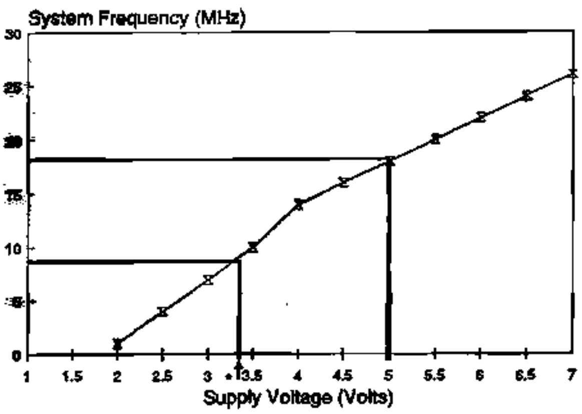
The move toward lower operating voltages is not without its trade-offs. A fundamental problem is performance. Although lowering voltage dramatically reduces power consumption, it also reduces the field across the transistor; this in turn reduces the transistor's performance. As supply voltage decreases, the frequency of operation goes down (see Figure 13). To illustrate how significantly a decrease in voltage can impact performance, the performance of a 5V device would be roughly halved if operated at 3.3V.

Table 4
JESD8.1 DC Characteristics

		Limits		
Description	Parameter	Min.	Max.	Conditions
Output Low Voltage	V_{OL}		0.4V	I_{OL} = 4.0 mA
Output High Voltage	V_{OH}	2.15V		I_{OH} = -200 μA
Input Low Voltage	V_{IL}	-1.2V	0.8V	$V_{OUT} \geq V_{OH}$ (min.) *or*
Input High Voltage	V_{IH}	2.0V	4.8V	$V_{OUT} \leq V_{OL}$ (max.)

Notes: V_{CC} = 3.3 ± 0.3V, across operating temperature range
Source: JEDEC

Figure 13
Supply Voltage versus Frequency



* Arrow indicates 3.3V
Soure: Hitachi

Conversion

Power savings would be considerable for systems fully converted to the new low-voltage standard. However, systems based on mixed-level voltages would equate to only moderate savings. The issue from the systems integrator's point of view is that, in order to take full advantage of the switch to 3.3V, all components need to be available. Many component specs are not at 3.3V yet; for a large-scale conversion to occur, a critical mass of needed components will have to exist. The conversion is no simple task. No boilerplate plan exists; there will have to be a transition phase. It seems that many suppliers are preparing to introduce their products initially to operate over the range of 3.3V to 5V. Companies delivering portable solutions will not wish to involve themselves in more levels of voltage than are absolutely essential. Applications that need the benefits of low voltage will be re-engineered.

Component Availability

Meanwhile, access to adequate supplies of devices is spotty, and specification compatibility is an issue. For instance, although it is not widely known, many Japanese suppliers offer 3.3V products. Although current 16M memory devices operate internally at 3.3V through a step-down feature, their interface is still at the 5V level. Another issue is whether suppliers of memory devices will redesign the current volume shipper, the 1M, to the new standard.

Certain product areas may present significant difficulties when it comes to the transitions to low voltage. Such products include disk drives, analog-to-digital (A/D), EPROMs, liquid crystal displays (LCDs), and radio frequency (RF). The recently introduced 1.8-inch small form-factor disk drives operate at the 5V level. Dataquest believes that the 1.2-inch version could be introduced next year to operate at the 3.3V level. We believe that some of the drives—for example, the 1.8-inch and 2.5-inch drives—may be reworked to operate at the lower-voltage levels. It is unlikely that this rework would go beyond the 2.5-inch form-factor, however. A few suppliers have announced EPROMs/OTPs that can be read at 3.3V, but programming at that level would pose a major challenge. Low voltage is more of a concern for flash memory devices because of their in-circuit programming requirement. Suppliers are currently struggling to reach a 5V program voltage. Of course, no one is even talking about bringing LCD operation into the realm of 3.3V. Systems already currently incorporate a separate power supply for the LCD, however, and it is expected that the current levels of ±15V will also be reduced to help improve battery life.

Reliability and Noise

Lower operating voltage also means less heat generation, helping both circuit manufacturers and system designers improve packaging and reliability. Also, the fact that low-voltage operation may enable certain devices to be housed in lighter packaging can be a bonus as the lighter packaging tends to be more resistant to certain kinds of damage. For example, heavy ceramic packaging is susceptible to cracking when dropped because of the sheer weight involved.

Another advantage inherent in lower operating voltages pertains to a reduction in system "noise" generation of electromagnetic interference and RF interference. Moving to a 3.3V system, though, entails no advantages with respect to ground bounce. Ground bounce—a function of inductance, the switching speed of the transistor, and the amount of current that is put through the transistor—may in fact be adversely impacted. If the same loading and transistor switching times are used in a 3.3V system as in a 5V system, migrating to the lower voltage level will only exacerbate the problems associated with ground bounce (that is, performance degradation and reliability). To alleviate this problem, the JEDEC specification for LVTTL has limited the current that can be switched to 4.0mA. However, it does not set any limits on switching speed (edge rates). Optimizing output switching speeds for system performance will be a major challenge for semiconductor manufacturers and will require systems-level expertise.

Although questions have been raised about how the switch to lower voltage would affect electrostatic discharge (ESD), it appears that because ESD dissipation occurs at the pad area and because the peripheral transistors on a 3.3V device will not shrink, susceptibility to ESD should pose no additional problems.

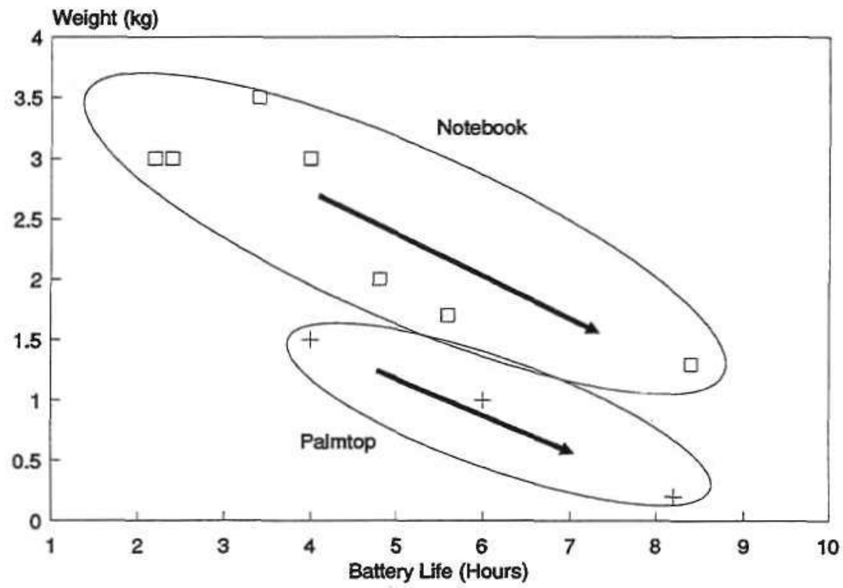
Battery Technology

Extending the useful battery life of a portable system is a major objective. In estimating how long a battery should last in order to meet the most common requirement, companies appear to be assuming a rule of thumb that batteries should last about an eight-hour working day. A pair of AA batteries, the preferred power source for handheld designs, can supply only 2.7V toward the end of their operating life. Therefore, unregulated two-battery systems cannot support the requirements of 3.3V devices; they require a more aggressive design such as 3V ±10 percent. The pervasive nicad battery produces a nominal 1.1V during recharge but can get up to 1.3V. In a standard three-cell arrangement, this could result in 3.9V being supplied to the system if a regulator is not employed. Until battery technologies can provide a flatter voltage over time, regulated systems will be the norm for high-performance, battery-operated systems. However, advances are occurring in battery technology to lead companies to believe that improvements will be forthcoming.

Driving Applications

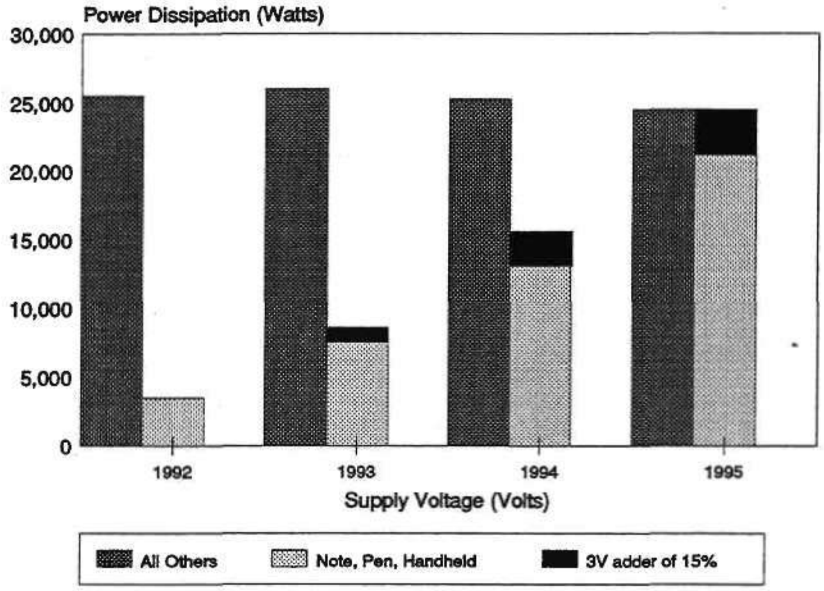
The rapid migration to a low-voltage standard is being driven by the need to extend the battery life of handheld or portable systems as shown in Figure 14. Popular applications are likely to include laptop, notebook, and palmtop computers; cellular phones; and memory cards. Dataquest expects the smaller form-factor portable PCs, by virtue of their high volume and high visibility nature, to play a leadership role in driving the migration to low-voltage systems (see Figure 15). Dataquest believes that the high-growth portion of the PC market (as represented in Figure 15 by the second bar) may see some

Figure 14
Battery Life Trend



Source: Hitachi

Figure 15
Worldwide PC Shipments Forecast



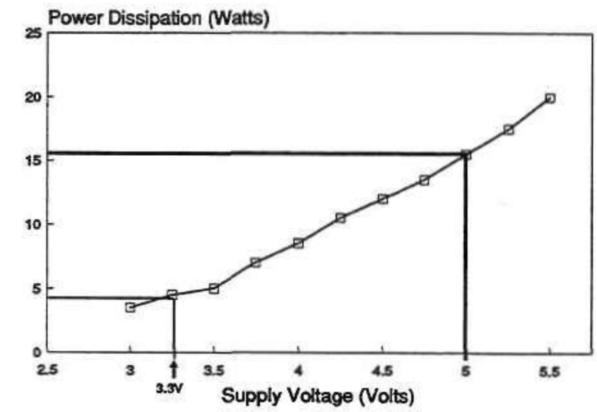
Source: Dataquest (May 1992)

3.3V-based systems in the 1993 time frame. For this reason we indicate here a potential 15 percent adder to the market segment that incorporates our forecast of notebook, pen-based, handheld, and companion PC shipments.

When operating voltage is reduced from 5V to 3.3V, theoretical component power consumption declines by more than 50 percent. Figure 16 shows how power dissipation is affected by reducing the supply voltage.

The motherboard of a typical notebook PC consumes approximately 35 percent of the system power; therefore, that reduction translates directly to significant battery life enhancement. But converting the CPU alone to 3.3V operation is not sufficient to provide the significant battery life enhancement needed in order to achieve the range of 8 to 10 hours of battery life. The conversion to lower-voltage operating systems will occur in stages. The first notebook PCs taking advantage of lower-voltage technology will be mixed-voltage systems because only the motherboard will operate at 3.3V. However, if today's typical notebook consumes 10W, for a 1992 hybrid product with the CPU, logic, and main memory converted to 3.3V, wattage would be in the order of 7W. Such a system will have an operational battery life of 7 or more hours.

Figure 16
Supply Voltages versus Power Dissipation (40-MHz 386 PCMB with 64KB Cache)



Source: Hitachi

When the PC's peripheral subsystems (such as hard drive, floppy drive, modem) are converted to 3.3V operation, additional power savings are achievable; such savings would equate to a notebook of today's size and weight offering battery life of 9 hours or more. Dataquest does not expect full 3.3V systems to be available until 1993.

Dataquest Perspective

This new technology will take time to develop, and many issues remain to be resolved. Dataquest believes that blanket conversion will not progress quite as rapidly as many industry spokespeople are predicting. Clearly, the PC arena is experiencing a great deal of design activity centered on the very small form-factor PCs. Some of the key players in the PC arena are working together to ensure that an adequate supply of critical components will be available according to the new low-voltage specifications. Most of the component suppliers are simply recharacterizing existing 5V products to the new standard, however, and interface problems may arise owing to the apparently variable interpretation of JEDEC's 3.3V standard of the I/O threshold levels. Moreover, certain clone manufacturers have been known to push an IC beyond its data sheet specification or to base their designs on "typical" rather than "worst-case" specifications. While this practice may work in "typical" applications, there is no guarantee that the system will consistently function as expected. In fact, inconsistent or "soft" errors may be a direct result of a manufacturer not designing for worst-case conditions. Current confusion in relation to the low-voltage standards may exacerbate this problem. To further compound the confusion, those attempting to optimize designs for a 3.3V environment will find their efforts stymied because the existing standards are in flux.

Despite all the talk that multivoltage systems will be announced in the spring of 1992, followed by fully converted systems in the fall, we believe that this aggressive transition schedule will get pushed out anywhere from 6 to 18 months. With increasing IC integration, chip designers would be ill-advised to simply take existing components wholesale and respecify them for the lower voltage. Extensive redesign may be necessary and, for the broad range of components, will take some time. Despite the fact that product design cycles are ever-decreasing, an average system design cycle will still take between 12 and 18 months, and many of these designs will not be under way until a larger selection of the requisite low-voltage parts is available. Other significant concerns that will still require extensive attention relate to test, design, and device modeling. It may be advisable for IC manufacturers to proceed with such experimentation by recharacterizing existing devices to the new low-voltage standard.

By Gerald J. Banks
Patricia Galligan

In Future Issues

Along with our regular features, "European Pricing Update" and "State of the Industry," forthcoming issues of *Dataquest Perspective* will report on:

- Dataquest's 11th annual semiconductor conference
- Capital and R&D expenditure of European companies
- SRAM forecast
- Country rankings
- European semiconductor five-year consumption forecast

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9204 April 24, 1992

In This Issue...

Pricing Analysis

European Pricing Update

Standard logic prices are unchanged over the previous month, as are analog prices. A recently announced price decrease for microcomponents is now beginning to appear in the pricing analysis, and competition among microcomponent suppliers is increasing as more of them are entering the market.

By Byron Harding and Mike Glennon *Page 2*

Market Analysis

State of the Industry

The SIA European book-to-bill ratio for March was 0.98, declining from February's 1.04. The fall of this ratio below 1 is unexpected, and is related to the lower than expected booking data. Adjustments to previous months' data now indicate an underlying shortfall in this year's European semiconductor market. Over the past 12 months the European market has declined by 1 percent, while in the United States 12-month-to-date growth is running at a healthy 7 percent.

By Mike Glennon *Page 4*

Worldwide DRAM Technology Alliances

The growing use of strategic alliances for the development of future generations of memory products was predicted by Dataquest as far back as 1986. The demands made by memory products are becoming more and more stringent, giving even greater needs for strategic alliances in the field of memory development and manufacture. This article examines the evolving network of DRAM alliances across the world, and assesses the impact and competitive significance of these alliances.

By Ronald Bohn and Byron Harding *Page 8*

End-User Analysis

1992 Worldwide Semiconductor Supplier of the Year

The annual Dataquest Semiconductor Supplier of the Year Award has been won by Motorola for the major supplier category—the fourth consecutive year Motorola has won. The medium-size supplier award was won by Analog Devices, and the niche supplier award was won by Dallas Semiconductor. Quality was the overriding criterion used by nearly half of the respondents to decide the adequacy of their suppliers. This article examines this and the other criteria major semiconductor purchasers use when assessing their suppliers.

By Mark Guidici and Jim Eastlake *Page 14*

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File inside the *Dataquest Perspective* binder labeled Semiconductors *Europe*

Pricing Analysis

European Pricing Update

Table 1 shows European Semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Standard Logic

There are no changes in the prices for standard logic. Many suppliers are busy introducing new CMOS and BiCMOS product families, specifically aimed at low-voltage operation. Business is improved over the same period last year, and this is across all applications.

Analog

Little change has occurred in analog component prices across Europe.

Microcomponents

The prices of the 386SX and 386DX have dropped by about 30 percent for the DX and about 10 percent for the SX, following announced price reductions. Competition among suppliers in this market will increase as more suppliers are now entering the market. Demand for the 286 is still declining, as the 386 becomes the entry-level processor.

Memory

DRAM

Prices for the 256K DRAM are flat or slightly upwards from our last update. Volume supply and demand is falling off quickly. The 1M price has seen erosion, and there are instances of very low pricing in small volumes, but demand is finally moving to 4M; manufacturers can still shift 1M DRAMs on SIMMs, though. The 4M DRAM has seen some price movement at last. This is believed to be a result of new reference prices (RPs), which are now widely known, and are applicable from April 1 for confirmed bookings for the second quarter of 1992. The indications are that, translated into European currencies, the 256K, 1M, and 4M DRAM RPs have each declined from the first quarter. However, our estimates suggest that, for bookings confirmed in US dollars, the RP for the 256K increased slightly, the 1M remained flat, and the 4M declined.

Note that the effect that RPs have on market prices varies directly in proportion to the market share held by Japanese-manufactured products. Our estimates show that the Japanese-manufactured share of the European market is 15 percent for 256K DRAM; 25 percent for 1M; 70 percent for 4M; and 90 percent for 16M. Siemens and IBM are now beginning to sample 16M in France.

Average contract price per Mbit is as follows: 256K = \$6.40; 1M = \$3.50; 4M = \$3.62.

EPROM

EPROM prices are still under severe pressure. Also, Europe continues to be the market with the lowest prices in the world for EPROM products at the densities reported here. Some withdrawals from the European market are expected if the situation does not improve soon.

Average contract price per Mbit is as follows: 1M = \$3.00; 2M = \$2.82; 4M = \$3.50.

SRAM

All generations of SRAM tracked here have seen some price erosion. Again, Europe is earning the reputation for being the market with the lowest prices in the world. However, the erosion is slowing down, and we expect that prices have reached some stability now.

Average contract price per Mbit is as follows: 64K = \$27.70; 256K = \$13.80; 1M = \$9.90.

Current Exchange Rates

1 US dollar =
- 0.572 UK pounds
- 1.626 deutsche marks
- 5.505 French francs
- 0.795 ECU

By Byron Harding
Mike Glennon

Table 1
European Semiconductor Pricing—April 1992
All Prices in US Dollars (including import duty where relevant)

Device Family	Product	Package	Mean 1K Price	Mean 10K Price	25K+ Contract Price	Lead Time in Weeks
Standard Logic	74F00	PDIP	0.12	0.10	0.09	4–6
Fast TTL	74F74	PDIP	0.14	0.13	0.12	4–6
	74F138	PDIP	0.18	0.17	0.15	4–6
	74F244	PDIP	0.25	0.24	0.21	4–6
Standard Logic	74AC00	PDIP	0.19	0.17	0.15	8–12
Advanced CMOS	74AC74	PDIP	0.24	0.21	0.20	8–12
	74AC138	PDIP	0.35	0.30	0.26	8–12
	74AC244	PDIP	0.43	0.37	0.35	8–12
Analog	741 Op. Amp.	TO92	0.17	0.12	0.11	4–6
	CODEC/Filter 1	[1]	2.90	2.65	2.50	6–10
	CODEC/Filter 2	[2]	5.75	5.45	5.00	6–10
Microcomponents	80386SX-16	PQFP	49.75	49.00	48.00	8–12
	80386DX-25	CPGA	104.00	102.00	98.00	8–12
	80286-16	PLCC	11.70	11.00	10.00	4–6
	68020-16	PQFP	31.00	28.00	26.00	4–6
	R3000-25	CPGA	135.00	120.00	110.00	4–10
Memory						
DRAM	256K-8 (256K×1)	PDIP	1.95	1.70	1.60	2–8
	1M-8 (1M×1)	SOJ	4.10	3.65	3.50	2–6
	1M-8 (256K×4)	SOJ	4.10	3.65	3.50	2–6
	4M-8 (4M×1)	SOJ	15.30	14.90	14.50	2–8
	9M-8 (1M×9)	SIMM	37.00	34.00	33.50	2–4
	1M-7 (1M×1)	SOJ	4.10	3.65	3.50	2–8
	1M-6 (1M×1)	SOJ	4.28	3.81	3.66	4–10
	4M-7 (4M×1)	SOJ	15.30	14.90	14.50	4–8
	4M-6 (4M×1)	SOJ	16.00	15.60	15.20	6–10
	16M-8 (4M×4)	SOJ	184.00	179.00	174.00	8–14
UV EPROM	1M-17 (128K×8)	CDIP	3.85	3.30	3.00	2–6
	2M-17 (256K×8)	CDIP	7.50	6.40	5.65	2–8
	4M-17 (512K×8)	CDIP	18.00	16.00	14.00	4–10
SRAM	64K-85 (8K×8)	PDIP	2.20	1.90	1.75	4–10
	256K-85 (32K×8)	PDIP	4.00	3.65	3.50	4–8
	1M-85 (128K×8)	PDIP	13.00	10.50	10.00	2–10

[1] Group 1: Commercial temp, serial, PDIP, A/µ law
[2] Group 2: Commercial temp, serial, PLCC, A/µ law, programmable
Source: Dataquest (April 1992)

Market Analysis

State of the Industry

The SIA flash three-month average European book-to-bill ratio for March was 0.98, a surprise decrease over February's revised figure of 1.04, as shown in Figure 1. January's book-to-bill ratio has also been revised, this time upwards slightly to 1.04. Actual billings for March were $1,056.1 million, a growth of 21.4 percent over the previous month, and 5.9 percent over the same month the previous year. Three-month average bookings increased by 2.7 percent over the previous month, and declined 2.1 percent over the previous February.

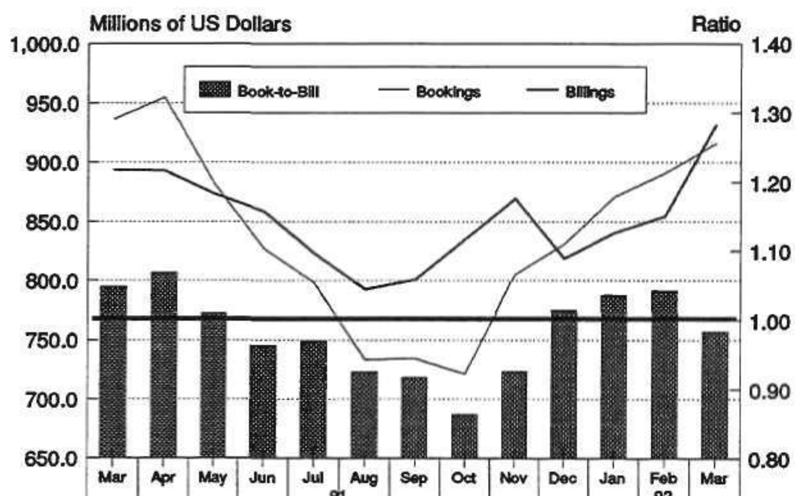
The prognosis last month for the slower start to the year, when compared with previous years, was that this could be an indication of a firmer year. However, this does not now seem to be the case. Figure 2 shows the 12-month moving average growth for both Europe and the United States, and it is clear that the last 12 months have declined over the previous 12 months in Europe. The United States shows a strengthening recovery, which has not yet reached Europe. The worst is yet to come, as the billings trend follows the bookings trend, usually by about three months, and the lack of an indication of an upturn in bookings growth means the decline may have further to go.

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trend and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billing and three-month average booking figures. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

Figures 3, 4 and 5 show the forecast and actual three-month average bookings, actual monthly billings, and book-to-bill ratio from the Dataquest forecast model.

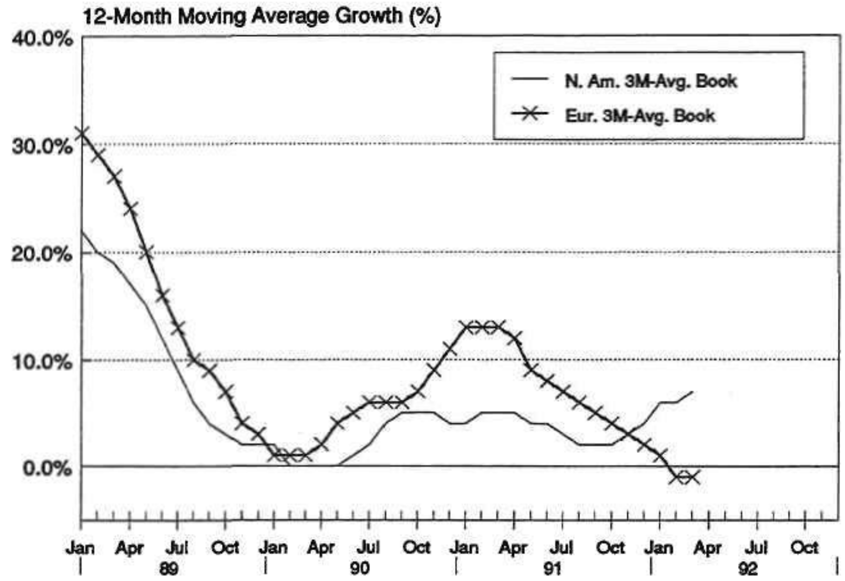
Figure 1
European Total Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Mar	Apr	May	Jun	Jul	Aug 91	Sep	Oct	Nov	Dec	Jan	Feb 92	Mar
Book-to-Bill	1.05	1.07	1.01	0.96	0.97	0.93	0.92	0.86	0.93	1.02	1.04	1.04	0.98
Bookings	936.3	954.6	882.4	827.3	798.3	733.5	734.6	721.4	805.1	831.0	871.0	891.0	915.8
Billings	893.5	893.0	873.5	858.7	823.0	792.7	800.8	835.2	869.4	818.7	840.5	854.5	931.5

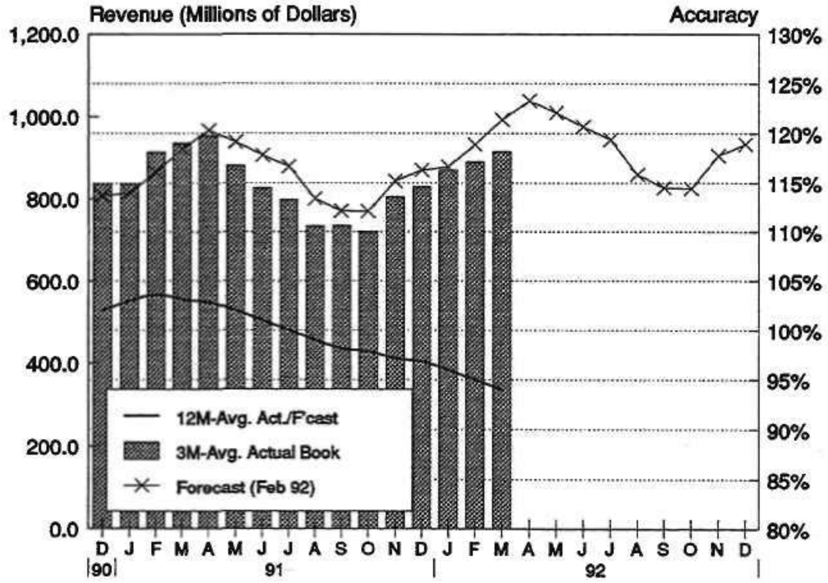
Note: Last two months are preliminary
Source: WSTS, SIA

Figure 2
US and European Total Semiconductor 12-Month Average Growth
(Three-Month Average Bookings)



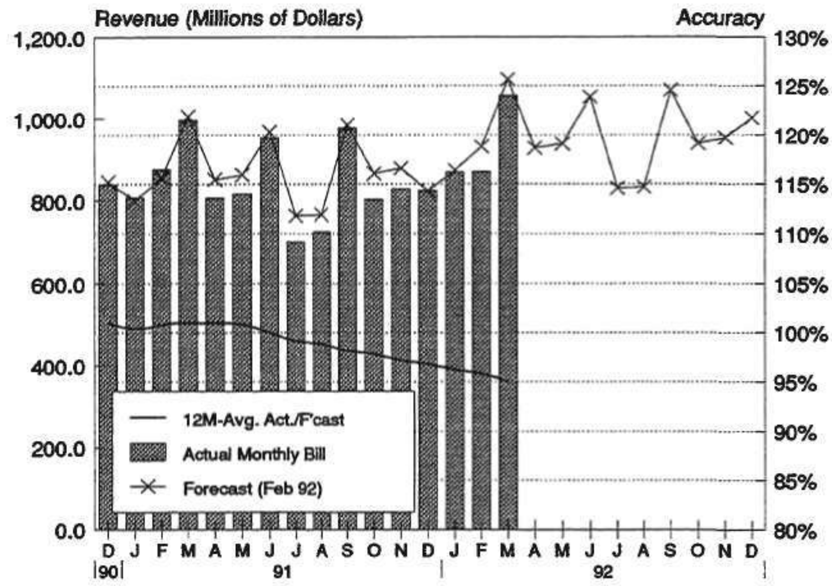
Source: WSTS, SIA

Figure 3
European Total Three-Month Average Bookings



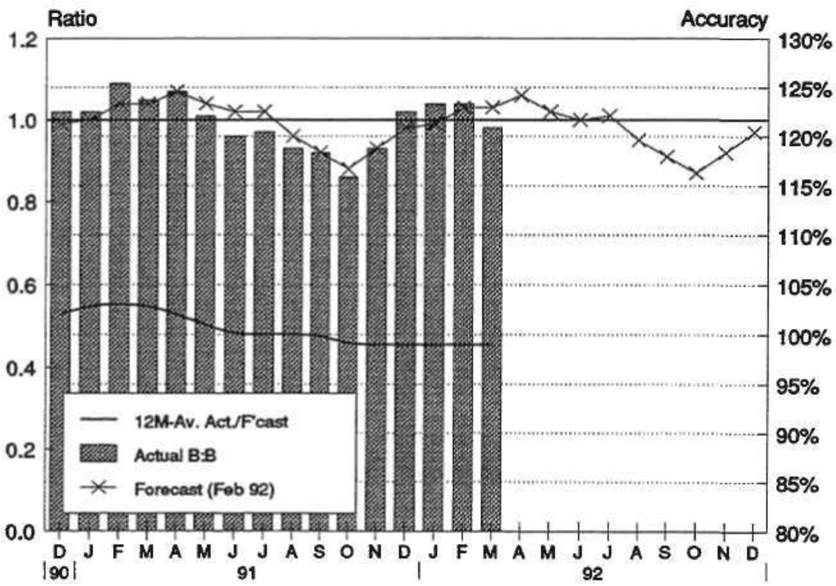
Note: Last two months are preliminary
Source: WSTS, SIA, Dataquest (April 1992)

Figure 4
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary
Source: WSTS, SIA, Dataquest (April 1992)

Figure 5
European Total Semiconductor Book-to-Bill Ratio



Note: Last two months are preliminary
Source: WSTS, SIA, Dataquest (April 1992)

The adjustments made to the billing data, and in particular to the booking data, indicate that the outlook for the next few months is bleak. The forecast model calculates a booking growth of 7.4 percent for 1992, and a billing growth of 8.8 percent. However, the year-to-date billing growth is a mere 4.4 percent. As much of the growth for Europe's semiconductor industry comes from the first quarter, this does not bode well for the rest of the year.

The revised figure for February's actual billings gives an anomalous data point, where month-on-month growth is zero, and growth over the previous year is negative. This would indicate the figure is likely to be revised. However, an examination of the monthly three-month average booking data shows a decline over the previous year on a monthly basis since May of 1991, with the exception of November 1991 and January 1992. The three-month average actual booking data has also been below the forecast values since May 1991. This may indicate an underlying trend which can only be interpreted as bad news for Europe's semiconductor industry. To counter this, however, the US booking actuals are still consistently ahead of the forecast model predictions, and have been since November 1991. This is using a forecast model growth figure of 5.7 percent.

Dataquest Perspective

Germany has been the driving force behind much of Europe's growth for the past two years, but the outlook for the country for 1992 indicates revenue growth may be minimal. A recent visit by Dataquest's analysts revealed a bleaker picture than originally assessed for Germany. The consumer equipment market is still suffering from excess inventories, and this is putting a brake on semiconductor sales to these manufacturers. For example, there is an inventory of more than 1 million TV sets in the country, resulting in a cutback in TV set production across Europe. Nevertheless, Europe's TV manufacturers are investing in additional manufacturing facilities for the longer term.

Germany represents roughly 60 percent of the automotive electronics market for Europe, and this market is also in difficulties. While the semiconductor content of cars is increasing, new car production is faltering. The suppliers to the automotive electronic equipment manufacturers are struggling to find significant growth in this business.

The EDP market in Germany is also weak, but this market is normally lower than the European average. To counter this, the UK market for EDP is strengthening; the United Kingdom represents the largest EDP market for semiconductors.

The communications segment gives the greatest support to the market in the near future, and this business is being supported by exports of communications equipment such as exchanges. However, Austria is showing a big increase in equipment production, with manufacturing moving to the country from Germany due to Austria's closer strategic and trading links with Eastern Europe.

At the product level, microcomponents—specifically microprocessors—are showing good growth, and may provide much of the growth in Europe in 1992. First-quarter growth for these products is high, even compared with the first quarter of last year, when revenue was also significantly higher than the previous year.

ASIC business across Europe is also growing well. High-end engineering charges (NRE) are maintaining $50,000 to $100,000 levels, and averages are improving as low-volume and low-gate count designs are implemented in field-programmable gate arrays (FPGA). There are signs that volume users of ASICs are beginning to exercise routes from FPGA to gate arrays which have been put in place by many gate array suppliers. This is in response to greater volumes of products required by the end equipment, and is an effort on behalf of the equipment suppliers to reduce costs.

The problems of short-term business seen by many semiconductor suppliers over the past year has resulted in these companies chasing longer-term, less certain business. In particular, the area of chip set products for application-related solutions has pointed to high revenue and lucrative profits. The first products seen in this area were PC chip sets, and the area of greatest interest at the moment is chip sets for GSM telephone handsets. However, the volume business for this market has yet to take off in Europe, and there are many suppliers competing hard for a share of this business, with chip sets already designed and prototyped. The overall result will be heavy competition among suppliers, followed ultimately by competition on price alone. The GSM chip set market is only one area of chip set focus; multimedia and HDTV are soon to follow.

While the GSM chip set business has all the indications of poor profitability and severe competition, many suppliers are adopting the "solutions" approach implied by this strategy and applying it to their general business. This is an extension of the applications approach taken by many of these companies over the past few years. The solutions approach involves cross-product teams engaging with a potential customer to supply a range of products to provide a complete solution to the customer.

Solution selling is really a new name for vertical integration. The only real difference is that new product development is now geared towards fitting the solution approach, and many companies are adjusting their organizations to fit the solutions strategy. The inclusion of customer service, delivery and quality are all part of this "solution" for the customer, and this month's *Dataquest Perspective* covers the achievements of worldwide semiconductor suppliers in their efforts to excel in these areas, with the announcement of the Semiconductor Supplier of the Year. This is likely to be the area of greatest focus at the strategic level for semiconductor companies over the next few years.

By Mike Glennon

Worldwide DRAM Technology Alliances: Global Evolution Motivated by Survival of the Fittest

In 1986, Dataquest predicted that strategic alliances would be an electronics industry megatrend for the rest of this century. During 1991, two DRAM alliances captured global attention: the IBM/Siemens joint-manufacturing venture on 16M DRAMs and the Hitachi Ltd./Texas Instruments second-source pact for 64M DRAMs. This article presents the evolving worldwide network of DRAM alliances as of December 1991 and assesses the impact and strategic competitive significance of the top arrangements.

Table 2 shows the worldwide network of DRAM technology alliances by product density as of December 1991. The table shows more than 20 alliances. The footnotes to Table 2 provide the definitions for each type of alliance and highlight special arrangements. Alliances other than those listed in the headings of Table 2 are noted in parentheses and defined in the table. This information includes internal and external consumption.

Dataquest conducted an informal poll of DRAM analysts in Tokyo, London, Seoul, Taipei, and San Jose, California, regarding the critical significance of each alliance in terms of strategic competitiveness and actual or prospective market impact. Table 3 shows Dataquest's perspective on the most significant worldwide DRAM alliances.

Tables 2 and 3 build on a mass of information and insight. Using that informational mass, this article analyses the top half-dozen worldwide DRAM pacts regarding what each alliance partner gives and receives from the alliance—or does not give nor receive—with a focus on the long-term market implications for both DRAM users and IC suppliers.

IBM/Siemens

In terms of both strategic competitiveness and potential market impact, Dataquest analysts view the IBM/Siemens joint-development alliance on 16M and 64M DRAMs as the most significant alliance shown in Table 2. On July 4, 1991, these two global giants extended their prior 64M DRAM joint-development program to joint manufacturing of the 16M device, and the market continues to reverberate.

Table 2
Worldwide DRAM Technology Alliances

	1M DRAM Alliances		4M DRAM Alliances		16M DRAM Alliances	
Supplier	Second-Source Agreements	Fab Agreements	Joint-Venture Agreements	Fab Agreements	Joint-Venture Agreements	Joint Development
Goldstar		Vitelic-MOSel				
Hitachi	Goldstar (LA)		Goldstar		Goldstar (LA)	
Hitachi						TI (and 64M DRAM)
IBM			Siemens (JD)			Siemens (and 64M DRAM)
IBM			Micron (LA)			
Matsushita		Intel (also Sales Agency Agreement)				
Micron	Sanyo (64K×16 device)					
Motorola	Goldstar (based on Toshiba DRAM design)					
NMB			Hitachi (OEM arrangement based on Hitachi production technology)			
NMB			Ramtron International (JD)			
NMB					Ramtron	
Oki	SGS-Thomson (LA)		SGS-Thomson		SGS-Thomson	
Oki				Vitelic-MOSel	Vitelic-MOSel	
Samsung	Intel (OEM)					
Sanyo			Mosaid			
TI			HP-Canon-Singapore		HP-Canon-Singapore	
TI			Acer			
TI	Mitsubishi					
Thorn EMI	NMB (LA per Thorn's Inmos-based patent)					
Toshiba	Motorola		Motorola			Motorola
Toshiba	Siemens (LA)					
Wang	Micron (LA re SIMMs organized ×9)					

Definitions/Notes:
FA = Fab agreement: supplier offers fab capacity for partner's product technology. In most cases, the supplier provides fab capacity and produces the partner's DRAM design.
JD = Joint development: the companies jointly agree to develop new products, which may or may not be marketed separately.
JV = Joint venture: the companies form a new joint-venture company to develop, manufacture, and market new products.
LA = Licensing agreement: supplier receives or issues a license to partner for an up-front fee and/or royalties.
OEM = OEM arrangement: supplier sells product to alliance partner, which is sold under partner's name.
SA = Sales agency agreement: supplier sells its partner's products as either a sales representative or a value-added reseller.
SS = Second-source agreement: the companies agree to develop consistent specifications to ensure a second source.
Source: Dataquest (April 1992)

What the Partners Give and Get

This section examines the "gives and gets" of the IBM/Siemens alliance. Readers should note in general that the items exchanged in many of the DRAM alliances shown in Table 2 sound similar (for example, process technology, risk reduction). The common strategic threads will be noted in the alliance assessments; however, this article spotlights unique or special alliance factors whenever possible.

IBM: Reducing Technology Dependence

IBM Corporation provides three tangibles for the 16M DRAM alliance: the basic device design; the 0.5-µm process technology (which runs on 8-inch wafers); and the fab in France. Siemens AG's practical contributions include capital and engineering talent—the latter for translating IBM's proprietary design into a product suitable for European and worldwide merchant market consumption (for example, an eventual shrink version).

Table 3
Top Worldwide DRAM Alliances

Strategic/Competitive Significance	Market Impact (Current/Potential)
1. IBM/Siemens; Texas Instruments/Hewlett-Packard/Canon/ Government of Singapore	1. IBM/Siemens 2. Texas Instruments/ Hewlett-Packard/Canon/ Government of Singapore
3. Toshiba/Motorola	
4. Hitachi/Goldstar Hitachi/Texas Instruments Texas Instruments/Acer	3. Hitachi/Goldstar IBM/Micron Texas Instruments/Acer Toshiba/Motorola

Source: Dataquest (April 1992)

What does IBM receive? Some practical elements have been indicated: an estimated 50 percent contribution by Siemens on fab costs and risk-sharing by Siemens on merchant market technology development. IBM is also likely to receive a supply of 16M devices starting next year for systems such as the PS/2 line.

IBM aims for key long-term strategic benefits. First and foremost is a counterbalance in Europe—and, perhaps, eventually North America—to Japan's worldwide strength in DRAMs. Second is an evolution by IBM, which is an internal DRAM supplier as well as user, toward a global shared fab strategy, perhaps allowing for entry into the merchant market.

Siemens: a Stake in the DRAM Merchant Market

What does Siemens get in exchange for its capital and clout in European and other merchant markets? Siemens' DRAM efforts have been lagging. Now, it should be able to make a timely ramp-up during the second half of 1992 in the 16M DRAM arena. An unresolved issue is whether Siemens will become an independent DRAM supplier or a supplier of IBM DRAM products.

Eventually, Siemens might be permitted to use IBM's 0.5-µm process to expand its ASIC product offerings. However, to date Siemens has received no license to the IBM process.

64M DRAM Joint Development

The 16M manufacturing alliance accentuates the significance of the partner's prior joint-development effort on 64M DRAMs. The 64M alliance presumably was proceeding favorably, as shown by the dramatic extension to the 16M part. The exchange items are similar; Siemens can promise 64M DRAM product technology to merchant market customers later this decade. IBM will be assured of supply for internal demand while balancing the strength of Japan-based suppliers.

TI/HP/Canon/Government of Singapore

In terms of strategic competitiveness, Dataquest analysts view the 4M/16M DRAM joint venture between Texas Instruments (TI), Hewlett-Packard Company (HP), Canon, and the government of Singapore as equal in significance to the IBM/Siemens arrangement. Dataquest analysts consider this arrangement to be second most significant in terms of current or potential market impact. We believe that this alliance is a unique and perhaps trend-setting global consortium of DRAM users with their supplier.

TI: the Give and Get

Texas Instruments (no mystery) supplies the DRAM technology and runs the Singapore joint-venture fab. The technology for 4M DRAMs is a 0.6-µm process using 6-inch wafers; for 16M devices, a 0.5-µm process and 8-inch wafers are used. For TI, this alliance conforms with the company's long-term strategy for spreading the risk associated with the volatile international DRAM business. In exchange for DRAM technology and know-how, TI reduces the risk associated with opening its fifth sub-micron CMOS manufacturing plant in Asia—a costly $300-million-plus venture. Texas Instruments has an option to become the majority partner.

Besides capital contributions by the partners, the company has some likely, although not assured, major customers for the fab's output. The alliance also provides TI with an expanded presence for serving users in Asia, including migrating Japan-based customers.

HP: a Network of Strategic Alliances

In addition to customer-name credibility, HP's major contribution to date is advanced customer payments. For HP, the alliance provides a guaranteed supply of DRAMs in line with the company's partnership share (nearly

25 percent) if quality and price conditions are acceptable to HP.

For Hewlett-Packard, the real benefit is linked to the company's worldwide network of strategic alliances. The alliance should strengthen its alliance partners over the long term. For example, TI is one of the leading suppliers of DRAMs to Hewlett-Packard. In turn, HP supplies computer and other systems to TI. Hewlett-Packard and Canon have an alliance in the printer business. The strategic upshot for Hewlett-Packard: the alliance enhances the global position of Texas Instruments, a key North America–based DRAM supplier, vis à vis other world competitors.

Canon: the Other DRAM-User Partner

Like Hewlett-Packard, Canon, the second DRAM-user alliance partner, provides advanced customer payments in exchange for a guaranteed supply of DRAMs given acceptable quality and price terms. In addition to strengthening HP and TI, two long-term alliance partners, Canon's IC manufacturing equipment group is likely to win increased account penetration at TI (and perhaps, over time, HP).

Government of Singapore: a Host of Benefits

The government of Singapore's main contribution is financial and other support. For Singapore, the alliance ensures a share of the joint venture's output of DRAMs to Singapore-based computer companies—a critical need there during periods of spot shortage. The alliance also advances Singapore's CMOS processing technology base for production of memory and ASICs (for example, gate arrays). The alliance puts the tiny city-nation on the global DRAM map.

Toshiba/Motorola

In terms of both strategic competitiveness and current and potential market impact, Dataquest analysts rank the DRAM alliance between Toshiba Corporation and Motorola Inc. as the third most significant arrangement. The first version of the alliance was formed during 1986 and expanded toward the end of 1990. Uncertainty associated with an alliance element—Toshiba's rights to Motorola's 68030 microprocessor—has diminished the market impact somewhat. Nevertheless, this alliance of two giants of the IC business, one Japan-based and the other North America–based, has had a direct impact on both DRAM market trends and the global competitive balance.

Toshiba

In this alliance, Toshiba provides the DRAM design and process technology. Toshiba leads the DRAM development efforts including development of the 16M DRAM. In exchange, Toshiba receives the right to sell Motorola's 68030 MPU in Japan. Toshiba never received the rights to sell the 68030 (or the 68040) in world regions other than Japan.

For Toshiba, the alliance arrangement enables Toshiba to supply 1M DRAMs from Motorola's Scotland fab while avoiding import duty and European reference pricing constraints.

Motorola

In exchange for Toshiba's limited license on the 68030, Motorola has received 1M and 4M DRAMs from the Tohoku, Japan joint-venture fab. Motorola resells the product in regions such as North America and Europe. Motorola can produce 1M DRAMs in its worldwide network of fabs. The 4M DRAM can only be produced in the Tohoku fab. In order to gain worldwide rights to 4M DRAMs, Motorola presumably must give Toshiba worldwide rights on the 68030 or 68040.

For Motorola, a key long-term strategic goal of the alliance is acquisition of DRAM technology (for example, 16M DRAMs) and manufacturing know-how. An unresolved issue is whether Motorola will develop 16M DRAM alone or with Toshiba. For example, during 1991 there were rumors in the trade press regarding plans for a DRAM plant in Europe, to be owned jointly by Motorola and Toshiba. Nevertheless, Dataquest believes that eventually the Tohoku fab will produce 16M DRAMs for Motorola.

Hitachi/Goldstar

Dataquest views the DRAM alliance between Hitachi Ltd. and Goldstar Electronics Company Ltd., which comprises a series of licensing and fab agreements between a first-tier Japan-based supplier of DRAMs and an emerging IC power from Korea, as the third most significant DRAM pact in terms of current and potential market impact. The arrangement ranks fourth regarding strategic competitive significance. This agreement represents one of the key alliances between Japan- and Korea-based IC suppliers.

In this alliance, Hitachi provides the DRAM technology, including product design. During 1989, Hitachi designated Goldstar as a second source for Hitachi's 1M part, meaning a market boost for Goldstar's advance in global IC markets. In addition to establishing an alternate source for 1M DRAMs, Hitachi also receives some supply for resale.

Recently, Hitachi extended Goldstar's alliance to the 4M device. The Hitachi/Goldstar alliance is still evolving. For example, the 4M arrangement currently carries some of the hallmarks of a fab agreement and of an OEM arrangement. Nevertheless, this alliance is advancing and includes the 16M device.

IBM/Micron

Table 3 shows that several alliances tied for third place in terms of current and potential market impact. Dataquest analysts rank the alliance on 4M DRAMs between IBM and Micron Technology Inc., two North America–based companies, among those deemed third most significant regarding market impact.

IBM provides the DRAM process technology, which runs on 8-inch wafers. Micron uses its own 4M DRAM design, having elected not to develop IBM's proprietary design for merchant market consumption. (Note the challenge for Siemens in the 16M arena.) For IBM, the alliance provides another balance to Japan's worldwide DRAM strength: a stronger, competitive, low-cost North America–based supplier of DRAMs, as well as some attractive licensing revenue.

For Micron, the alliance provides access to IBM's process technology. The alliance also provides the relatively small company, which competes against the global DRAM giants, with a key long-term strategic partner. The agreement is likely to extend to the 16M device.

Texas Instruments/Acer

Dataquest analysts rank the joint venture in 4M DRAMs between Texas Instruments and Acer Incorporated (Taiwan) as one of the third most significant DRAM arrangements in terms of current and potential market impact. The agreement also is tied for fourth-place ranking regarding strategic competitive significance. This agreement exemplifies another key user/supplier alliance—here, between a North America–based supplier of DRAMs and a Taiwan-based user.

Texas Instruments' Role

The "gives and gets" for Texas Instruments through this alliance are consistent with those of TI's alliance with HP, Canon, and the government of Singapore. In exchange for its technology, Texas Instruments reduces the risk associated with construction of this $250-million-plus investment. The technology for 4M DRAMs is 6-inch wafers based on an advanced CMOS trench-capacitor design. This alliance purposely bypassed the 1M part but is likely to be extended to the 16M density.

Acer's Role

Acer's contribution will be capital—about 75 percent of the quarter-billion-dollar-plus cost. The joint venture marks Acer's entry into vertically-integrated DRAM production. The real key for Acer: a guaranteed supply (50 percent) of the total output of the joint-venture fab, which should meet a full third of the 4M DRAM requirements for this system manufacturer. Past DRAM shortages have played havoc with this company's manufacturing plans.

Hitachi/Texas Instruments

Dataquest analysts view the joint-development agreement for 16M DRAMs between Hitachi and TI among the fourth most significant DRAM alliances in terms of strategic competitive significance. When Dataquest analysts ranked the alliances, the recent dramatic extension of the alliance to 64M DRAM—a second-source pact had just been announced. The strategic significance of this alliance between two giants of the DRAM business, one Japan-based and the other North America–based, has presumably increased since the announcement of the 64M deal at the end of November 1991.

The exchange items and goals behind this alliance in general are similar to those noted in the other alliance discussions. The bottom line is that both companies want to reduce the capital risk associated with developing new generations of DRAM. Texas Instruments also views DRAM process expertise as a key stepping-stone for technology migration to digital signal processors

(DSPs) and other advanced devices. Even so, the current results and evolution of this alliance have in some instances been unique.

16M DRAM Joint Development

The Hitachi/Texas Instruments joint-development effort on 16M DRAMs led to the design of an innovative DRAM package known as the lead on chip with center bond package, which both suppliers will use. By contrast, the 16M joint-development agreements resulted in two different 16M designs: Hitachi's stacked-cell structure and Texas Instruments' trench-based storage cell approach.

64M DRAM: a Second-Source Arrangement

The goal of the 64M DRAM joint-development effort will be a second-source arrangement. Hitachi and Texas Instruments will develop a common 64M DRAM design. They will also use common design automation and the same 0.35-µm manufacturing processing technology. The suppliers will separately engage in mass production and marketing.

As noted, the alliance strategically aims to reduce each partner's financial exposure to the risk of ultimately low-price DRAM parts that can be exorbitantly expensive to develop. The alliance should also lead the partners to other technology paths for ASICs and DSP chips.

The alliance could affect the course of Japan–US trade. Significantly, Hitachi took a license on Texas Instruments' Kilby patent as part of the agreement. For Texas Instruments, the Hitachi license strengthens the Kilby patent in Japan in the face of Fujitsu's ongoing legal challenge.

Dataquest Perspective

Everyone affected by the DRAM market—users, suppliers, investors, and governments—must prepare for the impact of the strategic alliance megatrends during the rest of this decade. Table 2 shows a nearly exhaustive list of DRAM technology alliances between suppliers or suppliers and users, including governments.

Dataquest realizes that some alliances will terminate with little impact. As shown in Table 3, however, Dataquest's DRAM analysts in Tokyo, London, Seoul, Taipei, and San Jose now see or foresee sharp market impact and strategic competitive significance from alliances such as the IBM/Siemens pact, the joint venture between Texas Instruments/Hewlett-Packard/Canon/Government of Singapore, the Toshiba/Motorola deal, and the Hitachi/Texas Instruments joint effort.

The economic realities of the 1990s indicate some long-term consolidation of the DRAM supplier base. DRAM alliances are not a sign of weakness, but rather a necessary step for survival. From the supplier side, DRAM alliance participants like Hitachi, Motorola, Texas Instruments and Toshiba are not the weak of the IC world. Although Dataquest at present anticipates no universal trend toward DRAM user/supplier alliances, Texas Instruments' strategy for Asia—for example, the Acer venture and the Singapore arrangement—emerges as one model for suppliers during the 1990s. DRAM alliances can also be a technology path to other products such as ASICs or DSPs. Readers should note that some of the DRAM players notably absent from Table 1 include AT&T, Fujitsu, Mitsubishi, Matsushita, and NEC.

What is the wild card in this whole set of global DRAM alliances? IBM. As the year 1992 commences, IBM will be changing and assessing or reassessing its many business options. The IBM/Micron deal shows a limit to the impact of IBM's proprietary DRAM technology on the market, but IBM's impact remains significant. Dataquest analysts already foresee significant market impact and strategic competitive effect from the IBM/Siemens alliance, especially in world regions such as Europe and North America. As IBM reshapes its business during 1992 and thereafter, the DRAM market might also be reshaped.

By Ronald Bohn
Byron Harding

End-User Analysis

1992 Worldwide Semiconductor Supplier of the Year Awards Go to Motorola, Analog Devices and Dallas Semiconductor

The fourth annual Dataquest Semiconductor Supplier of the Year Awards were presented at the Forecast '92 Conference on March 19, at Dataquest headquarters in San Jose, California, before an audience of more than 175 people. Awards were made in three categories of semiconductor suppliers. The Major Supplier Award went to Motorola for the fourth consecutive year; the Medium-Size Supplier Award again went to Analog Devices; and the Niche Supplier Award went to newcomer Dallas Semiconductor. The worldwide semiconductor user sample that we polled chose these three companies as the overall best in supporting their requirements of quality, price, delivery, technical support and customer service.

Methodology

The Semiconductor Supplier of the Year Award is based on data collected from electronics companies around the world that purchase semiconductors. Using telephone surveys, Dataquest collected data from companies listed in Electronic Business (EB) magazine's top 200 US electronic companies, and the respective EB top 50 electronic companies for Europe and Japan. Dataquest reviewed this list and deleted software companies and companies that manufactured or distributed semiconductors in order to ensure that the sample consisted of semiconductor users.

We identified the main semiconductor purchasing location for each company and sent a letter explaining the survey and a list of eligible semiconductor suppliers from our worldwide supplier database. The survey asked the respondents for their choice of Semiconductor Supplier of the Year in three size categories, as follows:

- Major suppliers (annual revenue of more than $500 million)
- Medium-size suppliers (annual revenue between $50 million and $499 million)
- Niche market suppliers (annual revenue of less than $50 million)

For each category the respondent was asked which supplier ranked the highest in each of the following areas:

- On-time delivery
- Quality
- Price
- Technical support
- Customer service

In the event that an electronics company named its own captive semiconductor source as the preferred supplier, the respondent was asked to exclude that choice and vote again.

There was one respondent per company. If the first respondent contacted at a company did not care to participate, a second respondent was chosen at random for that company from our procurement site database. If the second choice did not participate, a third site was chosen, and if the third respondent did not respond, the company was dropped from the survey. Scores were calculated for each of the five performance areas in each category. For each category, the five performance scores were combined into one aggregate score to determine the supplier of the year for that category.

Survey Results

The 144 company sites responding to this year's survey represent about 20.5 percent of the world's consumption of semiconductors, both in 1991 and estimated in 1992 (see Figure 6). The concentration of purchasing power highlighted here reinforces the need for sound strategic supplier links and how, by meeting the needs of the largest semiconductor users, suppliers are guided to meet the rest of the market's requirements.

Table 4 summarizes the rankings of each size category's top five suppliers as voted by the worldwide EB sample. The relatively high percentage of votes received by the top seven major suppliers, compared with the other two categories, indicates the large number of these smaller suppliers and their fragmented markets, and that the larger companies often have a broader product line and higher market awareness.

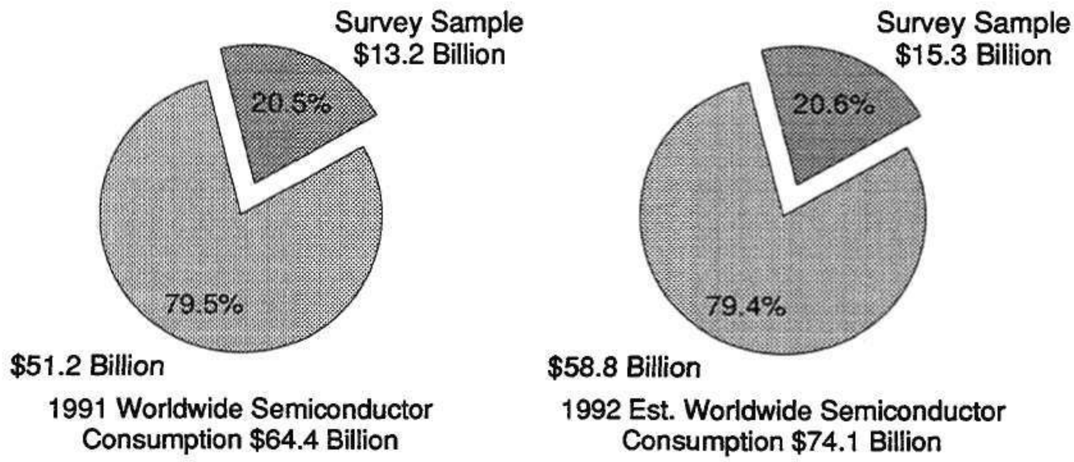
This year we asked our sample to rank in importance the five categories that determined

Table 4
1992 Semiconductor Supplier of the Year Rankings

Rank	Major	Vote (%)	Medium-Size	Vote (%)	Niche	Vote (%)
1	Motorola	30	Analog Devices	17	Dallas Semiconductor	26
2	Texas Instruments	13	Cypress	14	WaferScale	8
3	National	11	IDT	6	MOSel	6
4	Intel	10	International Rectifier	5	Seeq	4
5	AMD	8	NCR	5	Actel	4
6	Philips	4	Allegro	4	Cherry	3
7	Toshiba	4	Maxim	4	Micro Linear	3
	Others	20	Others	45	Others	46
	Total	100	Total	100	Total	100

Source: Dataquest (April 1992)

Figure 6
Worldwide Purchasing Power



Source: Dataquest (April 1992)

the winners. Table 5 shows that, to procurement managers, the overall top-ranked category was not price, but quality. Delivery was second, price was third overall, technical support was fourth, and customer service was last. Semiconductor companies that want to focus on areas of importance to their customers should closely review Table 5.

It is impressive that the three winners in each category garnered at least a combined 37 percent of the vote. In the major category, the top three garnered more than half (54 percent) of the votes. It was also interesting to note that, despite our worldwide sample, this sample did not perceive Japanese and European semiconductor suppliers to have improved.

Table 5
Criteria Rankings for Supplier of the Year

Criterion	Percentage
Quality	48
Delivery	25
Price	11
Technical Support	8
Customer Service	8
Total	100

Source: Dataquest (April 1992)

Dataquest Perspective

This year's award winners exemplify the current market demands: excellent quality and on-time delivery at a fair price. The service aspects of the total cost equation still remain very important, but the inclination of the current market is for tangible returns to the bottom line. By winning the Major Supplier Award for the fourth consecutive year, Motorola has earned the right to be acknowledged as the semiconductor company to be compared with or emulated. Analog Devices earned its customers' votes again because of its across-the-board strengths, both in product and in support in the demanding analog semiconductor market. Maxim, the number-one niche market supplier last year, graduated into the medium-size category for this year's voting and was ranked a strong number seven there primarily because of the level of customer support. The newcomer to the top spot in the niche market category, Dallas Semiconductor, was recognized among the many smaller suppliers primarily for supplying excellent service and for its high-quality, fairly priced products.

The ranking of the five criteria tangibly confirms what has been espoused in books, seminars and journals: a quality product and its delivery to the customer's schedule are the qualifiers in today's electronics market. This year's winners successfully used the differentiators of price, technical support, and customer support to increase their customers' loyalty, despite a sluggish market. As the electronics market begins to improve, quality will remain an absolute sourcing criteria with delivery, and the other differentiators becoming even more important. The awards for 1992 were earned by best meeting customer needs in a challenging economic environment. Those aspiring to win the award next year should focus on the key areas set out in this article and concentrate on exceeding customer requirements.

By Mark Guidici
Jim Eastlake

In Future Issues

Along with our regular features, "European Pricing Update" and "State of the Industry," forthcoming issues of *Dataquest Perspective* will contain reports on:

- European semiconductor five-year consumption forecast
- Capital and R&D expenditure of European companies

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9203 March 27, 1992

In This Issue...

Pricing Analysis

European Pricing Update

New reference prices for DRAMs have been announced for second-quarter bookings. These are generally downward when measured in local currency, but the changes in a dollar value vary between a rise of 5 percent to a decline of 10 percent, depending on the product. There is little activity in prices in other product categories.

By Byron Harding and Mike Glennon *Page 2*

Market Analysis

State of the Industry

The SIA European book-to-bill ratio for February was 1.07, a rise over January. This is the third month in a row where the book-to-bill ratio has been above unity. The outlook for the rest of the year is looking a little brighter, as the US data indicate a consistent rise in business there. However, to counter this, 12-month average booking growth for Europe has yet to show an increase.

By Mike Glennon *Page 4*

European Community Semiconductor Tariffs

Exports of semiconductors to Europe are subject to various rates of import duty. This executive overview provides a concise historical review, discusses the applicable rates of duty for different stages of product integration, and debates whether the current tariff system is a workable one. This is a timely report, against the backdrop of continuing GATT talks, increasing world trade friction, and the unification of the European market.

By Byron Harding *Page 8*

Technology Analysis

MCM Design Tools Now Lead in Layout Growth

Multichip modules (MCM) are finding many applications in all electronic sectors. The development of this technology can have a major impact on the design of systems and equipment. This report identifies the advantages of using multichip modules, analyses who will buy them, and assesses the outlook for MCM design in Europe.

By Jim Tully *Page 17*

Company Analysis

Europe Gains a New Semiconductor Company

The semiconductor operations of MBB, the parent of Daimler-Benz, are to be combined into a single operation. The companies to be combined are AEG, Dialog Semiconductor, Telefunken, and Matra-MHS. The size of the new semiconductor operation places the new concern as the fourth-largest European semiconductor supplier. This report gives a quick overview of the new company, and analyses the likely success or failure of the venture.

By Mike Glennon *Page 21*

Pricing Analysis

European Pricing Update

Standard Logic

Prices are firming, with customers more willing to accept given prices. The overall result is a reduction in the spread of prices. The size of the market is shrinking in many accounts. As usual, the telecoms sector is supporting the majority of FAST orders, (although EDP is the volume dollar user) and FACT is used more widely. Table 1 shows European semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Analog

There is little change in the mono operational amplifier arena in Europe.

Microcomponents

More price declines in 286 volumes have occurred. The 386SX prices are declining a little, but these are cosmetic changes. The 486 price reductions announced by Intel come into effect this quarter, resulting in lower DX prices. The proposed entry of other 386 suppliers can only hasten the decline in prices, and also Intel's efforts to move users to 486-based products. The new DX2 devices are aimed at achieving this.

Memory

DRAM

Prices for 256K DRAM appear to have nearly reached rock-bottom; erosion has been only slight since our last update. Vendors and users are continuing to move to 1M; the 1M price has also seen erosion, and there are instances of very low prices. The 4M has seen a little price erosion, but the majority of supply continues to be Japanese-manufactured, and is therefore bound by reference prices (RPs). The supply of 4M DRAMs which are not affected by RPs is increasing steadily. These suppliers have a competitive advantage. The 1M×9 SIMM has dropped in price again, with the lowest prices on the three-chip version. The 16M price has remained flat, at around $185 in contract volume. However, there are offers of 4M×36 SIMMs using 16M DRAMs at $1,300, which translates into a unit price of only $145. Average contract price per Mbit is as follows: 256K = $6.32; 1M = $3.65; 4M = $3.71.

New DRAM reference prices have been released for second-quarter 1992 bookings. The indications are that, translated into European currencies, the 256K, 1M, and 4M reference prices all declined from the first quarter. However, our estimates show that, translated into US dollars, the 256K reference price increased by 5 percent; the 1M reference price stayed roughly the same; and the 4M reference price declined by nearly 10 percent. The effect of reference prices on bookings is proportional to the market share held by Japanese-diffused products. Dataquest estimates these shares are 15 percent of 256K, 25 percent of 1M, and 70 percent of 4M.

EPROM

EPROM prices continue to be under severe price pressures. Europe also continues to have the the lowest prices in the world for EPROM products at the densities reported here. Some withdrawals from the European market are expected if the situation does not improve soon. Average contract price per Mbit is as follows: 1M = $3.20; 2M = $3.05; 4M = $3.75.

SRAM

All generations of SRAM tracked here have seen some price erosion. Again, Europe is earning itself the reputation for being the market with the lowest prices in the world. However, the erosion is slowing down, and our next update is expected to report flat prices. Average contract price per Mbit is as follows: 64K = $28.00; 256K = $14.00; 1M = $10.00.

Current Exchange Rates

1 US dollar =
- 0.577 UK pounds
- 1.648 deutsche marks
- 5.597 French francs
- 0.808 ECU

By Byron Harding
Mike Glennon

Table 1
European Semiconductor Pricing—March 1992
All Prices in US Dollars (including import duty where relevant)

Device Family	Product	Package	Mean 1K Price	Mean 10K Price	25K+ Contract Price	Lead Time in Weeks
Standard Logic	74F00	PDIP	0.12	0.09	0.09	4-6
Fast TTL	74F74	PDIP	0.14	0.12	0.12	4-6
	74F138	PDIP	0.18	0.16	0.15	4-6
	74F244	PDIP	0.25	0.22	0.21	4-6
Standard Logic	74AC00	PDIP	0.19	0.15	0.15	4-6
Advanced CMOS	74AC74	PDIP	0.24	0.19	0.20	4-6
	74AC138	PDIP	0.35	0.27	0.26	4-6
	74AC244	PDIP	0.43	0.35	0.35	4-6
Analog	741 Op. Amp.	TO92	0.17	0.10	0.11	4-6
	CODEC/Filter 1	[1]	2.90	2.50	2.50	6-10
	CODEC/Filter 2	[2]	5.75	5.30	5.00	6-10
Microcomponents	80386SX-16	PQFP	55.50	53.50	52.50	6-7
	80386DX-25	CPGA	149.00	144.00	139.00	6-8
	80286-16	PLCC	11.70	11.00	10.00	4-6
	68020-16	PQFP	31.00	28.00	26.00	4-6
	R3000-25	CPGA	135.00	120.00	110.00	4-10
Memory						
DRAM	256K-8 (256K×1)	PDIP	1.95	1.65	1.58	2-8
	1M-8 (1M×1)	SOJ	4.10	3.85	3.65	2-6
	1M-8 (256K×4)	SOJ	4.10	3.85	3.65	2-6
	4M-8 (4M×1)	SOJ	15.30	15.00	14.85	2-8
	9M-8 (1M×9)	SIMM	38.00	36.00	35.00	4-10
	1M-7 (1M×1)	SOJ	4.10	3.85	3.65	2-8
	1M-6 (1M×1)	SOJ	4.28	4.02	3.81	4-10
	4M-7 (4M×1)	SOJ	15.45	15.15	15.00	4-8
	4M-6 (4M×1)	SOJ	16.10	15.80	15.60	6-10
	16M-8 (4M×4)	SOJ	190.00	186.00	184.00	8-14
UV EPROM	1M-17 (128K×8)	CDIP	4.00	3.60	3.20	2-6
	2M-17 (256K×8)	CDIP	8.00	7.00	6.10	2-8
	4M-17 (512K×8)	CDIP	19.00	17.00	15.00	4-10
SRAM	64K-85 (8K×8)	PDIP	2.20	1.90	1.75	4-10
	256K-85 (32K×8)	PDIP	4.00	3.65	3.50	4-8
	1M-85 (128K×8)	PDIP	13.00	11.00	10.00	2-10

[1] Group 1: Commercial temp, serial, PDIP, A/μ law
[2] Group 2: Commercial temp, serial, PLCC, A/μ law, programmable
Source: Dataquest (March 1992)

Market Analysis

State of the Industry

The SIA flash three-month average European book-to-bill ratio for February was 1.07, an improvement over January's revised figure of 1.03, as shown in Figure 1. Actual billings for February were $947.7 million, a growth of 8.2 percent over the previous month, and 8.3 percent over the same month the previous year. Three-month average bookings increased by 8.8 percent over the previous month, and 3.6 percent over the previous February.

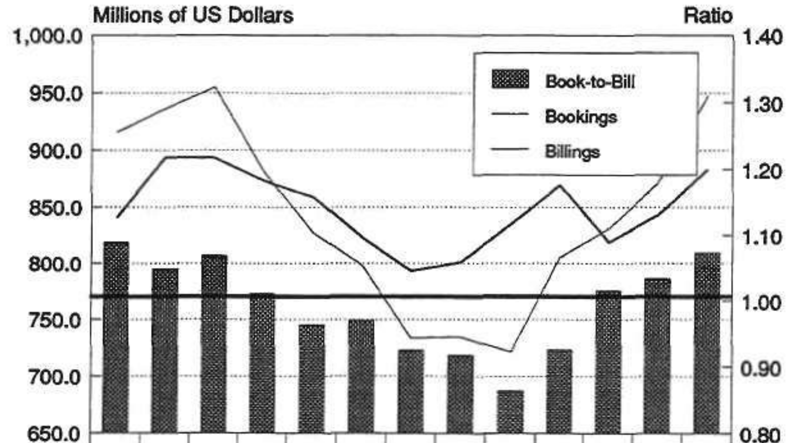
The booking and billings growth is lower than for the same period in 1991, which was around 17 percent for billings, and 15 percent for bookings. While this lower growth could be considered disappointing, it is perhaps an indication of underlying growth for the year. Much of last year's growth came from a short period of high growth in the first quarter, which was followed by a famine of orders for the rest of the year. This year might follow the same path, but the slower start could be a hint of a steadier year ahead.

While the slowing of growth in Europe continues, with the rolling 12-months-to-date growth in bookings still to begin its upturn, the outlook is more optimistic when bookings for the United States are examined, where 12-month average growth is now rising again, having reached its low-point in October 1991. This is clearly seen in Figure 2. This may be the first positive sign that the market is beginning to improve, although there are still many negative factors.

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trends and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billing and three-month average booking figures. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

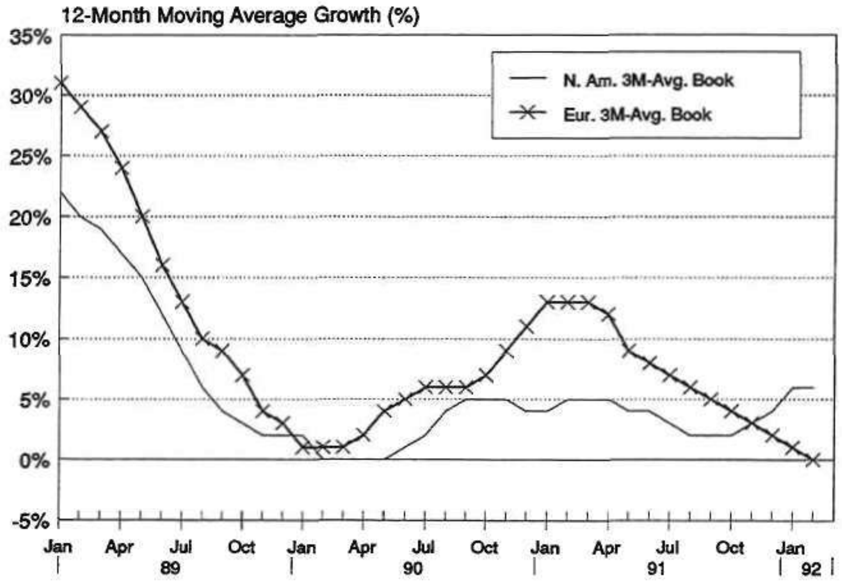
Figure 1
European Total Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Feb	Mar	Apr	May	Jun	Jul 91	Aug	Sep	Oct	Nov	Dec	Jan	Feb 92
Book-to-Bill	1.09	1.05	1.07	1.01	0.96	0.97	0.93	0.92	0.86	0.93	1.02	1.03	1.07
Bookings	915.3	936.3	954.6	882.4	827.3	798.3	733.5	734.6	721.4	805.1	831.0	871.0	947.6
Billings	840.4	893.5	893.0	873.5	858.7	823.0	792.7	800.8	835.2	869.4	818.7	843.0	882.9

Note: Last two months are preliminary.
Source: WSTS, SIA

Figure 2
US and European Total Semiconductor 12-Month Moving Average Growth (Three-Month Average Bookings)



Source: WSTS, SIA

Figures 3 and 4 show the forecast and actual three-month average bookings, and actual monthly billings from the Dataquest forecast model.

The anomaly of last month's discrete and opto-electronic revenues has been corrected: this was due to the overlap of a three-week December and a six-week January for some discretes suppliers. A look at the discrete bookings and billings, though, still shows the January data is out of line with the trend indicated by December and February. Discrete products are still shipping at a rate lower than indicated by the forecast.

The adjustment to the figures has also increased the book-to-bill ratio upwards, as was predicted last month. This month's figures are more in line with what would be expected, and are less likely to be adjusted now the uneven Christmas and New Year period is over.

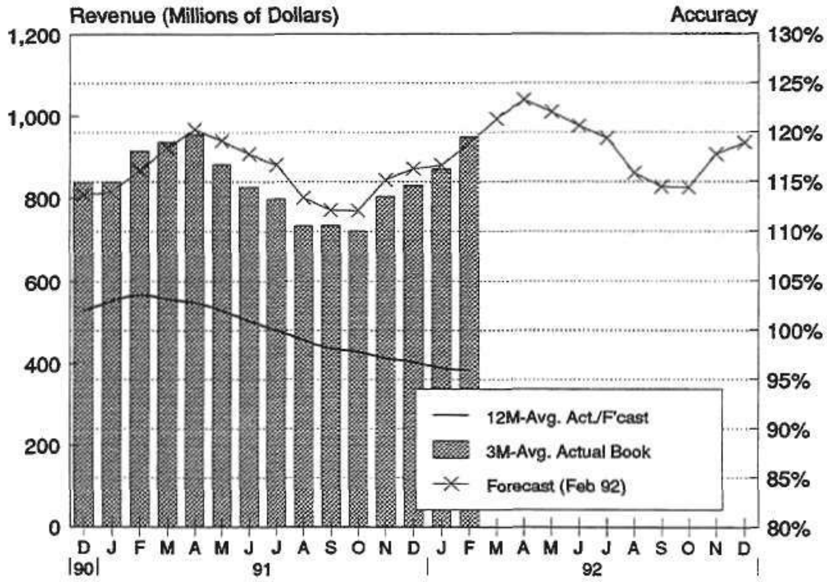
While it is unclear from the European data whether the upward signs indicated by the last two months' data is a repeat of last year's first-quarter growth, an examination of trends for US bookings points to a more positive outlook. The three-month average booking data, as shown in Figure 5, have been ahead of the forecast model since November of last year, and billings are now beginning to pick up on this earlier growth in bookings. The US market is often a leading indicator for Europe, and this gives added optimism to the longer-term outlook for European growth.

Dataquest Perspective

The adjustments to the booking and billing revenues bring the data into line with what is expected at this time of year. The revenues are showing steady growth, although this is only for two months. A closer look at the factors behind the steady growth reveals microcomponents are again supporting the market, and particularly microprocessor shipments. This was the case last year, but while microcomponents continued in their steady growth, the rest of the market faded away.

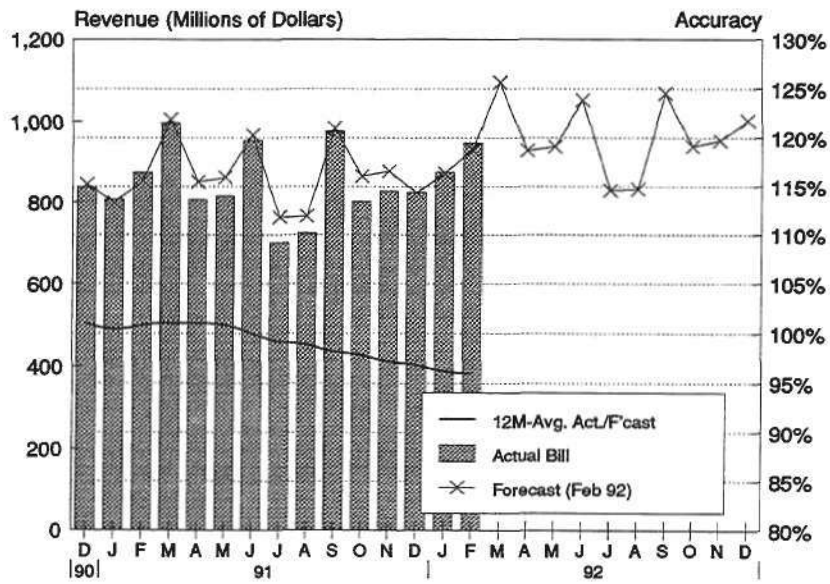
The new reference prices for DRAMs are now available, and these are generally downward. The additional manufacturing capacity due to come on stream over the next two years is being delayed as a result of the continually declining

Figure 3
European Total Three-Month Average Bookings



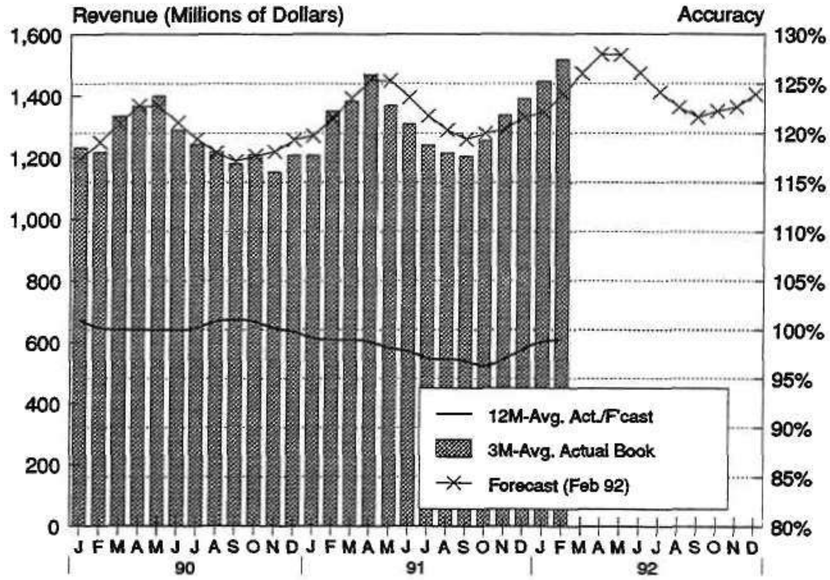
Note: Last two months are preliminary.
Source: SIA, WSTS, Dataquest (March 1992)

Figure 4
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary.
Source: SIA, WSTS, Dataquest (March 1992)

Figure 5
North American Total Semiconductor Three-Month Average Bookings



Note: Last two months are preliminary.
Source: SIA, WSTS, Dataquest (March 1992)

memory prices, with some plant switch-ons being delayed by up to two years. The uncertain outlook for the memory market is forcing manufacturers to consider other products for manufacture at these expensive fabrication plants.

Standard logic products are not increasing in unit volume shipments, particularly bipolar parts. CMOS standard products are still displacing bipolar in the declining number of logic sockets. However, the older HC family is still winning designs, as the traditionally conservative designers are reluctant to switch to newer AC logic parts. The best news so far for the remaining suppliers has been the announcement of Signetics pulling out of many products in the United States. The general consensus is that this will also happen in Europe. Fewer suppliers clearly means less pressure on price for the remaining manufacturers.

The state of the German economy still gives cause for concern, and the political uncertainty within Europe adds to this. Elections are due across Europe and also in the United States in the next 18 months, beginning with the United Kingdom in April. Changes in governments always mean changes in policy, and attracting manufacturing to Europe, while still keeping out unfair competition, is a difficult path to tread for inexperienced new ministers. Political posturing over contentious trade issues will be rife over the next few months, and the loser in the end may well be the Uruguay Round of the General Agreement on Tariffs and Trade.

By Mike Glennon

European Community Semiconductor Tariffs: an Executive Overview for Suppliers and Buyers

Introduction

Exports of semiconductor devices to the European Community (EC) from third countries (non-EC countries) are subject to ad valorum import duties (that is, proportional to value). A weighty legislative document is released annually by the European Commission detailing the Common Customs Tariff (CCT) for the following calendar year. The complexity of this legislation, together with the high-profile coverage the media has given to other trade matters in the EC, has caused a certain amount of confusion in the international semiconductor community regarding the subject of EC semiconductor tariffs and related issues. This executive overview, which is extracted from a larger, comprehensive special report, provides a concise and authoritative source of reference on this subject for semiconductor suppliers and buyers. Readers are recommended to use the references at the end for further information on areas of special interest.

Background

The European Community is the last major semiconductor market in the world which continues to apply conventional rates of import duty on semiconductor devices. In 1985, the United States, Canada and Japan indefinitely suspended their conventional rates of import duty on semiconductor devices and computer printed circuit boards (PCBs). A number of Asia/Pacific countries have recently agreed to do the same.

The EC and other countries have progressively reduced tariff and non-tariff barriers to international trade through various rounds of multilateral talks that began after the Second World War. The General Agreement on Tariffs and Trade (GATT) came into force on January 1, 1948 following initial talks in 1947, and continues to be the only forum for multilateral trade talks. The current round of talks which began six years ago, known as the "Uruguay Round," is still in progress. The possible effect on EC semiconductor tariffs when these talks are concluded is discussed in the Dataquest Perspective at the end of this executive overview.

In 1968 the EC formally adopted the current system of the CCT for all forms of produce exported to the EC. However, the concept of the CCT was originally introduced when the European Economic Community was formed in 1957, and was based upon an arithmetic average of the import tariffs formerly applied in each member country.[1] The purpose of the CCT has been one of a set of measures "to promote the efficiency and competitive capacity of its industry on an international scale."[2] This has often been referred to in the European Community as "levelling the playing field" against external competition. In the context of the semiconductor industry, the European Electronic Component Manufacturers' Association (EECA) has determined that the manufacturing costs of European semiconductor suppliers are at least 20 percent higher than in the United States or Japan.[3]

The present CCT is based upon a 1987 European Commission Council Regulation,[4] which is republished by October 31 every year in the Legislation series of the *Official Journal of the European Communities.* This regulation serves to differentiate between 97 general product groups in order specify the rates of duty which are applied against exports from third countries. Semiconductor devices comprise a small subset of one of these groups.

Another purpose of this differentiation is to track the volume of imports and exports of different products between the EC and third countries. Every EC customs office records the shipment of products in and out of the EC by CCT code and submits this to a central point for consolidation of trade statistics. The European Commission uses this information to develop and support its policies for EC industries, including the tariff structure.

Product differentiation is more detailed in areas which are of strategic importance. Taking a particular example in the semiconductor sector, there was only 1 product code for all semiconductor memory devices in the 1987 regulation. In the current version there are 15 product codes for MOS memory devices and 1 code for other memory devices. This indicates the growing importance of MOS memory to the EC semiconductor industry.

Table 2 summarizes the major semiconductor device families covered by the CCT and the corresponding rates of import duty. Also included in this table are some of the key materials used in the manufacture of semiconductor devices, examples of electronic assemblies which use finished semiconductor devices, and some examples of completed electronic equipment. This draws the "big picture" of the European electronic products tariff structure, from raw materials to final end equipment. The rates of duty shown are based upon published legislation from the European Commission for the year 1992.[5] Note that there has been no change in the rates of duty on semiconductor devices between 1991 and 1992, although product differentiation has increased.

Terms of Reference

The European Commission adopted a system of classification for goods in its 1987 Council Regulation called the Combined Nomenclature, or CN for short, in which each single product is defined by an eight-digit code. This replaced the previous system of Nomenclature of Goods for External Trade Statistics of the Community and Statistics of Trade Between Member States, or NIMEXE for short, in which a six-digit code was used.

The CN system is used to unambiguously identify a product and apply the correct rate of import duty when it enters the European Community from a third country. The duty is applied as a percentage of the product's CIF value—or in other words, the sum of its cost, insurance, and freight. This is the general rule. In addition, each EC member country may apply its own national sales tax (such as, value-added tax) on top of this import duty. The rate of sales tax currently varies from one EC country to another. One of the goals of the unification of the EC market on January 1, 1993 is a standard rate of sales tax for all EC member countries.[6] However, this executive overview is only concerned with EC import duties under the CCT.

Correctly identifying the product by its CN code so that the appropriate level of import duty can be applied is only the first stage in the customs process. The next important step is to identify the country of origin of the product, so that duty concessions or penalties may be applied, according to the trading status between the EC and that country. National sales taxes will normally remain in place, independent of any duty concessions.

Table 2

European Community Import Duties for Electronic Components and Products
(Based upon conventional rates)

Code	Description	1992 Duty
Silicon Ingots		
	Not yet sliced into wafers	
28046100	Minimum purity 99.99%	6.0%
28046900	Maximum purity 99.99%	6.0%
Unprocessed Wafers		
	Doped but not yet diffused	
38180010	Doped silicon	7.6%
38180090	Other doped material	7.6%
Processed Wafers		
	Diffused but not yet cut into die	
85421101	Digital MOS IC die on wafer	9.0%
85421188	Non-MOS digital IC die on wafer	9.0%
85421910	Non-digital IC die on wafer	9.0%
85412110	Transistor <1W die on wafer	9.0%
85412910	Transistor >1W die on wafer	9.0%
85411010	Diode die on wafer	9.0%
86413010	Thyristor die on wafer	9.0%
85415010	Other discrete/opto die on wafer	9.0%
Die		
	Cut from wafer but not yet packaged	
85421105	Digital MOS IC die	14.0%
85421189	Non-MOS digital IC die	14.0%
85421920	Non-digital IC die	14.0%
85412190	Transistor <1W die	14.0%
85412990	Transistor >1W die	14.0%
8541109*	Diode die	14.0%
85413090	Thyristor die	14.0%
85415090	Other discrete die	14.0%
85414010	LED die	14.0%
85414091	Solar cell die	4.6%
85414093	Photosensor die	4.6%
85414099	Other opto die	4.6%
Assembled devices		
	Packaged die not yet mounted on PCB	
85421105	Monolithic digital MOS IC device	14.0%
85421189	Monolithic digital non-MOS IC device	14.0%
85421920	Monolithic non-digital IC device	14.0%

(Continued)

Table 2 (Continued)
European Community Import Duties for Electronic Components and Products
(Based upon conventional rates)

Code	Description	1992 Duty
854220**	Hybrid (multidie) IC device	14.0%
85412190	Transistor <1W device	14.0%
85412990	Transistor >1W device	14.0%
8541109*	Diode device	14.0%
85413090	Thyristor device	14.0%
85415090	Other discrete device	14.0%
85414010	LED device	14.0%
85312090	LED/LCD display	4.4%
85414091	Solar cell device	4.6%
85414093	Photosensor device	4.6%
85414099	Other opto device	4.6%
Passives not yet mounted on PCB		
85321100	Fixed tantalum capacitor	7.0%
85322200	Fixed aluminium capacitor	7.0%
85322300	Fixed ceramic single capacitor	4.9%
853224**	Fixed ceramic multilayer capacitor	4.9%
85322500	Fixed paper/plastic capacitor	4.9%
853230**	Variable/adjustable capcitor	7.0%
85331000	Fixed resistor	5.3%
85333***	Variable wirewound resistor	5.3%
85334***	Variable other resistor	5.3%
PCBs		
PCB without diffused devices mounted		
85340011	With multicircuit contacts only	6.2%
85340019	With other circuit contacts only	6.2%
85340090	With passive devices mounted	6.2%
PCB with diffused devices mounted		
84731010	Used in typewriters and WP systems	4.0%
84732110	Used in battery calculators	6.3%
84732910	Used in mains-supply calculators	4.0%
84733010	Used in other EDP systems (e.g. PC)	4.0%
84734010	Used in other non-EDP office systems	4.0%
90099010	Used in photocopier systems	7.2%
85179081	Used in telephone systems	7.5%
85179092	Used in telegraph systems	7.5%
85179011	Used in other communication systems	4.6%
85229091	Used in audio and video systems	5.8%
85299070	Used in radio and TV systems	7.2%

(Continued)

Table 2 (Continued)
European Community Import Duties for Electronic Components and Products
(Based upon conventional rates)

Code	Description	1992 Duty
84159090	Used in air conditioning systems	5.3%
84189990	Used in refrigerators and freezers	3.8%
84229010	Used in dish washers	3.5%
85099090	Used in food mixers	5.1%
85169000	Used in microwave ovens	5.1%
85389010	Used in electricity control systems	4.6%
85309000	Used in public transport systems	4.4%
870899**	Used in private transport systems	4.9%
88033090	Used in private aircraft systems	4.9%
90069190	Used in photographic cameras	7.2%
90330000	Used in medical/industrial systems	5.6%
92099400	Used in musical instrumenents	5.0%
Systems		
Equipment using PCBs and devices		
8469****	Typewriters and WP systems	4.6%
84701000	Battery calculators	12.0%
84703000	Mains-supply calculators	4.1%
8471****	Other EDP systems (e.g. PC)	4.9%
8472****	Other non-EDP office systems	4.4%
9009****	Photocopier systems	7.2%
8517****	Communication systems	7.5%
8518***	Audio amplifiers	4.9%
8519****	Audio reproduction systems	9.5%
8520****	Audio recording systems	7.0%
8521****	Video systems	14.0%
85251090	Radio/TV transmission systems	4.9%
85252090	Radio/TV transceiver systems	6.5%
852530**	TV/Video cameras	4.9%
9006****	Photographic cameras	7.2%
85269290	Remote control systems	6.2%
8527****	Radio receiver/recording systems	14.0%
8528****	TV/video receiver/monitor systems	14.0%
8415****	Air conditioning systems	5.3%
8418****	Refrigerators and freezers	3.8%
84221100	Domestic dish washers	4.9%
85094000	Food mixers	5.1%
85143010	Infrared ovens	4.1%
85165000	Microwave ovens	5.1%
8530****	Public transport systems	4.4%
870899**	Private transport systems	4.9%

(Continued)

Table 2 (Continued)
European Community Import Duties for Electronic Components and Products
(Based upon conventional rates)

Code	Description	1992 Duty
88033090	Private aircraft systems	4.9%
8535****	>1KV electrical switching systems	4.6%
8536****	<1KV electrical switching systems	4.6%
8537****	Electrical switching display systems	4.1%
9010****	Semiconductor lithography systems	4.9%
9018****	Medical/diagnostic systems	5.3%
9019****	Breathing and therapy systems	4.6%
9022****	X-ray and radiography systems	4.6%
90302090	Cathode-ray oscilloscopes	11.0%
92071090	Electronic musical instruments	6.0%

PCB = Printed circuit board, including SIMMs and SIPs
CN = Combined Nomenclature, used by EC to differentiate products
* Various codes, please refer to EC Council Regulation 2587/91
Source: Dataquest (March 1992)

Before discussing the subject of duty concessions, it would be useful at this point to define the countries which comprise the European Community. The EC member countries are Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and the United Kingdom. Trade between member countries is not subject to any import duty.

Duty Concessions

There are a great number of legislative documents concerning trade arrangements between the EC and individual third countries. Numerous revisions and amendments to these arrangements result in a complex web of mutual concessions. The duty concessions that currently exist between the EC and third countries are summarized below.

The EC has a zero-duty arrangement with member countries of the European Free Trade Association (EFTA). The EFTA member countries are Austria, Finland, Iceland, Norway, Sweden and Switzerland. The tiny country of Liechtenstein is affiliated by protocol with EFTA, and is expected to become a full member in the near future. EC and EFTA countries are continuing discussions of mutual economic integration, creating what is known as the European Economic Area (EEA), but some institutional problems still have to be overcome. In parallel to these discussions, some EFTA countries have made independent applications to become members of the EC.

The EC also applies generalized tariff preferences on products from nearly 200 developing countries.[7,8] This is where the CCT (i.e. import duty) is fully suspended on exports of products to the EC from each developing country up to a ceiling of shipments per annum. The normal rate of import duty is applicable on any shipments above this ceiling. In the case of integrated circuits (ICs), this ceiling is ECU 5.513 million (or just under $7 million at current exchange rates). The purpose of the tariff preference arrangement, under the umbrella of the United Nations, is for "improving access for developing countries to the markets of the preference-giving countries." Examples of countries benefiting from this arrangement are Colombia, Brazil, Uruguay, Cyprus, Singapore, China, Malaysia and India. Rather interestingly, South Korea continues to be included in this list as a developing country. However, benefits have been temporarily suspended since 1987 until an mutually satisfactory agreement is reached on intellectual property rights between the EC and South Korea.

Those remaining countries, not covered by the above, and which are Contracting Parties of the GATT, and/or have Most-Favored Nation (MFN) trading status with the EC, are generally subject to "conventional" rates of duty on products exported to the EC. This covers the overwhelming majority of exports to the EC, and as such, is regarded as the normal rate of duty. Exports from the United States, Canada, and Japan are subject to this rate. It is also this rate of duty which forms the focus of this executive overview.

Any other countries not covered by any of the forementioned are subject to an "autonomous" rate of duty on products exported to the EC. This rate of duty is generally much higher than the conventional rate. In theory, these are typically countries with no diplomatic relations with the EC, and so represent a negligible volume of potential exports to the EC. Also, in exceptional cases where the autonomous rate is lower than the conventional rate, the autonomous rate will apply. In practice, the autonomous rate is very rarely used.

Another rate of duty is applicable for very small consignments sent from one private individual to another or contained in a traveller's personal luggage up to a ceiling value of ECU 200 (or just under $250 at current exchange rates). This is called the "standard" rate of duty, and is a flat rate of 10 percent regardless of the product type. This rate is mentioned for information only.

Rules of Origin

Rules of origin define the method by which a product's origin is determined. This is important in order to apply the correct rate of duty, bearing in mind the concessions made to certain third countries, as discussed in the previous section. For lower-technology products such as tobacco or steel, this is a relatively trivial exercise, and reference to the European Commission 1968 *Regulation on the Common Definition of the the Concept of the Origin of Goods*[9] is sufficient guidance. This states that the origin of goods is defined as the country "in which the last substantial process or operation, that is economically justified, was performed." Where a number of processes have been performed in different countries, this is interpreted to mean the country where the most value was added to the goods.

In the manufacture of very large-scale integrated (VLSI) circuits, various complex processes can occur in several different countries. Assigning a single country of origin to a VLSI semiconductor device can therefore be equally complex, and some clarification of the 1968 rule of origin is needed. The European Commission published an unambiguous rule of origin for the integrated circuit[10] in 1989. This regulation identifed the process of diffusion (or fabrication) as the last substantial operation to determine origin for an IC. In other words, diffusion was determined to be the highest contributor to added value. This results from the ever-increasing complexity of integrated circuits, some of which have as many as 4 million transistors diffused on a piece of silicon smaller than a postage stamp, and therefore the high value of the diffusion process compared with other stages in the manufacture of an IC. Dataquest published its analysis of the regulation at the time of its release.[11]

There are a small number of special exceptions to the IC origin rule, such as the preferential semiconductor origin rule for EFTA countries. Also note that discrete semiconductor devices, such as a single transistor or diode, generally have their origin determined by the assembly or packaging process. This is because assembly is usually the largest contributor to added value for these products.

The United States and Japan generally determine the origin of all types of semiconductor device, including ICs, by the assembly or packaging process. There was strong opposition by the US Semiconductor Industry Association (SIA) to the EC IC origin rule when it appeared. US manufacturers with IC assembly facilities in the EC, but no diffusion, feared that because their products would no longer be regarded as European in origin they would be subject to greater import duty. This is a misunderstanding of the effect of the IC origin rule, which Table 3 should clarify. In fact, the major benefit of the IC origin rule is in the implemention of antidumping action. This allows the EC to apply antidumping duties dependent on where ICs are diffused rather than where they are assembled.

It is also relevant to discuss the case of the printed circuit board. The EC definition of a

Table 3
Effect of IC Origin Rule

Manufacturing Stage		Before IC Origin Rule		After IC Origin Rule		Change in Status	
Front End Diffusion	Back End Assembly	Origin Status	Duty Payable	Origin Status	Duty Payable	Origin Status	Duty Payable
EC	EC	EC	None	EC	None	No change	No change
EC	Non-EC	Non-EC	On package	EC	On package	Reversed	No change
Non-EC	EC	EC	On die	Non-EC	On die	Reversed	No change
Non-EC	Non-EC	Non-EC	On both	Non-EC	On both	No change	No change

Source: EECA

which are regarded by many semiconductor manufacturers as semiconductor devices. Indeed, SIMMs and SIPs are very much a standard product in the electronics industry, and are listed beside ICs in suppliers' product catalogues. However, they are not subject to the same rate of import duty as semiconductor devices. In many cases the rate is significantly lower, as shown in Table 2. Semiconductor memories are increasingly being exported to the EC in this format.

The European Commission considered the introduction of a rule of origin for PCBs. This was primarily to be used in context with antidumping proceedings against certain electronic equipment manufacturers from third countries with assembly operations within the EC.[12] The definition would have been related to the origin of the semiconductor devices mounted upon the PCB. This caused much consternation in the electronics industry, as it was feared this would lead to discrimination against import of SIMMs and SIPs based upon a new origin rule. However, a section of the regulation which dealt with the problem of circumvention of antidumping duty was regarded as inconsistent with GATT, and the PCB origin rule which was to have been employed in this context never appeared. This anticircumvention rule, which the media christened the local content rule, is now effectively defunct.

Dataquest Perspective

The issue of tariff and non-tariff barriers to trade is a global one that has been addressed through the various rounds of GATT talks since the end of the Second World War. The level of these barriers have been progressively reduced after each round by reciprocal concessions between all GATT contracting parties or countries. The preamble to the present text of the General Agreement on Tariffs and Trade states the goals of the Contracting Parties as:

> "Recognizing that their relations in the field of trade and economic endeavor should be conducted with a view to raising standards of living, ensuring full employment and a large and steadily growing volume of real income and effective demand, developing the full use of resources of the world and expanding the production and exchange of goods,
>
> Being desirous of contributing to these objectives by entering into reciprocal and mutually advantageous arrangements directed to the substantial reduction of tariffs and other barriers to trade and to the elimination of discriminatory treatment in international commerce ..."

Whereas the EC continues to maintain a semiconductor tariff, it should be borne in mind that other countries also maintain tariff and non-tariff barriers in this and other industries. Each country has certain strategic industries it wants to protect against external competition, and in the final analysis, the sum of any concessions made by one country to another should generally be reciprocated in equivalent value after each round of GATT talks. In other words, at the start of each round of talks, each contracting party begins negotiations as an equal. There are no scapegoats. Negotiations are multinational, multiindustrial, multilingual, and multiconcessional. No wonder each round of GATT talks stretches on for many years.

During the Uruguay Round of talks, the EC has offered to reduce its import tariff on integrated circuits by one-third (that is, from 14 percent to 9 percent) if other contracting parties can produce reductions in tariff or non-tariff barriers in this or other industries to the same effective value. To date, the EC has not received satisfactory offers of reciprocal concessions.

In the case of Japan, the offer of improved market access would be a valuable concession in return for the EC tariff reduction. Table 4 shows estimated worldwide regional semiconductor market shares by worldwide regional suppliers for calendar year 1991. It is clear from this table that the Japanese semiconductor market is dominated by Japanese suppliers, which control 87.8 percent of the total business, whereas European suppliers held a minority 0.7 percent share. Although this weak share is mainly a result of non-tariff barriers, it should be recognized that market access is a two-edged sword, and European suppliers must also aggressively pursue business in this market.

Table 4 shows that the European semiconductor market is shared more equally than those of the United States and Japan. The market share of US and European suppliers is around 40 percent each, with most of the remaining 20 percent

Table 4
Estimated Worldwide Regional Market Shares of Worldwide Regional Suppliers: Preliminary Estimates for 1991 (Percent)

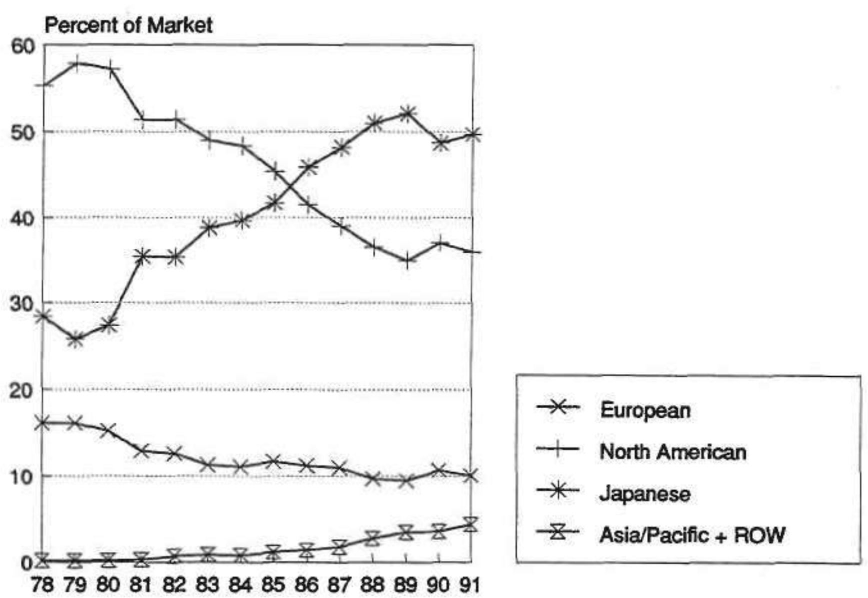
	Regional Suppliers				
Regional Markets	North America	Japan	Europe	Asia/ Pacific	World Total
North America	68.2	21.7	6.5	3.6	100.0
Japan	10.9	87.8	0.7	0.6	100.0
Europe	41.7	17.7	37.5	3.1	100.0
Asia/Pacific	34.7	37.7	9.9	17.8	100.0
World Total	35.9	49.7	10.1	4.4	100.0

Source: Dataquest (March 1992)

share held by Japanese suppliers. In fact, even in their home market, European suppliers do not hold a majority share. Naturally, there is a fear that if semiconductor import tariffs are reduced or abolished, their domestic share will decline even further. The logic in this argument is that if non-EC suppliers are already competitive against European suppliers—and they clearly are—then any reduction in the tariff can only lead to an increase in their competitiveness with a consequential erosion in European suppliers' market share.

Figure 6 shows estimated worldwide semiconductor market share by worldwide regional suppliers over the last 13 years. European and US market share has almost continuously declined over this period while Japanese and Asia/Pacific share has risen. European suppliers are concerned that their share will decline further, ultimately being overtaken by Asia/Pacific, to become the smallest supply base in the world. The European Commission's *Policy Statement on the Electronics and Information Technology Industries*[13, 14, 15] addresses these concerns and

Figure 6
Worldwide Semiconductor Market Share by Supplier Base Region



Source: Dataquest (March 1992)

proposes an integrated course of action to reverse this trend.

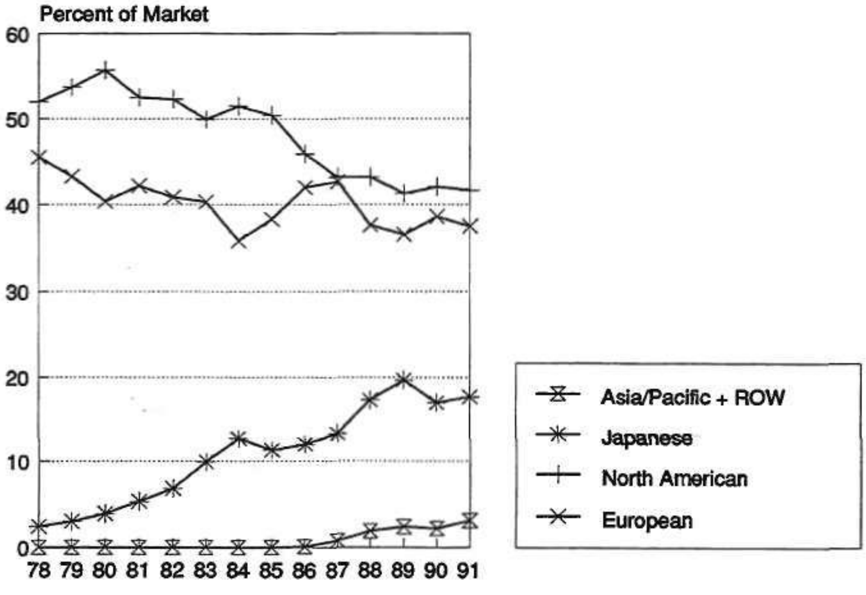
Figure 7 shows estimated European semiconductor market share by worldwide regional suppliers over the same period. Clearly the trend in the worldwide arena is reflected in the European market. As discussed earlier, a reduction in the tariff may accelerate this trend.

While the EC maintains its tariff barrier against third countries, it is interesting to note that prices for commodity ICs in Europe are very competitive against other world markets. For example, according to Dataquest's regional semiconductor pricing database,[16] European prices on standard memory devices are consistently lower than those in Japan, and are very similar to North American prices. This indicates that exporters of semiconductors may only be making marginal profits in the European market, while European manufacturers, with typically higher manufacturing costs, may not be making any profits at all.

Dataquest believes that an immediate reduction in, or the complete abolition of, the semiconductor tariff in the EC could have one of the following results:

- Exporters to the EC could increase their free on board (FOB) prices by the percentage savings made in the semiconductor tariff reduction. This would mean European market prices would remain unchanged, EC semiconductor manufacturers' profit margins (if any) would remain unchanged, and exporters profit margins would increase. This additional profit could be used towards investment in new products, thereby making them more competitive against EC semiconductor manufacturers.
- Exporters to the EC could maintain their FOB prices at a constant level. This would mean that European market prices would fall, EC semiconductor manufacturers' profit margins (if any) would fall, and exporters profit margins would remain unchanged. This could make the European market the cheapest in the world, and therefore the least profitable. The survival of EC semiconductor manufacturers would therefore depend mainly on export markets, in which they are currently relatively weak.

Figure 7
European Semiconductor Market Share by Supplier Base Region



Source: Dataquest (March 1992)

- Most likely, a combination of the above two extremes would occur, with a bias towards the first. This bias is likely because semiconductor manufacturers throughout the world are having difficulties making profits. As semiconductor prices in the European market are already competitive against other world markets, it is better business sense to make a return on sales than to further lower market prices.

The effect of a significant reduction, or total abolition, of the EC semiconductor tariff on EC semiconductor manufacturers would therefore be substantial. If it were achieved before these manufacturers had properly restructured to benefit from the unification of the EC market, it is likely to be disastrous.

The scenario seen by Dataquest, therefore, is that the EC semiconductor tariff will be reduced in easy hurdles leading into the 21st century through successive rounds of GATT talks. The target of a zero-rated EC semiconductor tariff should be realized within 20 years.

By Byron Harding

(This executive overview is an extract from a larger, comprehensive special report which is available separately on request. This report, entitled *EC Semiconductor Tariffs and Related Issues: a Guide for Suppliers and Buyers*, clarifies the subjects of duty suspension, antidumping duty, anticircumvention, and local content. It also presents the perspectives of the European Commission and the major trade associations representing international semiconductor suppliers and buyers.)

Appendix—References

1. Treaty establishing the European Economic Community, dated 25 March 1957, Article 19, paragraphs 1 and 2
2. EC Commission Communication 89/C235/02 dated 13 September 1989, "Concerning autonomous tariff suspensions," Section 2.1 Role of the Common Customs Tariff, paragraph 1
3. EECA Memorandum dated 15 March 1990, "On considering a reduction in the integrated circuit tariff"
4. EC Council Regulation 2658/87 dated 23 July 1987, "On the tariff and statistical nomenclature and on the Common Customs Tariff"
5. EC Commission Regulation 2587/91 dated 26 July 1991, "Amending Annex I to Council Regulation 2658/87"
6. EC Council Directive 91/680/EEC dated 16 December 1991, "Supplementing the common system of value-added tax and amending Directive 77/388/EEC with a view to the abolition of fiscal frontiers"
7. EC Council Regulation 3831/90 dated 20 December 1990, "Applying generalized tariff preferences for 1991 in respect of certain industrial products originating in developing countries"
8. EC Council Regulation 3587/91 dated 03 December 1991, "Extending into 1992 the application of Regulations 3831/90, 3832/90, 3833/90, and 3835/90 applying generalized tariff preferences for 1991 in respect of certain products originating in developing countries"
9. EC Council Regulation 802/68 dated 27 June 1968, "On the common definition of the concept of the origin of goods"
10. EC Commission Regulation 288/89 dated 03 February 1989, "On determining the origin of integrated cicuits"
11. Dataquest, ESIS Research Bulletin 1989-02 dated March 1989, "The EEC Rules on Made in Europe—Article 5 No. 802/68 Analyzed"
12. Dataquest, ESIS Research Bulletin 1990-24 dated September 1990, "European Commission Origin Rule for PCBs"
13. EC Communication SEC(91)565 dated 03 April 1991, *The European Electronics and Information Technology Industry: State of Play, Issues at Stake, and Proposals for Action*
14. Dataquest, Semiconductors Europe report dated November 1991, republishing the above, entitled *European Commission Policy Statement on the Electronics and Information Technology Industries*
15. EC XIII Magazine News Review issue 4/91 dated December 1991, article "The European Electronics and Information Technology Industry," Council Resolution, invitation to the European Commission and Member States
16. Dataquest, *DQ Monday* Report issued twice monthly via on-line service covering IC markets in Europe, United States, Japan, Taiwan, Hong Kong and South Korea.

Technology Analysis

MCM Design Tools Now Lead in Layout Growth

The multichip module (MCM) is emerging as the most important packaging technology since surface mount and will find increasing use in all electronic sectors. The technology demands new EDA tools, and vendors are quickly rising to this opportunity. But what are MCMs, which tools are needed, and who will buy them? Also, who will be the early adopters of the tools and devices, and how will the technology affect system design? This article analyses these questions and assesses the outlook for MCM design in Europe.

System Interconnect Problems

The interconnection of ICs possessing 400 or more pins using conventional printed circuit boards leads to one conclusion: the large board area occupied by PCB tracks can negate the high levels of integration achieved within the IC. Either large areas of the board cannot be used for components because of the density of copper track, or large numbers of layers must be used. Both scenarios are usually unacceptable. Furthermore, as system speed increases, and tracks start to behave as transmission lines, interconnection becomes a nightmare.

Packaging and interconnection of ICs accounts for a significantly higher proportion of equipment cost than the total IC cost. This is therefore a major consideration in equipment design.

Problems Answered—Enter the MCM

Multichip modules answer the above problems and are the next generation of packaging technology, beyond surface mount, which meet the future needs of systems designers.

In general, MCMs eliminate individual IC packages in favor of bare die mounted on a common substrate, leading to improved packing density and system performance (due to reduced interconnection delays and track impedances).

Mainframe computer companies are not strangers to this technology, with IBM, NEC, Cray and Fujitsu introducing machines based upon MCM technology during the 1980s. Personal computer companies are also keenly interested in MCMs. For example, a complete Macintosh SE computer was implemented on a 2.5 × 3.5 in. silicon substrate as a joint project between Apple Computer and the Dow Chemical Company.

Many other applications exist, especially in the automotive, microwave, high-speed digital and high-power areas. Dataquest estimates that the market for MCMs will grow at a very fast rate, achieving 109 percent compound annual growth rate over the next five years (Figure 8).

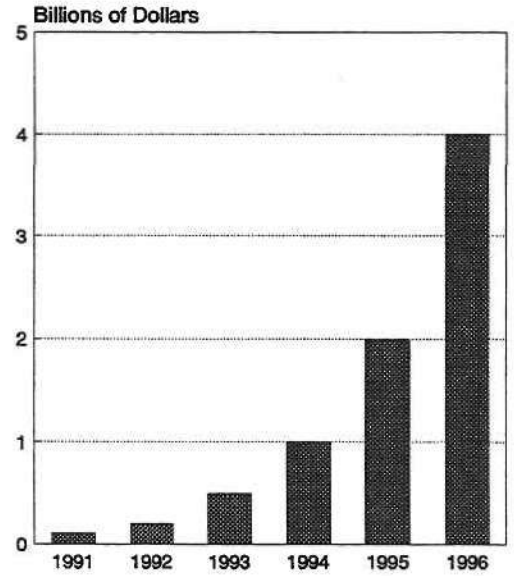
MCM Technologies

MCM substrates have been categorized over a spectrum of technologies by IPC committee IPC-MC-790. These range from high-density PCBs through to full silicon implementations as detailed below. (Note: When comparing interconnect densities, the normal metric is the length of interconnect material, in centimeters, per square centimeter of substrate, per layer.)

MCM-L (Laminated)

This is fabricated using typical PCB processes and materials. It is targeted at low-end applications requiring interconnect densities of

Figure 8
Worldwide MCM Market Growth—Assembled Modules



Source: Dataquest (March 1992)

50 to 150 cm/cm^2 at up to 100 to 200 MHz.

Favored by the automotive industry because of its relatively low cost, it typically uses chip-on-board (COB) assembly, wire bonded to the substrate, then encapsulated for protection.

MCM-C (Ceramic)

This consists of ceramic substrates (both cofired and low-dielectric constant ceramics) offering economical interconnect densities between 100 and 250 cm/cm^2. It is a traditional thick-film hybrid process, and favored by aerospace and military sectors because of harsh environmental capabilities. COB and flip-chip assembly are commonly used. Metal encapsulation offers physical protection and improves EMC screening.

MCM-D (Deposited)

This means deposited wiring and dielectric on silicon, ceramic or metal substrates. It uses thin-film processes for interconnect densities of 200 to 400 cm/cm^2 and above. Silicon substrates offer good thermal properties because the devices are also silicon and exhibit the same thermal expansion characteristics. MCM-D substrates are still under development. The state-of-the-art in wafer size is eight inches, which can only support one or two typical modules and are therefore limiting economical production. Assembly is by using tape automated bonding (TAB) and flip-chip.

Most MCMs today are of the MCM-C type, used for computer, aerospace and military applications, involving thick-film hybrid technology on ceramic substrates.

A major deciding factor in the choice of MCM technology for a given application is the cost per interconnect density. For low densities (below approximately 50 cm/cm^2), MCM-L offers the lowest cost. Roughly between 100 and 200 cm/cm^2, MCM-C is lowest. MCM-D is expected to offer lower cost at higher than 200 cm/cm^2 interconnect capacities.

The advantages of MCMs over PCBs may be summarized as:

- Higher chip density or reduced overall size
- Reduced mechanical and thermal stresses (especially in the case of MCM-D)
- Lower interconnection delays
- Improved electrical performance
  - High speed and frequency (over 1 GHz)
  - High power and voltage handling
- Increased reliability and system-level manufacturability
- High temperature capability with MCM-C and MCM-D (up to 250°C, limited only by solder melting—but thermal design is a critical issue)

MCM Design Tools

At present, the European consumption of MCMs is approximately 35 percent of world production. It follows that there is a great deal of interest in MCM design tools. Such tools are currently offered by all broad-line EDA vendors, notably Valid Logic, Mentor Graphics, Racal Redac, Dazix and Scientific Calculations. However, Dataquest research indicates that no more than 15 to 20 stations have yet been sold in Europe. Yet MCM tools are closer to system-level tools (which have heavy European consumption) than to IC tools, so why have so few been sold in Europe?

Not surprisingly, MCM advantages depend upon the perspective of the individual user company. Dataquest research shows that the relative importance of MCM characteristics are heavily influenced by sector as shown in Table 5.

Table 5
Relative Importance of MCM Interests by Sector

Sector	Key MCM interests (in order of importance)
Automotive	Cost, environmental, size, performance,
Telecom	Cost, performance, size,
Consumer	Cost, size
Computer	
– PC	Cost, size, performance
– Portable	Size, cost, performance
– Workstation	Performance, cost, size
– Mainframe	Performance, size, cost,
Mil/Aero	Environmental, size, performance, cost

Source: Dataquest (March 1992)

At this time, MCM devices are relatively expensive. Hence the high-end computer industry, where cost is relatively unimportant, is the major consumer. In Europe, a substantial amount of computer production takes place, but relatively little computer design (because non-European computer companies manufacture equipment in Europe but design elsewhere). However, a considerable amount of design is undertaken by the telecoms, consumer and automotive sectors, where cost is a key driver. This explains the moderately high MCM consumption in Europe with relatively low penetration of MCM design tools.

For these reasons, we believe the penetration of MCM design tools in Europe will be in order of the following sectors:

1. Military and aerospace
2. Computer
3. Automotive
4. Telecoms
5. Consumer

One of the basic problems with MCMs is that prototype devices cannot be tested and modified in the same way as PCBs. In other words, a prototype device is much more difficult to make design changes to using traditional cut-track and wire-link methods. This means that more up-front analysis is needed in order to achieve a right-first-time design. In this sense, MCM design more closely resembles IC design.

Substrates for MCMs fit between PCBs and ICs. ASIC layout tools would seem ideal for substrate design, except that MCM substrates are much larger—typically several inches per side. Also, for IC design, two or three metal layers and two poly layers are the extent of IC interconnects, whereas MCM substrates and PCBs can have 20 or more layers. On the other hand, PCB design software, which is capable of large dimensions and many layers, is not typically suitable for track and gap dimensions of less than 3 mil.

Dataquest believes that MCM technology will impact EDA tools in a number of ways. For example, the number of gates per gate array is currently rising, leading to problems of reduced yield, increased pin-out and higher nonrecurring engineering charges. In the future, companies will bypass these problems by combining a number of lower gate-count devices in a module. A very similar situation exists in the case of mixed signal ASICs: several lower-complexity (simpler) devices will be mounted in a mixed signal MCM.

User Companies

The type of candidate company for MCM design tools is likely to vary with MCM technology. Most systems companies involved in ASIC design typically perform logic design and simulation, then pass a netlist to the ASIC manufacturer which, in turn, performs placement and routing. This situation contrasts with that of printed circuit boards, where the manufacturer typically undertakes no layout design. Hybrids are different again, as explained below.

Before the late 1970s to early 1980s, most large systems companies owned a PCB fabrication facility. Over the years, these facilities have mostly been sold off (often in management buy-outs) because of insufficient capacity utilization. However, those companies (especially in the automotive, aerospace and military sectors) possessing hybrid manufacturing facilities have mostly retained those facilities. In the case of ASICs, systems companies very rarely manufacture their own devices, instead choosing to source devices from the merchant ASIC marketplace.

We believe, therefore, that MCM-L and MCM-C layout designs will be largely undertaken by systems manufacturers, while MCM-D layout will be undertaken by silicon MCM manufacturers. This situation is summarized in Table 6.

MCM design tools will not be driven by manufacturers in the same way as semiconductor manufacturers influenced the EDA market because the tools are mainly a suite of new back-end tools designed to integrate with existing front ends. Also, PCB and hybrid manufacturers will undertake little or no design and are, in any case, a fragmented group of relatively small companies possessing little individual power or influence when compared with semiconductor companies.

Table 6
Multichip Module Design and Manufacture

MCM Type	Manufacture	CAE Design	Layout Design
MCM-L	Specialized PCB manufacturer	Systems company	Systems company
MCM-C	In-house or hybrid manufacturing company	Systems company	Systems company
MCM-D (Silicon)	Specialized silicon MCM manufacturer	Systems company	MCM manufacturer

Source: Dataquest (March 1992)

Product Requirements

An "ideal" MCM design station should provide facilities to allow the entire module to be designed using current top-down methodologies, synthesizing individual devices if required. The building of a behavioral description of the entire module should be facilitated, together with support for mixed-level simulation at the device, module and system levels.

MCMs are characterized by several naked die mounted very close together in a confined space. Couple this with another characteristic of MCMs (high operating frequencies) and several analysis problems result:

- Thermal issues: Thermal problems are intensified through the popular use of solder-bump flip-chip device packaging and assembly, because the major heat transfer path is through the solder bumps. Thermal analysis has never reached its potential as a system analysis tool. We believe the technique to be indispensable for MCM design, which will provide a welcome boost to the thermal analysis market.
- Parasitics: The extremely close proximity of signal-carrying tracks at high frequencies and the need to provide impedance-matched substrates will inevitably require transmission line analysis of crosstalk, reflection and characteristic impedance. This will, yet again, raise the profile of companies supplying this technology such as Quantic Laboratories, Quad Design Technology, Contec and Swiftlogic.
- Testing: Companies usually operate a multilevel testing strategy in connection with MCMs; testing the chip, module, PCB and system. Testing is a major problem at the module level, since chips are densely packed into a sealed unit; and also at the chip level, because it is difficult to test both bare die and flip-chip packages. Yet, individual chips must be tested before assembly in order to minimize rework and repair. MCM design will therefore more sharply bring into focus the testing problem, increasing the use of boundary scan testing and boosting the need for test logic synthesis.

The expected increase in the use of lower gate-count devices within MCMs suggests a growing need for functional partitioning tools to assist engineers to decide which devices to assign to which modules. This is no different fundamentally to the (currently unserved) need to partition at other levels (that is, IC and system levels).

Another problem exists for MCM designers. The creation of die outlines in parts libraries is difficult because semiconductor manufacturers do not usually publish the data. Terminal dimensions are also a problem for the same reason. This often requires devices to be individually measured by MCM design and manufacturing companies—sometimes on a per-batch basis! We expect systems companies to bring considerable pressure to bear on semiconductor companies in order to solve this problem.

Dataquest Perspective

The market for MCM design tools is still small. However, many electronics systems companies are evaluating the technology and undertaking a number of trial designs. Through this process, they hope to gain a competitive advantage by moving along the experience curve of this important technology in advance of other companies.

At present, MCMs offer an expensive solution to packaging and interconnection problems. Substantial growth in Europe of MCM design tools growth depends upon considerable price reductions in order to be acceptable to consumer, telecoms and other major European electronics sectors. But price reductions will only occur as a result of higher-scale economies. Yet, most existing MCM sales are into high-end computer, and aerospace and military applications—two declining sectors. So where are these scale economies to come from? We believe they will come from the high end of the other sectors, gradually creeping lower (eventually) into some low-cost consumer products. However, a finite risk exists that this growth will never occur!

Even so, MCMs are without doubt one of the major packaging "events" of this decade, solving many problems and offering many advantages over PCB-only solutions. In partnership with the PCB, MCMs can achieve exceptional growth over the next five years. But design tools must keep pace with this technology. Rebadged PCB or IC layout tools are not adequate for the MCM design task and those vendors which focus on this emerging segment, providing quality tools, can expect to achieve significant growth over the next several years.

By Jim Tully

Company Analysis

Europe Gains a New Semiconductor Company

The consolidation of semiconductor companies continues in Europe, with the formation of another large semiconductor supplier. The electronic component and subsystems operation of Daimler-Benz is being formed into a new company, and it will focus on the areas of semiconductors, microsystems, automotive equipment and special technologies. The new company will present a formidable opponent for Europe's existing semiconductor suppliers, with strong backing from the parent company, Daimler-Benz.

To form the new company Daimler-Benz will acquire the outstanding 50 percent of Matra-MHS, and will add this to the 100 percent share it already has of Eurosil, and Telefunken, and the majority ownership of Dialog Semiconductor and Siliconix. The new company—as yet unnamed—will be formed on July 1, and will begin operating at the start of 1993.

The Semiconductor Operations

The semiconductor activity of the new company will be formed from the existing operations of the five companies. Dataquest estimates these five companies' combined European revenue in 1991 was $398 million. This would place the enterprise as the fourth-largest European-owned semiconductor supplier, displacing GEC Plessey Semiconductors. Its worldwide revenue is estimated to be $582 million in 1991. The newly formed company would reach tenth position in the 1991 European semiconductor rankings. Table 7 gives the revised European market share ranking table for the top 10 suppliers in Europe, based on Dataquest's preliminary market share estimates for 1991.

The companies give a balanced spread of semiconductor products. Table 8 shows Dataquest's estimates of the companies' 1991 European and worldwide revenue, and reflects the revenue and expertise contribution each will make to the new venture.

Matra-MHS' main area of expertise is in memory and microcomponents, specifically SRAM and microprocessor. Telefunken has most of its revenue in analog and discrete and optoelectronic products, focused mainly in Europe.

Table 7
Preliminary 1991 European Total Semiconductor Rankings Including Daimler-Benz

1991 Rank	Company	1991 Sales ($M)
1	Philips Semiconductor	1,172
2	Siemens	964
3	SGS-Thomson	887
4	Motorola	770
5	Intel	622
6	Texas Instruments	629
7	Toshiba	509
8	NEC	452
9	National Semiconductor	408
10	Daimler-Benz	398
	Total All Companies	11,366

Source: Dataquest (March 1992)

Siliconix has significant expertise in power ICs and smart power, and is mainly focused in the United States. Dialog is one of the leading suppliers of mixed signal ASICs into Europe, and Eurosil has expertise in low-voltage CMOS devices.

Dataquest Perspective

The combination of the five companies gives a whole which should be greater than the sum of its parts. Daimler-Benz' previous semiconductor acquisitions have clearly been strategic, as the products supplied by these companies fit in well with the equipment manufactured by Daimler-Benz. In addition to the semiconductor operations, the other divisions of the components group will also give to Daimler-Benz the technology it needs to develop future products in its automotive, aerospace and defense operations.

There is a danger that the newly formed division will become too dependent on the parent for orders, and to counter this Daimler-Benz has stated that only 20 percent of the output of the new company will be supplied to the parent by the middle of the decade. This will force the new company to compete for merchant business in the wider European and worldwide marketplace. This competition should provide the extra revenue needed to support continuing high investment in equipment, manufacturing facilities, and products.

Matra-MHS has a great deal of expertise in both defense and space applications, and the reliability and harsh conditioning these applications areas demand will be very suitable for underbonnet automotive applications. The outlook for military, space and defense markets is weak, as peace breaks out in the world, and military

Table 8
Daimler-Benz Semiconductor Group
Preliminary Estimated 1991 Revenue of Member Companies
(Millions of Dollars)

	Dialog	Eurosil	Matra-MHS	Siliconix	Telefunken	Total	Percent of Total
Total Semiconductor	20	28	104	130	300	582	
Total Integrated Circuit	20	28	104	59	137	348	64.2%
Bipolar Digital	0	0	0	0	7	7	1.3%
MOS Digital	20	21	99	0	12	152	28.0%
Memory	0	0	35	0	0	35	6.5%
Microcomponent	0	0	37	0	0	37	6.8%
Logic	20	21	27	0	12	80	14.8%
Analog	0	7	5	59	118	189	34.9%
Discrete	0	0	0	71	89	160	29.5%
Optoelectronic	0	0	0	0	74	74	13.7%

Source: Dataquest (March 1992)

budgets are reduced, so Matra-MHS will have to turn more towards other applications if the growth of the company is to be maintained. However, Matra-MHS is one of the few space-approved suppliers in Europe, and its major contribution to the parent will be its space expertise.

Matra-MHS is also a member of the ESPRIT project to develop new 0.7 and 0.5 µm ASIC processes (ACCES), and so will provide a sourcing point for advanced maufacturing processes within the group. In addition, the company has a license for the SPARC RISC microprocessor, and will be able to use this as the core for embedded engine management systems. However, the company has so far failed to produce any SPARC-based devices.

Telefunken has a significant presence in consumer products, and this is apparent from its focus on analog, and discrete and optoelectronic products. The consumer market has enjoyed a short boom, especially in eastern Germany, but is now undergoing some consolidation. However the outlook for this market is more optimistic than for the military market. Telefunken's contribution to the new company will be its knowledge of high-volume, low-cost manufacture, gained in consumer markets.

Siliconix's strength lies in its power transistor expertise. This will position the company well in the rapidly growing automotive sector, where the demand for smart power applications is showing high growth. This expertise will contribute significantly to Daimler-Benz requirements in its automotive applications, particularly in high-end products.

Eurosil and Dialog are, perhaps, the companies which fit least well into the parent company's strategy. However, the high-performance mixed signal ASICs designed by Dialog find many applications in the automotive sector. The design knowledge which lies within the company can therefore be put to good use.

It is when the future is considered that the inclusion of Dialog and Eurosil makes sense. Daimler-Benz has insisted the new company will not depend completely on the parent for orders, so the new operation will have to compete in the open market. A growing applications area in Europe is in telecoms, and both Dialog and Eurosil can make a significant contribution here. The low-power expertise in Eurosil will prove to be tremendously useful in portable applications, and the mixed signal expertise of Dialog will also be valuable in telecoms applications. The emerging GSM and CT2 markets for consumer-based wireless telecoms products will utilize the consumer manufacturing expertise available in Telefunken. It is therefore in the telecoms market that the commerical success of the new venture lies.

One of the reasons behind the consolidation by Daimler-Benz of its component operations will be related to the combined losses some of the individual companies are currently making. These losses are estimated at around $60 million for 1992, but the new company expects to be profitable by 1996. The consolidation of all of these companies into one operation should reduce cost. Daimler-Benz has the advantage in this consolidation that it is not overburdened with costly fabrication plants. This proved to be a heavy cost to bear in the formation of SGS-Thomson, and the merger of GE Solid State, Intersil, Harris and RCA into the new Harris. The new operation will have only one plant from Matra-MHS and two from Telefunken in Europe. Siliconix has two fab lines in Santa Clara, California.

The grouping of the companies may also be related to Daimler-Benz attempting to focus more on its core business, and keep peripheral business separate, thus following Philips' route of disposing of loss-making or none-core business operations.

The other worry for the new company could be cultural differences between the former members. This has shown to be an important consideration in the success or failure of other larger mergers. The most successful have been those which have exhibited strong leadership at the formation of the new operation, and have given the new company a strong strategic direction. Only time will tell whether this will happen at Daimler-Benz.

By Mike Glennon

In Future Issues

Forthcoming issues of *Dataquest Perspective* will contain reports on:

- Capital and R&D investment
- Memory forecast

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Dataquest Perspective

Semiconductors *Europe*

SCEU-SVC-DP-9202 February 28, 1992

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Pricing Analysis

European Pricing Update

Duty has been suspended on 1M slow SRAM, and prices have declined dramatically since the suspension. EPROM prices are also under severe pressure. Logic and microcomponent prices have changed little.

By Byron Harding and Mike Glennon *Page 2*

Market Analysis

State of the Industry

The SIA European book-to-bill ratio for December was adjusted downwards to 1.02 from the figure of 1.06 quoted last month. The ratio for January has fallen from December's adjusted figure, to 1.01. This decline is due to an uncharacteristically high growth in billings. Bookings growth is also higher than expected, but this is not sufficient to compensate for the high growth in billings.

By Mike Glennon *Page 4*

European Semiconductor Procurement Survey: Annual Report for 1991

The Dataquest survey of major semiconductor purchasers in Europe for 1991 is now complete, and the results highlight that end-user segments have different concerns and priorities. However, inventory reduction is the common denominator.

By Byron Harding and Sarah Jacob *Page 8*

European Regional Forecast Update

The assumptions made in the last forecast have changed, and these changes have had an impact on the regional forecast. This report updates the forecast, and identifies where the changes lie.

By Jim Eastlake *Page 16*

Company Analysis

Bull Invests in IBM

The investment of $100 million by IBM in the French state-owned computer company, Groupe Bull, brings to an end the uncertainty over who will win the hand of the company. A major beneficiary of the agreement is SGS-Thomson, which will increase its sales to IBM by $50 million.

By Mike Glennon *Page 23*

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File inside the *Dataquest Perspective* binder labeled Semiconductors *Europe*

Pricing Analysis

European Pricing Update

The 1M slow SRAM has seen rapid price erosion since January. This is a result of full duty suspension being granted by the European Commission, effective from January 1, 1992. Duty suspension is granted on products not available from within the EC, and which are not planned for development by a European manufacturer. The 1M slow SRAM satisfies this criteria.

Table 1 shows European semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Standard Logic

The standard logic market has shown no change, as the annual contract round has been completed. The volume of business is low, with no indications of a pickup in business yet.

Analog

Analog component pricing, when compared with last month, has seen no change. Neither is much change taking place in the mono operational amplifier arena in Europe, but the demand for CODEC/filter combination telecom ICs is still strong, although this sector is beginning to flatten out.

Microcomponents

Some price declines have occurred in microcomponents, but this is minimal. The volume of 286 business is very low, since most computer manufacturers have switched to 386SX products. R3000 business is good, but it is mainly embedded control applications, as few computer suppliers are using the MIPS processor for their computer manufacture in Europe.

Memory

DRAM

Prices for the 256K have fallen again, but this is bottoming out now. Vendors and users are continuing to move to 1M products. The 1M price has also seen some erosion, and there are instances of very low prices. The 4M has dropped substantially, and further erosion is expected. Very low prices are being seen from some vendors.

The 1Mx9 SIMM has also dropped in price again, with the lowest prices on the three-chip version. The 16M has dropped again also, with prices at around $185 for contract volumes. However, there are offers of 4Mx36 SIMMs using 16M DRAMs at $1,300, which translates to a unit price of only $144.

EPROM

EPROM prices have been under severe pressure. The parts tracked in the pricing analysis have fallen in price by 15 percent for the 1M, and around 10 percent for the 2M. The 4M part has fallen by 10 percent, to around $17.

SRAM

The 8Kx8 and 32Kx8 parts have seen some slight price erosion, but it is the 1M SRAM that steals the headline. Prices have fallen by as much as 20 percent since the last update for the 1M slow SRAM. This makes the European market even more competitive against all other world regional markets.

There is no concern about antidumping action, as no European manufacturers are participating, or planning to participate, in the 1M slow SRAM market. This has resulted in full duty suspension for this part. It is possible that MITI will voice concern at this new all-time price low, although a number of non-Japanese suppliers are selling at these prices also.

Current Exchange Rates

1 US dollar =
- 0.564 UK pounds
- 1.623 deutsche marks
- 5.537 French francs
- 0.794 ECU

By Byron Harding
Mike Glennon

Table 1
European Semiconductor Pricing—February 1992
All Prices in US Dollars (including import duty where relevant)

Device Family	Product	Package	Mean 1K Price	Mean 10K Price	25K+ Contract Price	Lead Time in Weeks
Standard Logic Fast TTL	74F00	PDIP	0.12	0.10	0.09	4–6
	74F74	PDIP	0.14	0.13	0.12	4–6
	74F138	PDIP	0.18	0.17	0.16	4–6
	74F244	PDIP	0.25	0.24	0.21	4–6
Standard Logic Advanced CMOS	74AC00	PDIP	0.19	0.17	0.15	4–6
	74AC74	PDIP	0.24	0.22	0.20	4–6
	74AC138	PDIP	0.35	0.32	0.26	4–6
	74AC244	PDIP	0.43	0.41	0.36	4–6
Analog	741 Op. Amp.	TO92	0.17	0.12	0.11	4–6
	CODEC/Filter 1	[1]	2.90	2.65	2.50	6–10
	CODEC/Filter 2	[2]	5.75	5.45	5.00	6–10
Microcomponents	80386SX-16	PQFP	56.00	54.00	53.00	6–7
	80386DX-25	CPGA	155.00	147.00	144.00	6–8
	80286-16	PLCC	11.70	11.00	10.00	4–6
	68020-16	PQFP	31.00	28.00	26.00	4–6
	R3000-25	CPGA	135.00	120.00	110.00	4–10
Memory						
DRAM	256K-8 (256K×1)	PDIP	1.95	1.65	1.60	2–8
	1M-8 (1M×1)	SOJ	4.15	3.90	3.70	2–6
	1M-8 (256K×4)	SOJ	4.15	3.90	3.70	2–6
	4M-8 (4M×1)	SOJ	16.00	15.20	14.90	2–8
	9M-8 (1M×9)	SIMM	38.00	36.00	35.00	4–10
	1M-7 (1M×1)	SOJ	4.15	3.90	3.70	2–8
	1M-6 (1M×1)	SOJ	4.40	4.10	3.90	4–10
	4M-7 (4M×1)	SOJ	16.16	15.35	15.45	4–8
	4M-6 (4M×1)	SOJ	16.80	16.00	15.60	6–10
	16M-8 (4M×4)	SOJ	198.00	188.00	185.00	8–14
UV EPROM	1M-17 (128K×8)	CDIP	4.00	3.60	3.20	2–6
	2M-17 (256K×8)	CDIP	8.00	7.00	6.10	2–8
	4M-17 (512K×8)	CDIP	19.00	17.00	15.00	4–10
SRAM	64K-85 (8K×8)	PDIP	2.20	1.90	1.80	4–10
	256K-85 (32K×8)	PDIP	4.00	3.65	3.50	4–8
	1M-85 (128K×8)	PDIP	13.50	12.00	10.50	2–10

[1] Group 1: Commercial temp, serial, PDIP, A/μ law
[2] Group 2: Commercial temp, serial, PLCC, A/μ law, programmable
Source: Dataquest (February 1992)

Market Analysis

State of the Industry

The SIA flash three-month average European book-to-bill ratio for the month of January was 1.01, a decrease over December's revised ratio of 1.02, as shown in Figure 1. Actual billings for January were a staggering 16.5 percent higher than December, at $961 million. Three-month average bookings increased to $880 million, a 5.9 percent growth over December's much revised figure of $831 million. When these figures are compared with January of the previous year, billings show a growth of 18.9 percent, and three-month average bookings show a growth of 5 percent.

These booking and billing amounts are surprising, because January's billings normally show a decline over December's, and bookings usually have flat growth or show a small decline. Discrete and optoelectronic billings contributed to the significant growth for January, with a 27 percent increase over December's actual billing figure. This is an unexpected increase, as the discrete and optoelectronic figure has declined in January for the past four years; and the discrete market has given a poor performance throughout 1991.

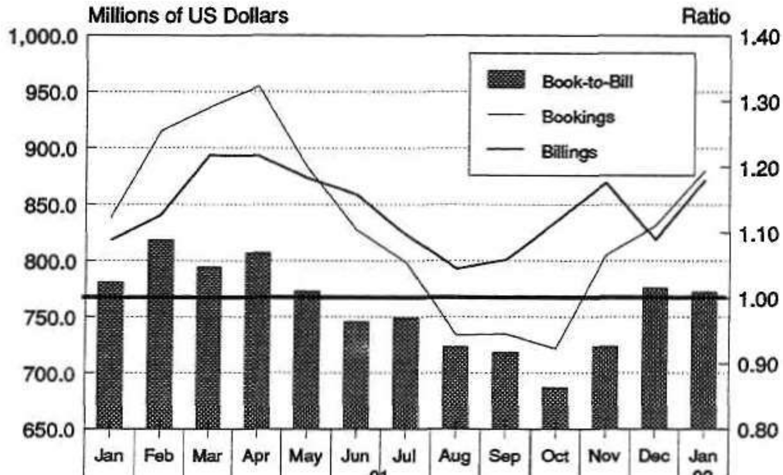
We believe the high growth for discrete products has come from demand for very high-power products in traction applications, and a general pickup in demand from automotive applications. However, we expected the final European discrete number to be restated downward.

Figure 2 shows the IC and discrete billings for the past two years, the January total showing a growth of 19 percent over the previous January. Total IC billings have grown 14 percent in January compared with December, and this figure also normally declines in January. Total IC billings growth compared with the previous year is 19 percent.

European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trend and seasonal variations and uses these, together with monthly weighting factors, to

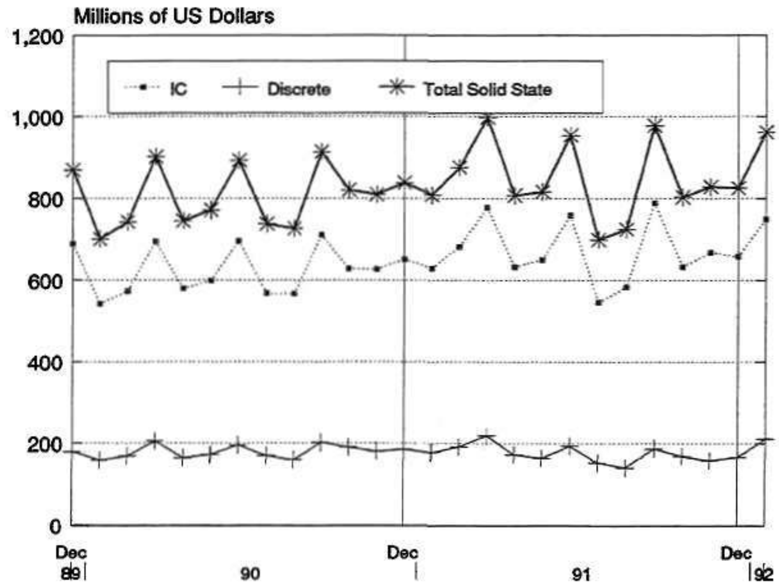
Figure 1
European Total Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Jan	Feb	Mar	Apr	May	Jun	Jul 91	Aug	Sep	Oct	Nov	Dec	Jan 92
Book-to-Bill	1.02	1.09	1.05	1.07	1.01	0.96	0.97	0.93	0.92	0.86	0.93	1.02	1.01
Bookings	838.2	915.3	936.3	954.6	882.4	827.3	798.3	733.5	734.6	721.4	805.1	831.0	880.0
Billings	818.4	840.4	893.5	893.0	873.5	858.7	823.0	792.7	800.8	835.2	869.4	818.7	871.5

Note: Last two months are preliminary.
Source: WSTS, SIA

Figure 2
European Total Semiconductor, IC and Discrete Actual Monthly Billings



Note: Last two months are preliminary.
Source: WSTS, SIA

forecast future billings and three-month average bookings; these figures represent an "average" year. When the actuals are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The forecast and actual figures are compared, and this ratio is averaged over 12 months to show underlying trends.

Figures 3, 4 and 5 show the forecast and actual three-month average bookings, actual monthly billings and book-to-bill ratios, from the Dataquest forecast model.

The actual billing figure for December has been adjusted upwards, as was predicted in January's State of the Industry, and this has altered the forecast for 1991 and 1992. The new billings figure for 1992 is $11,445 million. This represents a growth over the forecast value for 1991 of 8.8 percent, and a growth of 13.1 percent over the actual value for 1991. The monthly values have been adjusted accordingly in the forecast model.

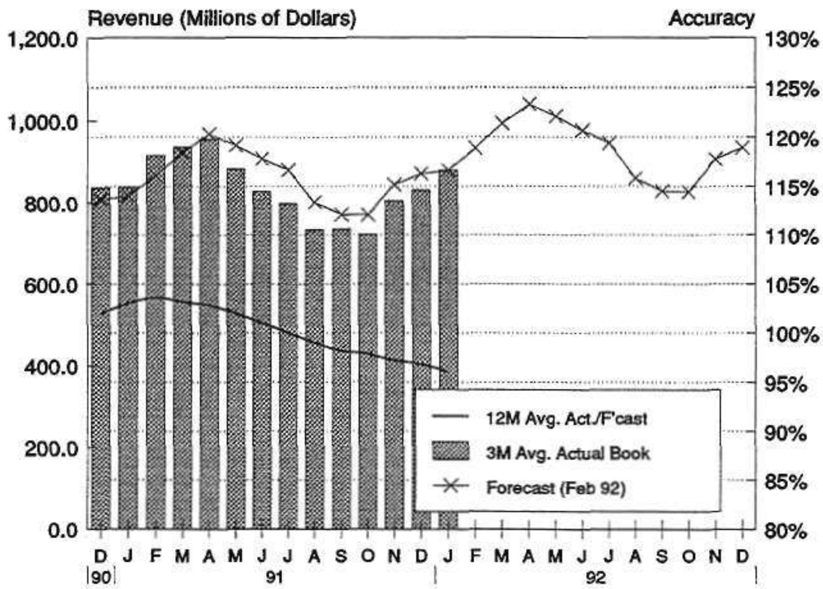
The increase in December's actual billings was much lower than anticipated, but the preliminary billing figure for January is much higher than expected, which could be due to the slipping of December's billings. The adjustment made to December's bookings is greater, and brings it closer to the expected value. January's average booking figure is within a million dollars of the forecast, indicating a possible upturn for the European semiconductor market. However, one month's preliminary results are not sufficient to judge the outlook for the whole year.

Dataquest Perspective

Actual billings for January have shown enormous growth over December, and also over the previous January, so the figure will almost certainly be restated. The booking figure is much closer to what would normally be expected, although also higher than average. If both the figures are restated, the book-to-bill ratio for January is quite likely to increase considerably.

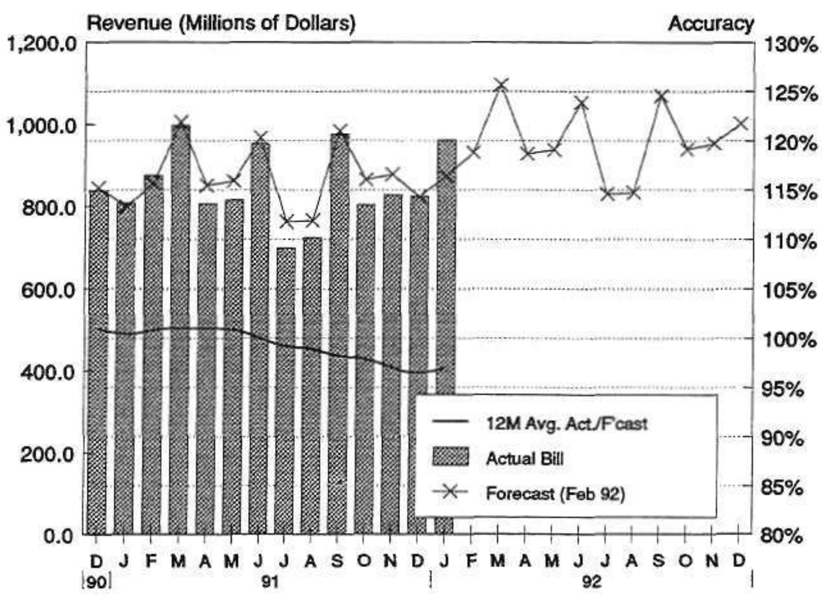
It is clearly too early to see how the year is likely to turn out on the basis of just one month's preliminary results, but it is tempting to try and predict the outlook for the year. Over recent years much of the final growth for the year has come from the first quarter of that year, so it will not be possible to predict any realistic outcome until the results for May are available.

Figure 3
European Total Semiconductor Three-Month Average Bookings



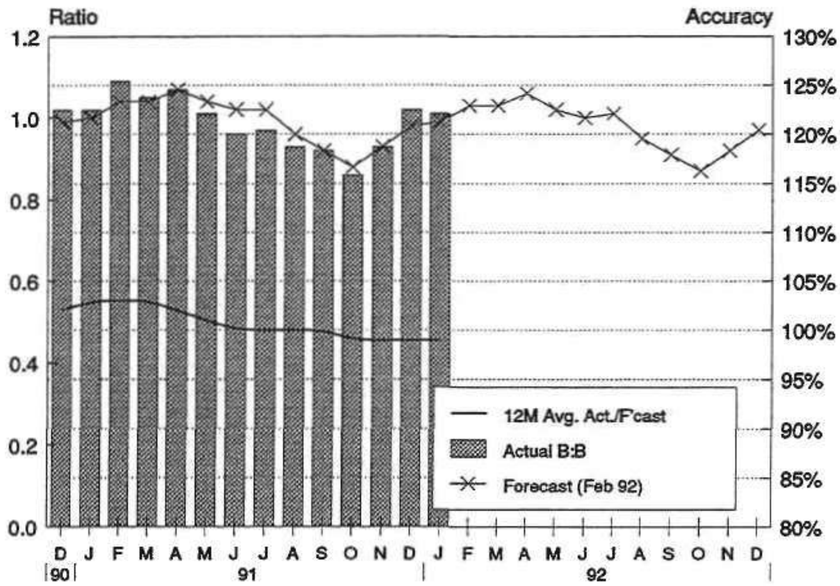
Note: Last two months are preliminary.
Source: SIA, WSTS, Dataquest (February 1992)

Figure 4
European Total Semiconductor Actual Monthly Billings



Note: Last two months are preliminary.
Source: SIA, WSTS, Dataquest (February 1992)

Figure 5
European Total Semiconductor Book-to-Bill Ratio
(Threee-Month Average)



Note: Last two months are preliminary.
Source: SIA, WSTS, Dataquest (February 1992)

The two factors that will affect growth for the year are memory and microcomponent. There is a hint of possible memory shortages during 1992, fuelled by the discrepancy between the expected 70 percent growth in demand, and MITI's announced 13.5 percent increase in the supply of 4M DRAM. However, MITI is acting in its role as memory's OPEC, adjusting supply to meet demand in order to maintain prices, and the end result will be a slowing of price declines for the product, rather than shortages. If a shortage of 4M DRAM appears likely, MITI will allow an increase in output of 4M DRAM.

The Japanese suppliers have a large share of the DRAM market, but there are other suppliers. These companies will also increase output where possible to meet a shortfall, should it appear. The 4M DRAM accounts for only a small share of the total market, although this share is growing.

High-performance microcomponent prices are under greater pressure to decline with the arrival of a choice of supplier for 386 products. This, coupled with a softer outlook for PC shipments in 1992, may result in another weak year for semiconductor components.

Finally, the German Bundesbank has just announced that the fourth quarter of 1991 showed a decline in the German gross national product. This could be the start of a recession for the German economy. As Germany has been the driving force behind the growth of the European semiconductor market for the past year, this could indicate a poor year for suppliers to Europe.

By Mike Glennon

European Semiconductor Procurement Survey: Annual Report for 1991

This report presents the results of our annual European semiconductor procurement survey, and our analysis of the key trends and issues arising. A summary of the semiconductor spending and inventory levels of the European semiconductor purchasing community are shown in Table 2. The survey highlights the following issues:

- End users in the electronic data processing (EDP) segment are more concerned about sourcing semiconductors made in Europe. As demand from this segment accounts for approximately one-third of total demand in Europe, it presents a significant issue for semiconductor suppliers.
- End users in the industrial, military and transportation segments are more concerned about reducing semiconductor prices. This means the price premium placed on semiconductors supplied to these segments will be under pressure in 1992.
- End users overall are still concerned about on-time delivery—at a time when most products are ex-stock—and quality. These are the same top issues raised in our last European procurement survey conducted a year ago, and they point to poor customer service and continued weakness in the business relationship between suppliers and users.
- Semiconductor inventory levels overall in 1991 were above target by an average of 8.5 percent. The segments that were particularly overinventoried were EDP, communications and transportation. The outlook for 1992 is for a one-third decrease in target inventories by survey respondents overall.
- Semiconductor spending by respondents to the survey is expected to increase by an average of 8.5 percent, when measured in dollars, for 1992 over 1991. The highest growth expectation in spending was reported in the EDP, consumer and military segments.

Methodology

The 1991 European semiconductor procurement survey was conducted during November 1991 to January 1992. The survey consisted of a 10-page questionnaire, requesting information on the procurement activities and concerns of the participants. The response sample size for the survey is estimated at 40 percent of the total semiconductor purchasing base in Europe, and represents a significant sample size for analysis.

Table 2
1991 European Procurement Survey, Summary of Results

	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Estimated Segment TAMs: Percent Share							
1991 (%)	29.8	22.5	17.8	17.4	4.3	8.2	100.0
1992 (%)	31.1	22.1	17.2	17.0	4.1	8.5	100.0
Semiconductor Spending							
1992 Growth (%)	10.3	6.0	7.2	11.8	9.2	5.2	8.5
Average Inventory Levels							
1991 (Days)							
Target	32.8	31.1	61.7	9.4	71.6	12.3	25.6
Actual	38.1	36.7	70.5	10.0	75.1	16.0	27.8
Discrepancy (%)	16.2	18.0	14.3	6.3	4.9	30.0	8.5
1992 (Days)							
Target	17.3	23.3	54.2	7.0	61.5	10.5	17.0
Reduction over 1991 (%)	47.3	24.9	12.2	25.5	14.1	14.8	33.6

TAM = total available market
Source: Dataquest (February 1992)

See Figure 6 for the representation from each end-user segment. Some of the key elements of this survey have been analysed for this report; these are semiconductor spending, purchasing criteria and inventory levels.

Purchasing criteria were assigned a score out of 10 for importance by each survey respondent. The questionnaire listed 16 distinct criteria, as shown in Figure 7, with space for respondents to add any other criteria they felt were relevant. An average score was calculated for each criterion. This was achieved by weighting each vote by the purchasing power of the respondent, namely the total estimated European expenditure on semiconductors given to us by the customer in 1991. Inventory levels were dealt with in a similar manner, calculating weighted average actual and target inventories in terms of weeks.

European Overview—Procurement Criteria

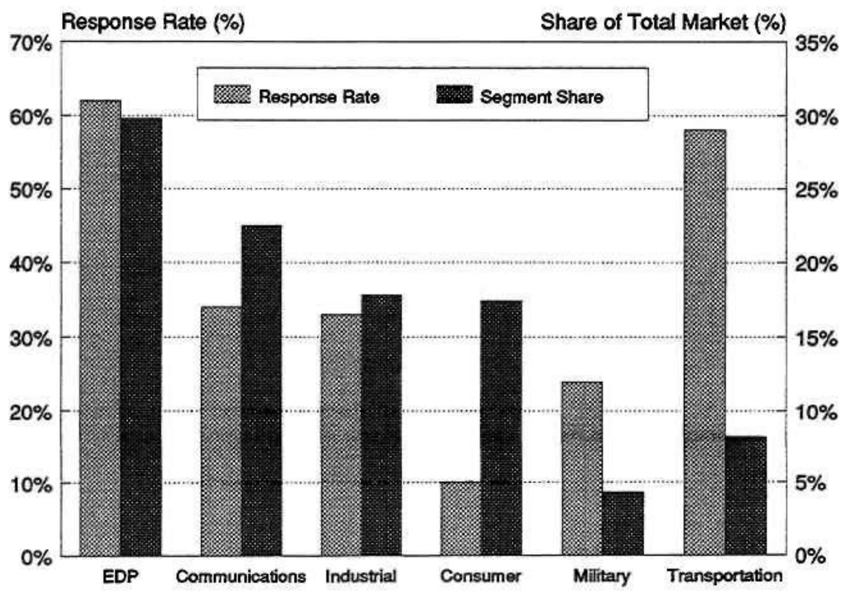
Our discussion of the ratings for the overall performance criteria and the individual segments starts with a list of the 5 top and bottom criteria: for the top 5 we begin with the *most important* issue; for the bottom 5 we begin with the *least important* issue. These are measured as a weighted average across all respondents.

All Segments

Top 5 Issues	
1	On-time delivery
2	Quality
3	Cost of ownership
4	Semiconductor prices
5	Vendor base reduction
Bottom 5 Issues	
1	Memories
2	ASICs
3	Offshore manufacture/procurement
4	Exchange rates
5	New products/obsolescence

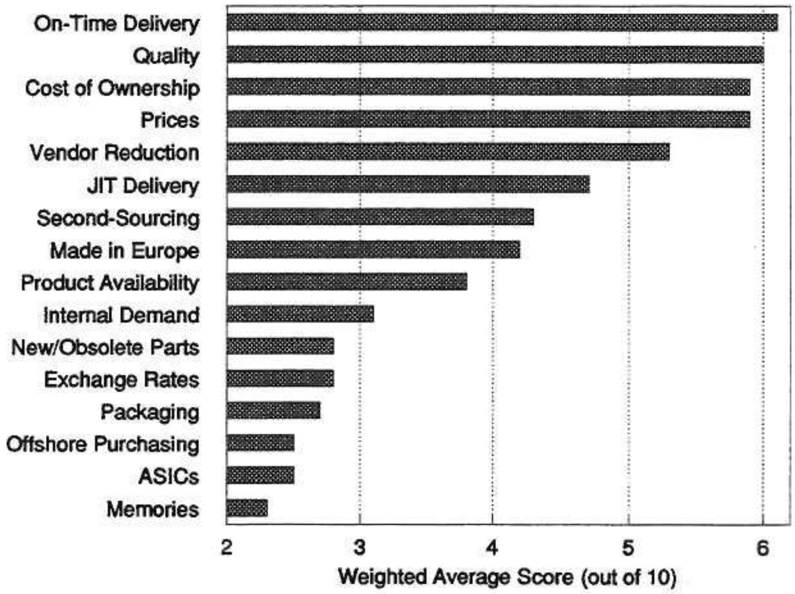
This order of priority differs somewhat from the results of our 1990 European semiconductor procurement survey. In particular, semiconductor pricing was a top criterion at that time. Since then, the European market has seen significant price erosion in a number of commodity product families, and it no longer constitutes a top-priority criterion to users. The criterion of semiconductor prices is one which rises and falls in priority on a regular basis, and demonstrates that supply and demand is rarely in balance.

Figure 6
European Semiconductor Segment Share of Total Market



Source: Dataquest (February 1992)

Figure 7
European Semiconductor Purchasing Criteria—Rankings 1991



Source: Dataquest (February 1992)

On-time delivery is the most important criterion overall that concerned semiconductor end users in Europe in 1991. On-time delivery means meeting the agreed delivery schedules that were committed to the customer.

Quality is the second most important criterion concerning end users. Quality is a broad term which includes product quality features such as electrical and mechanical standards, hard and soft error failure rates, and other product-specific measurables. Product quality is also a match between customer expectation and what is actually delivered. Different end users have different expectations, and it is up to the vendor to ensure it sells the right product to meet the quality requirement. Customer expectation of the standard service quality is also included in this definition.

Cost of ownership rates as the third most important criterion. This is a broad concept, which includes all the cost factors associated with end equipment production. It covers all the purchasing criteria in this report, as well as those which are the responsibility of the end user, such as administration, design-in and capital costs. Cost of ownership is a more accurate method of tracking total costs than just prices, although pricing has a high priority in contract negotiations.

Pricing is the fourth most important criterion to buyers. Whereas this often has the highest profile when comparing vendors and regional markets, it does not rank as the most important criterion to end users after analysis. Prices are related to cost of manufacture—at least in theory. A relatively low price does not necessarily mean a good price, because without a reasonable profit margin, semiconductor vendors cannot reinvest in new products, and the end user will suffer in the long term. However, a relatively high price is not necessarily a good price either, as this may indicate a monopoly in which a small base of vendors dictate product evolution. A good price is one which provides a reasonable profit margin to the vendor in order to continue to supply competitive products in the long term. Another factor that has a bearing on semiconductor prices in Europe is import duty. This subject is outside the scope of this report, but will be covered in depth in next month's issue of *Dataquest Perspective*.

Vendor base reduction ranks as the fifth most important criterion to buyers. A reduction in an end user's vendor base means less adminstration of contracts and accounts, and increases the opportunity for price discount on larger orders with the chosen vendors. This will also strengthen the link between vendors and end users.

It is interesting to note from the list of the semiconductor procurement criteria with the lowest priority that semiconductor memories do not currently constitute a major issue in Europe. This is because they are available freely, and are generally available at lower prices than in the North American or Japanese markets. However, supply and demand of memories is a volatile relationship, and in times of poor supply this becomes a major issue again. Dataquest maintains a worldwide regional semiconductor pricing database which supports this view.

Application-specific ICs (ASICs) also constitute a low level of concern to European end users. This is believed to be partly due to the fact that ASIC prices are competitive in Europe compared with other world markets. In addition, the communication segment accounts for a significant proportion of total demand for ASIC products in Europe, and they focus on high input/output rather than high gate complexity. Thus, because there are many ASIC companies able to offer solutions, availability is of little concern. This is opposite to the predominantly EDP end use for ASICs in North America. The situation in Europe is changing, though, and high complexity will become increasingly important in the future. Another factor resulting in the low priority purchasers give to ASICs is the fact that an increasing proportion of designs are right first time.

Offshore manufacture and procurement is not regarded as a major issue. This may be due to the drive to be seen to have products made in Europe, as well as the fact that European semiconductor prices, particularly semiconductor memories, are currently highly competitive with other world markets.

Exchange rate fluctuations had a low impact on procurement. This is because European currencies weakened only slightly against the US dollar, by an average of 2.5 percent between 1990 and 1991. The Group of Seven (G7) countries are working very hard nowadays to stabilize international exchange rates.

New and obsolete products are a relatively low priority. This may be a symptom of overcapacity in semiconductor manufacturing, in so much that if demand exists for a product, there will be a vendor willing to support it. Also, very few new products or technologies are entering the market at the moment; rather it is only enhancements in the performance of existing products that are present in the market.

Inventory Levels

The weighted-average target semiconductor inventory level in Europe in 1991 was 26 days, although it varies between segments. Of those that responded, 67 percent reported that they were over their target level; 27 percent reported they were at, or near, their target level; and 6 percent reported they were below their target level. Overinventory may be symptomatic of slow equipment markets, and could certainly be eased by more accurate forecasting of internal semiconductor demand. This forecasting issue ranked as tenth overall in the survey of procurement criteria, and was therefore not viewed as an important criterion by most procurement managers.

However, when asked about new target inventory levels in 1992, 70 percent of respondents reported that they would set a lower target than in 1991; 22 percent reported they would keep the same target level; and 9 percent reported they would increase the target level. The average decline in inventory of those companies reporting a reduction plan was 34 percent—an impressive inventory reduction plan for the equipment industry.

Comparing individual survey responses, it becomes apparent that purchasing criteria and target inventory levels vary between each segment. This is to be expected, as each segment has to satisfy its own equipment market conditions. These criteria may include equipment value, sales volume, profit margin, time-to-market, life cycle and level of competition. The criteria for a personal computer are significantly different to those of an automotive engine control system, and will be reflected in the demands placed upon the semiconductor vendor. This report looks more closely at the concerns of respondents from the segments of electronic data processing, communications, industrial, consumer, military and transportation.

Electronic Data Processing Segment

Top 5 Issues	
1	Made in Europe
2	Cost of ownership
3	Vendor base reduction
4	On-time delivery
5	Second-sourcing
Bottom 5 Issues	
1	Offshore manufacture/procurement
2	Exchange rates
3	ASICs
4	Product availability
5	Semiconductor memories

Our survey captured an estimated 62 percent of the total European semiconductor procurement base in this segment. This represents a substantial sample size for analysis. The EDP segment is estimated to consume 30 percent of all semiconductors in the European market.

EDP segment respondents expect an above-average increase in spending on semiconductors of 10.3 percent in 1992. However, this growth will come mainly from the larger manufacturers, while smaller ones see less growth in their spending. This is believed to be due to the greater level of investment by multinationals in European manufacturing, and hence local semiconductor procurement.

Target inventory levels varied from 3 to 70 days in this segment, with European manufacturers having the highest inventories. On average, 56 percent of EDP manufacturers were above their target level in 1991; 31 percent were at or near their target; and 13 percent were below target. Half of the respondents to the survey reported they planned to decrease their target inventories in 1992, by an average of 47 percent. Again, these were mainly European companies. In contrast, some North American companies were actually planning to increase their inventory levels in 1992.

EDP end users put a high priority on the procurement of semiconductors *made in Europe,* due to a mixture of wanting local relationships with Europe-based suppliers and wanting to be seen to be good European equipment suppliers. The first of these makes good business sense, as procurement logistics are much simpler when compared with dealing with overseas suppliers. However, the second reason probably stems from the confusion regarding local content, and the spectre of action by the European Commission if equipment manufacturers do not buy enough components which are *made in Europe*. This concern helps to drive local procurement of semiconductors, and the European Commission appears content to let the situation continue. New European manufacturing facilities by a number of Japanese and North American vendors will help to satisfy increased demand in 1992 and beyond.

Second-sourcing is another criterion particularly important to the users in this segment. Many of the semiconductor products needed to build EDP equipment are multisourced. Yet the one core product which serves to differentiate one EDP product from another is the CPU, but this product is traditionally proprietary, and is exemplified by the fact that just three companies account for 75 percent of all microprocessor sales in Europe in 1991. In an average PC, the CPU accounts for 25 percent of the total semiconductor content value, and the lack of competition between microprocessor suppliers is a concern to EDP equipment manufacturers.

Communications Segment

Top 5 Issues	
1	Quality
2	On-time delivery
3	Vendor base reduction
4	Cost of ownership
5	Product availability
Bottom 5 Issues	
1	Semiconductor memories
2	Exchange rates
3	Offshore manufacture/procurement
4	Semiconductor packaging
5	Made in Europe

Our survey captured an estimated 34 percent of the total European semiconductor procurement base in this segment. This represents a reasonable sample size for analysis. The communications segment is estimated to consume 22 percent of all semiconductors in Europe.

Semiconductor spending of respondents in this segment is expected to grow below average in 1992, against the expectation of our survey in 1990, which showed buoyant optimism for communications equipment export markets. This inconsistency is believed to be due to the fact that our 1991 survey included a large proportion of customer premise equipment manufacturers, whereas the major growth expectation in last year's survey came from central office equipment manufacturers.

Target inventory levels ranged from 7 to 80 days in this segment. Communications equipment manufacturers within the same geographic regions appear to have similar inventory levels, leading to the conclusion that national orders continue to account for a major portion of their business. Italy in particular is in a poor state, according to the survey.

On average, 92 percent of users in this segment reported they were above their target inventory in 1991, and none reported being below. For 1992, 69 percent of users planned a reduction, and the remainder planned to keep the same targets. This highlights a real concern for respondents in the communications segment for business growth in 1992. Dataquest believes that central office equipment manufacturers will be optimistic, due to opportunities in export markets, particularly to Eastern Europe.

The concern which tops the list in this segment is quality. In communications equipment, strict standards required for harsh environments are the norm, and this has clearly left room for improvement by semiconductor suppliers. The move towards mobile communications will increase the importance of quality. Semiconductor suppliers should take heed of this when targeting the communications segment.

Industrial Segment

Top 5 Issues	
1	Product availability
2	On-time delivery
3	Semiconductor prices
4	Quality
5	Vendor base reduction
Bottom 5 Issues	
1	Made in Europe
2	Semiconductor packaging
3	Offshore manufacture/procurement
4	JIT delivery
5	Internal demand

Our survey captured an estimated 33 percent of the total European semiconductor procurement base in this segment. This represents a reasonable sample size for analysis. The industrial segment is estimated to consume 17 percent of all semiconductors in Europe.

Industrial segment respondents increased their semiconductor spending above the European average from 1990 to 1991, although the outlook for increased spending in 1992 is below average. This segment is very much a mixed bag, and it is difficult to single out any clear cause of this trend. In addition, end users in this segment often purchase from distributors, which means there is no direct contact with suppliers.

Target inventory levels ranged from 40 to 90 days, with all respondents reporting they were above their target level for 1991. Consequently, each planned to reduce target inventories in 1992, by an average of 14 percent.

The top criterion in 1991 for the industrial segment was product availability. Certainly the diverse applications within this segment would require a certain volume of niche semiconductor products. This criterion highlights that the supply of these devices may not be as good as in other segments, because of the higher-volume purchasing of other segments and the stronger supplier-user relationships that develop as a result.

Another important issue arising from the survey was that of semiconductor prices. We believe there are two reasons for this, the first being that customers in this segment tend to purchase smaller volumes from distributors. Secondly, respondents to the survey included specialist power companies which typically buy state-of-the-art, high-power discrete semiconductors and smart-power ICs; these command price premiums over mature products.

Consumer Segment

Top 5 Issues	
1	Semiconductor prices
2	Quality
3	Product availability
4	Internal demand
5	Exchange rates

Bottom 5 Issues	
1	Second-sourcing
2	Vendor base reduction
3	Offshore manufacture/procurement
4	New products/obsolescence
5	Semiconductor packaging

Our survey captured an estimated 10 percent of the total European semiconductor procurement base in this segment. This represents a relatively small sample size for analysis. The consumer end-user segment is estimated to consume 17 percent all semiconductors in Europe. The respondents included manufacturers of VCRs and televisions.

Semiconductor spending of consumer segment respondents grew well above the European average in 1991, and is expected to continue to grow well in 1992. The manufacturing base for consumer equipment in Europe is growing quickly, which means semiconductor demand is being driven by manufacturing expansion as much as by growth in the consumer equipment market. However, it is worth noting that an Olympic year always has a positive effect on this segment, and this year's event will certainly be helping the growth in this market.

Inventories ran at between 5 and 14 days in 1991. The respondents were split between exceeding their inventory target levels and meeting their target. All respondents reported they planned to reduce target inventories in 1992. This is the leanest level of inventory found in any of the segments, and parallels the short time-to-market, low-profit margins, and high production volumes that characterize this market.

The key purchasing criterion for consumer segment respondents in 1991 was semiconductor prices. While this is a valid issue, due to the low profit margins on their equipment, we do not feel the sample size accurately reflected the overall concerns of this segment. Dataquest believes that quality and on-time delivery are a higher priority to the consumer segment overall. In many cases, consumer equipment manufacturers do not second-source on semiconductors, and the relationship with the supplier is very much a strategic one.

Military Segment

Top 5 Issues	
1	Semiconductor prices
2	Quality
3	JIT delivery
4	On-time delivery
5	New products/obsolescence

Bottom 5 Issues	
1	Exchange rates
2	Offshore manufacture/procurement
3	Made in Europe
4	Semiconductor packaging
5	Second-sourcing

Our survey captured an estimated 24 percent of the total European semiconductor procurement base in this segment. This represents a relatively small sample size for analysis. The military segment is estimated to consume 4 percent of all semiconductors in Europe.

Semiconductor spending in this segment in 1992 promises to show slightly above-average spending, according to respondents. The aftermath of the Gulf war did not provide any immediate growth in the military segment, and 1992 is expected be restricted by cutbacks in government spending.

Target inventory levels in 1991 varied between 60 and 180 days—the largest inventory of any segment. This is due to the relatively long life cycles of the equipment manufactured in this segment. Around 75 percent of respondents were happy that they were on target in 1991, but all respondents planned to lower their targets in 1992 by an average of 14 percent.

Semiconductor prices was the most important criterion, and reflects the economic constraints that are now being brought to bear upon the military equipment sector. Military-grade semiconductors command large price premiums over commercial-grade equivalents, but there will be added pressure to lower the level of these premiums in 1992.

Another important criterion raised was quality. This was the top criterion in our survey last year, and indicates the need for continued improvement by suppliers to this end-user segment.

Transportation Segment

Top 5 Issues	
1	Semiconductor prices
2	Quality
3	On-time delivery
4	Cost of ownership
5	Exchange rates
Bottom 5 Issues	
1	Offshore manufacture/procurement
2	Internal demand
3	Made in Europe
4	Semiconductor packaging
5	Semiconductor memories

Our survey captured an estimated 58 percent of the total European semiconductor procurement base in this segment. This represents a significant sample size for analysis. The transportation segment is estimated to consume 9 percent of all semiconductors in Europe.

Semiconductor purchasing in this segment grew above the European average in 1991, but respondents indicated that spending in 1992 would be below average. This is almost certainly related to the fact that, on average, the transportation segment had been overinventoried more than any other end-user segment in 1991.

Target inventory levels in 1991 ranged between 5 and 20 days, and of those that reported being overinventoried, the average excess inventory was 30 percent of target. This is the highest overshoot of all the end-user segments. All those surveyed planned to decrease target inventories in 1992.

As with the military segment, the top criterion to the transportation segment was price. In many ways, the reasons are similar. The harsh environment of transportation equipment requires automotive- or industrial-grade semiconductors, which command price premiums over commercial-grade equivalents. One way in which transportation end users are managing price reductions is to move the electronic assemblies from the engine area into the driver compartment, where the environment is less harsh and commercial-grade semiconductors can be considered.

Dataquest Perspective

The clear message to the semiconductor supplier is that service is still a significant shortcoming, as perceived by the semiconductor buyer. The importance of listening to the concerns of semiconductor end users can never be stressed too highly. One of the major changes that has been taking place in the electronics industry over the last few years is that semiconductor demand is becoming driven less by semiconductor technology and more by end-application needs. It is clear that many semiconductor vendors have realized this, and have restructured their marketing efforts to focus their product developments by end application.

This procurement survey has highlighted that the semiconductor purchasing criteria in each end-user segment often differ significantly, because the markets that each end-user segment addresses for its equipment sales are just as different. To understand the purchasing concerns of a semiconductor end user, the semiconductor vendor should attempt to understand the purchasing criteria of its customer's customer, thus gaining strategic insight to existing and emerging equipment markets, and highlighting new opportunities. It also adds synergy to the relationship between semiconductor supplier and semiconductor user.

By Byron Harding
Sarah Jacob

European Regional Forecast Update

An analysis of the seven major semiconductor markets comprising Western Europe reveals that, for the second successive year, the German semiconductor market had the strongest growth. This was driven by demand from telecoms and consumer equipment manufacturers. While the United Kingdom/Eire and Benelux semiconductor markets recovered from their decline in 1990, the French, Italian and Nordic semiconductor markets continued to decline. However, no regional market escaped the blight of economic recession.

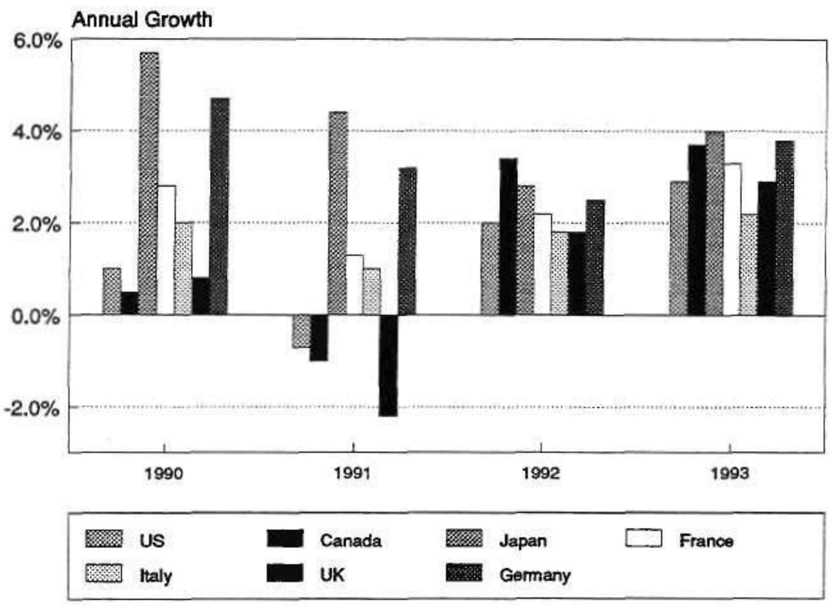
The outlook for 1992 indicates that all the regional markets will show some growth as the global economy slowly recovers. Strongest will be United Kingdom/Eire with its extensive base of Japanese and US equipment manufacturers. The weakest region will continue to be Nordic, as Swedish manufacturers look to reduce costs by moving production elsewhere, and as Finland recoils from the chaos in Russia.

Economic Background

The worldwide economic climate is expected to improve moderately in 1992. The key points of The Dun & Bradstreet Corporation's latest GDP forecast for the G7 countries, summarized in Figure 8, are:

- The US, Canadian and UK economies are expected to recover from recession with real GDP growth of 2.0, 3.4 and 1.8 percent respectively in 1992. The rate of recovery will be modest by comparison with historical averages owing to the relative shallowness of the recession. To put the US recession in perspective, if we assume that it has now run its course, then real output fell 1.6 percent from peak to trough, and unemployment peaked at 7.1 percent. In the 1973 to 1975 recession output fell by 4.1 percent and unemployment rose to 9.0 percent. In the 1981 to 1982 recession output fell by 2.8 percent and unemployment rose to 11.0 percent. In other words, the rate of recovery will be modest because there is relatively little to recover from. In the United States, tight state and local government budgets, and weak credit flows will also contribute to the moderation of growth.
- Real GDP growth is expected to decelerate in Japan and Germany in 1992, from 4.4 percent in 1991 to 2.8 percent in 1992 in Japan, and from 3.2 percent in 1991 to 2.5 percent in 1992 in Germany. This is good news since both

Figure 8
G7 Countries Economic Outlook—Real GDP Growth, Local Currencies



Source: Dun & Bradstreet (January 1992)

economies have been growing at unsustainably high rates, with no margin of spare production capacity. Slower growth will help put a lid on inflation.

- Real GDP growth is expected to accelerate in France and Italy in 1992, from 1.3 percent to 2.2 percent in the case of France, and from 1.0 percent to 1.8 percent in the case of Italy.

We expect signs of tangible recovery by mid-year; but ignore the inevitable election year political rhetoric bemoaning a moderately paced recovery. Under the circumstances we believe a speedier recovery would rekindle the fires of inflation. In the United States we expect re-enactment of investment tax incentives combined with the already low interest rates to spur business capital expenditure, which will boost sales of electronic systems and in turn drive semiconductor sales.

The Regional Markets

The results of Dataquest's preliminary market share survey indicate that the European semiconductor market grew by 9.8 percent in European Currency Units (ECU), or 6.6 percent in US dollars, in 1991. While this estimate is likely to be revised when the final market share survey is completed in April, the important point is that it indicates the European market recovered from the 6.0 percent ECU decline it experienced in 1990. However, this welcome recovery was not experienced in all the country markets that comprise Europe. Table 3 gives Dataquest's estimates for the size and growth rates of the seven markets that we track in Western Europe. The markets are expressed in their own local currencies. From the table we believe that the French, Italian and Nordic semiconductor markets continued to decline in 1991. The overall growth in the European semiconductor market was driven by recovery in Benelux, UK/Eire, Germany, and the smaller markets that comprise Rest of Europe.

Benelux

The Benelux semiconductor market—comprising Netherlands, Belgium and Luxembourg in order of size—is estimated to have been worth Fl 1,137 million in 1991. This represented an 11.7 percent increase over 1990. Thus, as Table 3 shows, Benelux grew the second-fastest of the European regional markets last year. This exceptional performance was the result of three factors:

- Steady recovery by Philips, continuing to capitalize on healthy consumer demand in the early part of 1991.
- Continued strength in the communications segment.
- The fact that the region has little computer production, as semiconductor demand from this segment across Europe, and indeed worldwide, was weak last year.

In the consumer segment the region continued to benefit from good demand for televisions, particularly from unified Germany, in the early part of the year. However, by mid-1991 all the television manufacturers across Europe were experiencing high inventories, so semiconductor demand dropped in the second half of the

Table 3
European Semiconductor Market Regional Growth Analysis (European Local Currencies)

Region	Currency	1989	1990	1991	1992	Growth 1990/89	Growth 1991/90	Growth 1992/91
Benelux	Gulden (M)	1,056	1,017	1,137	1,206	-3.7%	11.7%	6.0%
France	Francs (M)	8,857	8,334	8,216	8,627	-5.9%	-1.4%	5.0%
Italy	Lire (B)	1,486	1,414	1,347	1,441	-5.1%	-4.8%	7.0%
Nordic	Swedish Kronor (M)	4,399	4,091	3,809	3,923	-7.0%	-6.9%	3.0%
UK/Eire	Pounds (M)	1,595	1,529	1,665	1,865	-4.1%	8.9%	12.0%
Germany	Deutsche Marks (M)	5,044	4,986	5,602	6,051	-1.2%	12.4%	8.0%
Rest of Europe	Pesetas (M)	94,959	91,215	97,247	10,6971	-3.4%	6.7%	10.0%

Source: Dataquest (February 1992)

year. Demand from the leading communications equipment producers—Alcatel, Ericsson and AT&T—was healthy throughout the year. These companies continue to benefit from contracts they have won in eastern Germany and Eastern Europe. Demand from the main manufacturer of EDP equipment in this region, Tulip Computers, was affected by the slowdown in the European personal computer market: though the EDP segment represents a relatively small portion of the semiconductor market in the region.

In 1992, we forecast the Benelux market to grow by 6 percent over 1991, reaching Fl 1,206 million. While demand from the communications segment is still healthy, demand from the consumer segment is likely to be slow, certainly for the first six months of the year. The market for consumer goods is heavily dependent on prevailing economic conditions. As already explained, we see modest economic recovery establishing itself worldwide this year, but the critical market in Europe, Germany, will be affected by an economic slowdown. Thus, with inventory for consumer goods still high it is difficult to see much in the way of significant semiconductor orders in the first six months of 1992.

France

The French semiconductor market continued to decline last year. The market totalled FF 8,216 million, a decline of 1.4 percent compared with 1990. In the EDP segment, increased demand from Hewlett-Packard's factory in Grenoble failed to offset a sharp drop in demand from Bull, as this company continued to restructure. The result was a continued decline in EDP.

French semiconductor distributors had a particularly difficult year in 1991, as a result of many smaller electronics companies going bankrupt.

Semiconductor demand from the communications segment was flat. This was caused by tough competition in the market for terminal and PBX equipment, which in turn affected production. French communications equipment manufacturers are waiting for the take-up of new telecoms products such as GSM handsets and base stations, and video telephones.

In the consumer segment, demand for semiconductors was sustained by manufacturers of domestic appliances. French manufacturers have been concentrating on incorporating a lot of electronic functionality into their products as a means of differentiation. This increased pervasion of semiconductors is serving to boost semiconductor revenue.

The industrial segment in France was impacted by weak economic conditions. Many small to medium-size French electronics companies went bankrupt last year, resulting in a particularly difficult year for French semiconductor distributors. While, it had no effect on the semiconductor market, the French company Schneider became the world's biggest supplier of electronic meters through its acquisition of the US company, Square D. This will have important longer-term implications for the industrial segment in France.

A government spending freeze on defense, applied in 1990, continued to depress the military and areospace segment. Although new projects are in the offing such as the Rafael fighter and the LeClair tank, the government seems unlikely to release any contracts in the next 12 months. The positive aspect of the segment is Airbus on the civil aviation side, where semiconductor demand held up.

There was a significant slowdown in the transportation segment in 1991 caused fundamentally by the worldwide decrease in new car sales. The main automotive electronics systems manufacturers in France—Valeo, Ufima, Marelli Autronica, Bendix and Siemens Automotive—mainly supply to Chrysler, Ford and Fiat, so the recession in the car markets in the United States and Italy depressed semiconductor sales. The one bright spot in the transportation segment in France was the TGV train. Suppliers of high-power discrete thyristors and transistors experienced relatively good sales last year.

We forecast that the French semiconductor market will recover from its two consecutive years of decline in 1992, to grow by a modest

5 percent to FF 8,627 million. The critical assumptions are that:

- Bull will show signs of recovery, increasing its semiconductor spend over 1991.
- French communications equipment manufacturers will benefit from the early uptake of mobile telephones based on the GSM standard.
- The moderate economic recovery will stabilize the transportation, consumer and industrial segments.

Germany

The German semiconductor market sustained Europe again last year. It grew by 12.4 percent over 1990 to DM 5,602 million, the highest growth of any regional market. However, the sales which drove this growth took place largely in the first six months of the year.

Demand from the consumer segment had flattened by midyear and manufacturers saw inventories build, caused by consumer caution as the economy slowed. Prevailing economic conditions were reflected in decreased semiconductor spending by Bosch, VDO and other car components suppliers as the car market slowed. The EDP segment showed little growth, though this was due more to difficulties at Siemens Nixdorf Information Systems (SNI), which continued to make losses. The only segment to manage sustained growth was, again, communications. Siemens Telecom, Alcatel and others continued to place healthy semiconductor order through 1991 as they worked to fulfil government contracts aimed at rebuilding eastern Germany and other parts of Eastern Europe.

The outlook for the semiconductor market in 1992 is for a slow start to the year with growth re-established in the last six months. We forecast that the German market will grow by 8 percent over 1991, reaching DM 6,051 million. Key assumptions here are that:

- The German economy will be sluggish through the first half of 1992. But as the US and other European economies recover, German exports will pick up, and Germany will manufacture itself out of recession by the fourth quarter of 1992.
- The economic scenario given above will be mirrored in semiconductor demand from the consumer, transportation and industrial segments.
- Demand from the EDP segment will show modest growth as SNI continues to restructure.
- The communications segment will continue to show healthy growth as rebuilding of eastern Germany continues.

A pickup in business and consumer confidence based on economic recovery are critical for semiconductor market revival.

Italy

Like France, the Italian semiconductor market declined for the second successive year last year. We estimate that the Italian market was worth L 1,347 billion, a decline of 4.6 percent on 1990. The EDP segment and specifically Olivetti are critical to the growth of the Italian market; semiconductor consumption by both declined again. The positive aspect of the EDP segment was the increase in procurement from IBM and Hewlett-Packard. IBM makes mainframes, workstations and PC motherboards, and Hewlett-Packard makes laser printers, at various sites in Italy.

The second-largest application segment in Italy is communications, where inventory problems affected demand from the two leading semiconductor users, Italtel and Telettra. Elsewhere, the consumer, industrial and transportation segments slackened as the economic slowdown took hold.

We forecast that the Italian market will grow by 7 percent in 1992 to L 1,441 billion. The critical assumption is that Olivetti's restructuring will go smoothly and swiftly, and that combined with the economic recovery indicated above, sales of computers will pick up. Unlike, say, the United Kingdom where there is an increasing presence of foreign manufacturing plants, particularly from the United States and Japan, making products that will be consumed throughout Europe, electronics manufacturers in Italy depend on their products being consumed in Italy. Therefore, a pickup in business and consumer confidence based on economic recovery are critical for semiconductor market revival.

(A detailed study of the Italian semiconductor market can be found in ESIS newsletter 1991-19, "Market Update: Italy".)

The Nordic Market

The Nordic market—comprising Sweden, Finland, Denmark and Norway in order of size—showed the steepest decline of all the European regional markets last year. Dataquest estimates that the Nordic market was worth SKr 3,809 million, a decline of 6.9 percent on 1990.

The Swedish market represents 50 percent of the region, and here recession in the Swedish economy affected demand from all segments. Ericsson, which is the single largest customer in the region, continued to move manufacturing out of the country, thus decreasing semiconductor consumption. The company is strengthening production in Italy, Mexico and Australia. While Ericsson's telephone exchange business was healthy, the transmission side was depressed, so the company's overall semiconductor demand decreased. In EDP, Nokia Data Systems closed its PC factory in the country last year as business was down; while in consumer, demand from Electrolux, which produces domestic appliances, was down as well.

The EDP segment was the key source of growth in 1991 in the UK/Eire market.

The Finnish economy experienced the full effect of the economic confusion created by the break up of the Soviet Union in 1991; 30 percent of Finnish exports used to go to Russia. The break-up of the USSR has resulted in this market virtually disappearing for Finland, with inevitable consequences for the Finnish semiconductor market, which is estimated to have declined by as much as 15 percent.

The positive aspect of the Nordic market was Norway. Norway is an oil-producing economy; as the price of oil increased through the Gulf war, so the Norwegian economy strengthened. Thus, small though the country's semiconductor market is, it increased by 5 or 6 percent over 1990.

Following two years of decline, we expect the Nordic market to show a modest recovery in 1992. We forecast the market to grow by 3 percent to SKr 3,923 million. Gradual economic recovery in Sweden combined with the fundamental strength of Ericsson are the key assumptions behind this.

United Kingdom and Eire

Although the UK economy was firmly in recession last year, the UK/Eire semiconductor market managed to achieve respectable growth by comparison with some of its European counterparts. We estimate that the market grew by 8.9 percent over 1990, reaching £1,665 million. With one or two possible exceptions the growth came about through increased purchases by US and Japanese factories, which have been established in the region over recent years. In other words, market growth did not come about through increased purchases from UK or Irish companies; local companies whose primary market was the United Kingdom were impacted by the recession. Distribution sales—a good indicator of local demand in a country—declined by 12 percent in the United Kingdom last year.

A review of the applications segments reveals that the EDP segment was the key source of growth in 1991. Here Apple, Compaq and Sun in particular significantly increased local procurement last year. At a product level Compaq and Sun procured substantial quantities of memory modules, which boosted the UK/Eire memory market. The consumer segment started the year well with demand from the Japanese TV producers holding up well. However, the aforementioned slowdown in demand for consumer products in Germany resulted in a drop in order rates by midyear. The consumer segment was also blighted by a slump in sales of satellite receivers. In the communications segment, demand from GPT was low, with the company continuing to reposition and align with its shareholder Siemens. The military segment declined, as did the industrial segment, reflecting prevailing economic conditions; this was reflected in distributor sales. However, the transportation segment grew from its small base despite the slump in new car sales; the increased presence of Japanese car manufacturers combined with a revitalized Rover Group were the key contributory factors.

As the UK economy begins to recover, we see the UK/Eire semiconductor market leading the rest of Europe to higher growth in 1992. We forecast that semiconductor consumption will grow by 12 percent in the region this year, giving a market worth £1,865 million. The critical assumptions behind this forecast are that:

- Some degree of recovery will take place in the European PC market, sustaining the UK/Eire PC manufacturing base. Revenue growth also depends on an increased usage of DRAMs, and a shift to more powerful 32-bit microprocessors.
- Economic recovery does take place, and it results in at least flat demand from the industrial, consumer and communications segments.
- The new Japanese equipment factories continue to increase local purchases of semiconductors.

Rest of Europe

Dataquest includes the following countries in Rest of Europe, with market estimates for 1990:

- Switzerland, $265 million
- Austria, $224 million
- Spain, $197 million
- Turkey, $143 million
- Greece, $36 million
- Malta, $18 million
- Portugal, $11 million

In 1991, we estimate that semiconductor consumption in the combined countries which comprise Rest of Europe grew by 6.7 percent over 1990. Dataquest chooses to express Rest of Europe in the currency of the country whose market has grown fastest in the last five years, that of Spain. Thus the region grew to Pta 97,247 million last year. Of the big four countries—Switzerland, Austria, Spain and Turkey—the Austrian and Turkish markets showed above-average growth; the Spanish market was flat; and the Swiss market declined.

Austria has a strong base of consumer and communications equipment manufacturers. The country is well placed to serve Eastern Europe as well as the markets in the West. Philips, Alcatel and Siemens have large factories in Austria and demand from Austria's export markets lead to sustained demand for these factories. Thus, the Austrian market grew well last year.

In Switzerland, the unheard-of was happening in that banks were going bankrupt.

Turkey has similarities with Austria in that its main electronics factories make consumer and communications equipment, and that its "neutral" position has enabled it to trade with both East and West. Turkey also benefits from a source of low-cost labor, and to some extent it is a newly industrializing country, so there is a good domestic market for basic electronics goods such as telephone handsets and TVs. Thus, again in 1991 the Turkish semiconductor market grew above average for the region.

The Spanish semiconductor market experienced its second successive year of flat growth in 1991. A slowing economy combined with difficulties in the communications segment, which represents approximately 40 percent of the Spanish market, have stalled the Spanish market. The country is looking to the Barcelona Olympics and the Seville Expo '92 to revitalize the economy, and thus the semiconductor market. (A detailed analysis of the Spanish semiconductor market can be found in ESIS newsletter 1991-20, "Market Update: Spain.")

The Swiss semiconductor market was in difficulties in 1991 reflecting prevailing economic conditions. The unheard-of was happening in that banks were going bankrupt. This had a significant impact on the industrial and consumer OEMs that characterize the Swiss semiconductor market. Ascom, like many, was forced to put its work force on a short working week. The net result was that the Swiss market declined by approximately 10 percent.

The modest economic recovery will lead to a pickup in the Swiss and Spanish markets in 1992. While we expect the Austrian semiconductor market to slow compared with its growth in 1991, as consumer inventories are burned off, the Turkish market will sustain its growth. Thus, we forecast the Rest of Europe to grow by 10 percent overall in 1992, reaching a value of Pta 106,971 million.

Dataquest Perspective

As the European Community prepares to enact the single market at the end of 1992, it is interesting to review the various European semiconductor markets to look for indications of readiness for market harmonization. Clearly, the economic slowdown is taking its toll. But if the semiconductor market performance is any measure—and it should be as it reflects electronics production—then Germany with its strong internal market and indigenous manufacturers is well set for 1993. Its current slowdown will be short-lived; it is poised to manufacture and export its way back to growth.

The big are likely to get bigger, and take a larger share of the European market in the future.

The UK/Eire market had a tough time in 1990, the two countries taking the full brunt of memory price declines, but 1991 showed good recovery. However, unlike Germany the recovery has been driven by non-European customers. Its own electronics manufacturing base has felt the full impact of recession, and recoiled. It is Japanese and US electronics companies factories, positioned in the United Kingdom and Eire in readiness to supply Europe, that have sustained the market.

The French market has had a harder time of it over the past two years by comparison with Germany and the United Kingdom. Its customer base is predominantly French, and the bigger companies tend to be state-owned. The economic slowdown has led to companies such as Thomson and Bull making huge losses, and many smaller French electronics firms have gone bankrupt. The government has shown its readiness to intervene, but ultimately it can only guarantee business in France, and will find itself less able to protect its industry in the future.

The Italian semiconductor market has proved to be the weakest of the big four European territories over the past two years. So much has depended on Olivetti. The government's industrial policy has done little to attract foreign electronics manufacturers, and so the semiconductor market can expect to see little benefit from harmonization, post-1992.

In conclusion, the big are likely to get bigger and take a larger share of the European market, while the small will be left with a reduced share, with or without government help.

By Jim Eastlake

Company Analysis

IBM Invests in Bull

The battle to win the hand of Groupe Bull has finally been settled, with the French government deciding in favor of IBM, in preference to Hewlett-Packard. This agreement leaves only Olivetti without a rich patron to fund future development and technology. Siemens and Nixdorf have combined to form SNI, ICL has Fujitsu for its wealthy sponsor, and Bull now has IBM. However, there are significant implications for both France's semiconductor business as a result of this agreement, and the balance of power for RISC suppliers because of IBM's success. This report looks at the IBM–Bull agreement, and the implications of the agreement on the European semiconductor suppliers.

The Agreement

- IBM will take a stake in Bull of roughly 5.7 percent. The company is expected to pay $100 million for this share.
- Bull will have access to the IBM RISC microprocessor, the Power architecture; currently Bull is a MIPS user.
- Bull will join the IBM/Apple/Motorola design center cooperative, to develop RISC processors around the Power architecture. Bull already uses Motorola's 68030 and 68040 as the core processor for some of its computers.
- IBM gets access to the Zenith portable PC technology, an area where IBM is weak.
- IBM will get Bull's smart cards. Currently Motorola is buying CP8 smart card processors from Bull.
- IBM has an additional outlet for its Power architecture processors, displacing MIPS.

Dataquest Perspective

SGS-Thomson (ST) gains a major benefit from this agreement, as IBM has agreed to transfer its front-end technology to the company. This will give ST state-of-the-art manufacturing technology. However, it is of uncertain merit to ST, as the company is no laggard in advanced silicon processing. The real benefit to ST is the collaboration with IBM over future process research.

SGS-Thomson will also gain from an increase in IBM's semiconductor purchasing with the company. IBM has stated it will increase its semiconductor spending with ST to $100 million, from $50 million. This should help ST improve the utilization of its fabrication plants, although the increase only represents 3.5 percent of the company's total worldwide semiconductor revenue. The company's plants are presently running below capacity, and any improvement in utilization can only contribute to profitability. A point which should be considered, though, is that IBM would probably have increased its spending with ST anyway, as part of the inherent growth in the semiconductor market. IBM has also just approved the Transputer for use as the serial controller in its disk drives, and also given the exclusive license to Inmos for the manufacture of XGA graphics controllers. However, IBM did not commit to buying the controllers from Inmos.

The most significant consequence of the agreement comes from Bull's defection from the MIPS camp, to the Power architecture. This can be considered another nail in the ACE consortium's coffin, as major members of the consortium withdraw from the initial agreement. Bull joins Compaq, another major defector from the consortium. MIPS Computer is the biggest potential loser in the RISC stakes, as it has the most to gain from the success of the ACE consortium.

By Mike Glennon

In Future Issues

Along with our regular features, "European Pricing Update" and "State of the Industry," watch out for these articles in future issues of *Dataquest Perspective:*

- Import tariffs
- DRAM forecast

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Dataquest Perspective

Semiconductors *Europe*

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In This Issue...

Pricing Analysis

European Pricing Update

European component prices have shown little change over the past month, with minor changes in lead times.

By Byron Harding and Mike Glennon *Page 1*

Market Analysis

State of the Industry

The WSTS book-to-bill ratio for December has risen above 1.0. This is due to the combination of an increase in booking coupled with a decrease in billing. The decline in actual billings is suspiciously large. The new European forecast model reinforces the above-expected booking and below-expected billing, which has caused the book-to-bill ratio to rise above unity. The book-to-bill figure is not forecast by the model to rise above 1 until February.

By Byron Harding and Mike Glennon *Page 4*

European ASIC Market: the Growth of Standard Products

The ASIC market is undergoing a change in emphasis, as companies that previously only supplied ASIC products begin to introduce a range of standard products, targeted at very specific market areas. This represents a significant risk for these companies, as they may not be fully aware of the real cost of failure with standard products.

By Mike Glennon *Page 8*

New Fab Activity in Europe Slows

The number of new fabrication facilities being constructed in Europe over the past 18 months has fallen, and many of the projects already underway are progressing more slowly than was originally planned.

By Jim Eastlake *Page 12*

Pricing Analysis

European Pricing Update

In this first update for 1992, we provide preliminary 1991 European supplier rankings for the product families tracked below. Further details are available to clients of Dataquest's Semiconductors Europe service. Table 1 shows European semiconductor booking trends for orders of 1,000, 10,000 and 25,000 units or more.

Standard Logic

The standard logic market has shown no change over the Christmas period, with business quiet as expected. Most of the volume contracts for 1992 have been completed, so the volume price should show little decline over the next few weeks. The volume of business is poor, as the decline in PC business is not fully compensated for by the growth in telecoms business.

Top Suppliers in 1991: In the European bipolar standard logic segment, the top five suppliers were unchanged from 1990. In order of rank, these were Texas Instruments, National Semiconductor, Philips Semiconductor, Motorola and SGS-Thomson. However, the only supplier to grow its business in 1991 was Motorola. Many users are switching to MOS standard logic. In the European MOS standard logic market, the top five suppliers were Philips, Motorola, AMD, National Semiconductor, and Harris. Harris has de-emphasized its standard logic business, moving from the previous year's third position to fifth position in 1991.

Analog

Little change is taking place in the mono operational amplifier arena in Europe. CODEC/filter combination telecom ICs continue to be in strong demand, although this sector is beginning to flatten out in the present economic climate.

Top Suppliers in 1991: The top five suppliers to the European analog IC market in 1991, were Philips Semiconductor, SGS-Thomson, National Semiconductor, Siemens and Analog Devices. The only change in rank from 1990 was the movement of Analog Devices from seventh position to fifth position, mainly because of its acquisition of Precision Monolithics Inc (PMI).

Average contract booking prices have dropped quite suddenly for 4M DRAM, which has seen most action since December.

Microcomponents

There are significant declines in 386 and 486 prices following Intel's price cuts at the beginning of the year. However, it is the SX20, not recorded above, which is showing the greatest falls. The reductions are also for 486, but the 386 is easily the greater volume, and is outselling the 486 by more than 10 to 1.

Top Suppliers in 1991: The top five suppliers to the European MOS microcomponent IC market in 1991 were Intel, Motorola, NEC, Texas Instruments and SGS-Thomson. Intel controls one-third of the European market for MOS microcomponents, which covers microprocessors, microcontrollers and microperipherals. It has a two-thirds share of the European microprocessor market.

Memory

DRAM

The 256K DRAM market has seen some further price erosion in the first few weeks of 1992. There is a wide variance in prices, some as low as $1.10 from non-Japanese sources. The PLCC option commands an average premium of 3 or 4 percent, but with no premium from some sources. The 1M DRAM market has seen little action since the end of 1991 with average contract booking even rising slightly. Premiums for the ×4 configuration of 70ns speed have generally disappeared now. There remains a 5 percent premium on the 60ns speed option, but this is eroding.

The 4M DRAM has seen the most action since the close of December, with average contract booking prices dropping quite suddenly. This is seen as the release of pressure from the fourth quarter of 1991, when the EC reference price is believed to have contributed to the European market becoming more expensive for 4M than North America or Japan. The new 4M reference price allows Japanese-manufactured parts to be booked at a new low level, although this will remain a price floor through the first quarter of 1992. The ratio between 4M and 1M prices stands at about 4.0.

Prices for the 16M DRAM have fallen, approximately in line with the 4M. The average contract booking price is in the region of $190 now. The EC is believed to be providing company-specific reference prices for this part. Prices for the 1M×9 DRAM SIMM have seen some downward movement. The nine-chip solution price has remained relatively flat, while the three-chip solution has seen significant erosion, in line with the comments on the standalone 4M DRAM price.

The US DOC seems to be defining flash memory as EPROM, for trade purposes, as does the EC.

Top Suppliers in 1991: The top five suppliers to the European DRAM market in 1991 were Siemens, Samsung, Toshiba, Texas Instruments and NEC. The only supplier in the top five to grow its business in 1991 was Samsung, allowing it to overtake Toshiba and move into second position.

EPROM

The 1M UV EPROM market has seen rapid price erosion since December, with European and North American suppliers fighting for market share. Intel has limited its production of 1M parts, and is completely pulling out of the sub-1M market.

The 2M market is seeing similar price erosion as suppliers try to get established. Japanese suppliers do not feature strongly in the European market, and being bound by EPROM reference prices are not likely to be competing

Table 1
European Semiconductor Pricing—January 1992
All Prices in US Dollars (Including import duty where relevant)

Device Family	Product	Package	Mean 1K Price	Mean 10K Price	25K+ Contract Price	Lead Time in Weeks
Standard Logic	74F00	PDIP	0.12	0.10	0.09	4–6
Fast TTL	74F74	PDIP	0.14	0.13	0.12	4–6
	74F138	PDIP	0.18	0.17	0.16	4–6
	74F244	PDIP	0.25	0.24	0.21	4–6
Standard Logic	74AC00	PDIP	0.19	0.17	0.15	4–6
Advanced CMOS	74AC74	PDIP	0.24	0.22	0.20	4–6
	74AC138	PDIP	0.35	0.32	0.26	4–6
	74AC244	PDIP	0.43	0.41	0.36	4–6
Analog	741 Op. Amp.	TO92	0.17	0.12	0.11	4–6
	CODEC/Filter 1	1	2.90	2.65	2.50	6–10
	CODEC/Filter 2	2	5.75	5.45	5.00	6–10
Microcomponents	80386SX-16	PQFP	56.00	54.00	53.00	6–7
	80386DX-25	CPGA	155.00	147.00	144.00	6–8
	80286-16	PLCC	13.00	11.50	10.00	4–6
	68020-16	PQFP	31.00	28.00	26.00	6–8
	R3000-25	CPGA	150.00	140.00	132.00	4–10
Memory						
DRAM	256K-8 (256K×1)	PDIP	1.95	1.65	1.60	2–8
	1M-8 (1M×1)	SOJ	4.15	3.90	3.85	2–6
	1M-8 (256K×4)	SOJ	4.15	3.90	3.85	2–6
	4M-8 (4M×1)	SOJ	16.40	15.70	15.30	2–8
	9M-8 (1M×9)	SIMM	39.00	37.00	36.00	4–10
	1M-7 (1M×1)	SOJ	4.15	3.90	3.85	2–8
	1M-6 (1M×1)	SOJ	4.40	4.10	4.00	4–10
	4M-7 (4M×1)	SOJ	16.56	15.86	15.45	4–8
	4M-6 (4M×1)	SOJ	17.20	16.50	16.10	6–10
	16M-8 (4M×4)	SOJ	203.00	195.00	190.00	8–14
UV EPROM	1M-17 (128K×8)	CDIP	4.00	3.75	3.45	2–6
	2M-17 (256K×8)	CDIP	8.20	7.50	6.70	4–8
	4M-17 (512K×8)	CDIP	21.00	19.00	17.00	6–12
SRAM	64K-85 (8K×8)	PDIP	2.25	1.95	1.90	4–10
	256K-85 (32K×8)	PDIP	4.00	3.80	3.55	4–8
	1M-85 (128K×8)	PDIP	14.60	13.30	12.70	2–10

[1] Group 1: Commercial temp, serial, PDIP, A/μ law
[2] Group 2: Commercial temp, serial, PLCC, A/μ law, programmable
Source: Dataquest (January 1992)

in sub-2M markets; however, they are found in the 4M EPROM market. It is interesting to note that the US Department of Commerce (DOC) appears to be following the line that the European Commission has taken in its definition of an EPROM for trade purposes: that flash memory based on an EPROM cell structure is included in the definition. The DOC proposal is being hotly debated.

Top Suppliers in 1991: The top five suppliers to the European MOS EPROM market in 1991 were SGS-Thomson, Intel, AMD, Texas Instruments and Philips Semiconductor (that is, Signetics). Only AMD and Philips saw sales growth in 1991.

SRAM

Prices for the 8K×8 part have increased slightly, as the NMOS product is now nearing obsolescence. CMOS continues to be in demand for automotive and some telecoms applications.

The 32K×8 part has seen further price erosion, although it would seem that this part has hit rock-bottom now, with prices starting to rise again. There is a general switchover to manufacturing of 128K×8 parts. The average booking price for the 128K×8 part has seen most significant erosion. The ratio between 1M and 256K pricing stands at about 3.6.

Top Suppliers in 1991: The top five suppliers to the European MOS SRAM market in 1991 were Hitachi, NEC, Toshiba, Matra-MHS, and Mitsubishi. Hitachi had the strongest growth in business, thereby overtaking NEC, which held first place in 1990.

Current Exchange Rates

1 US dollar =
 0.555 UK pounds
 1.585 deutsche marks
 5.384 French francs
 0.774 ECU

By *Byron Harding*
Mike Glennon

Market Analysis

State of the Industry

The WSTS Flash three-month average European book-to-bill ratio for the month of December was 1.06, an increase over November's revised ratio of 0.93, as shown in Figure 1. The increase was driven by two factors, namely a rise in bookings coupled with a decrease in billings. Average bookings increased by 7.2 percent to $863.2 million while average billings decreased by 6.3 percent to $814.3 million.

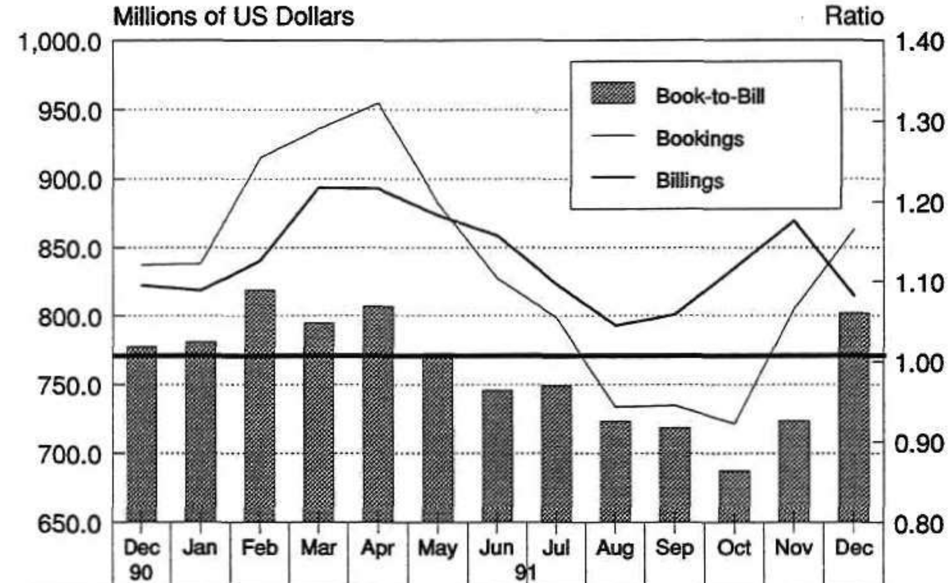
European Forecast Model

The Dataquest forecast model is based on the WSTS monthly billing and three-month average booking figures for Europe. The model calculates trends and seasonal variations, and uses these, together with monthly weighting factors, to forecast future billing and three-month average booking figures. These figures represent an "average" year. When the actual figures are compared with the forecast figures, an early indication of whether the year will be above or below average can be seen. The graphs present 25 months of data, to show the accuracy of the Dataquest model. The forecast and actual figures are compared, and the ratio is averaged over 12 months to show underlying trends.

The current three-month average booking model, shown in Figure 2, forecast $10,373 million for 1991, compared with an actual booking of $10,010 million—an accuracy of 97 percent. The model forecasts $11,159 million for 1992, a growth of 7.6 percent. The actual billing model, shown in Figure 3, forecast 1991 semiconductor revenue (using WSTS definitions) of $10,507, compared with an actual billing figure of $10,102 million—an accuracy of 96 percent. The billing model forecasts $11,433 million for 1992, a growth of 8.8 percent.

The December Flash Report gives the latest billing and three-month average booking figures, and these have been included on the graphs. The booking model forecast a small growth in booking, but the actual three-month booking is higher than forecast. December is traditionally a quiet month, being only three weeks' long, so the above-average booking growth should be viewed with suspicion. This figure is likely to be

Figure 1
European Total Semiconductor Orders Booked and Sales Billed
(Three-Month Average)



	Dec 90	Jan	Feb	Mar	Apr	May	Jun 91	Jul	Aug	Sep	Oct	Nov	Dec
Book-to-Bill	1.02	1.02	1.09	1.05	1.07	1.01	0.96	0.97	0.93	0.92	0.86	0.93	1.06
Bookings	837.3	838.2	915.3	936.3	954.6	882.4	827.3	798.3	733.5	734.6	721.4	805.1	863.2
Billings	822.3	818.4	840.4	893.5	893.0	873.5	858.7	823.0	792.7	800.8	835.2	869.4	814.2

Note: Last two months are preliminary.
Source: WSTS, Dataquest (January 1992)

restated; actual figures are currently running at about 95 percent of forecast, whereas this figure is 98 percent of forecast.

Due to currency fluctuations, 1991 shows up as a better year in Europe in absolute terms than it was in US dollars.

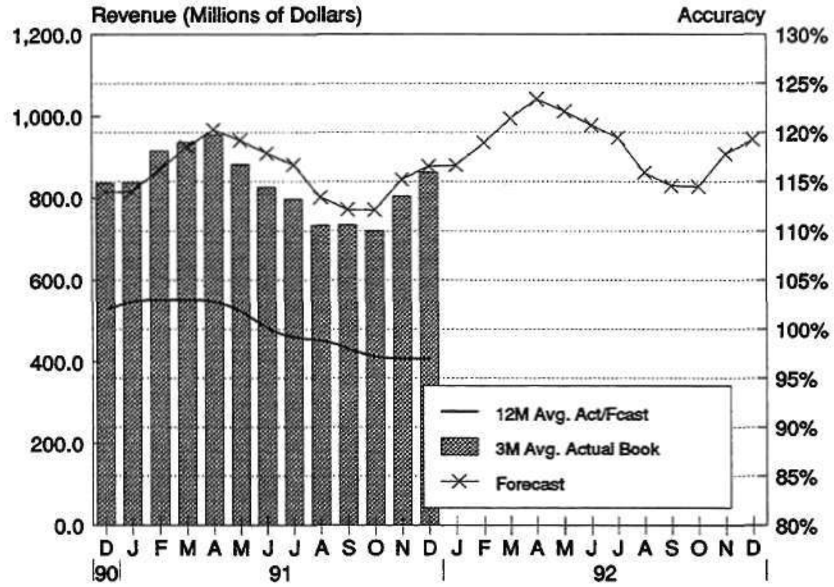
The billing figure for December is well below forecast. Actual billings are running at about 94 percent of forecast, whereas the December figure is 88 percent of forecast. The two extremes of high booking and low billing have given an exceptional and uncharacteristic growth to the book-to-bill ratio. The ratio is not forecast to rise above unity until February, as seen in Figure 4, and this may still be the case if the December booking and billing figures are restated, as they were for November.

Dataquest Perspective

Using WSTS Blue Book data for the months of January through November, and the WSTS Flash Report data for December as it stands, the total-year billings in Europe for 1991 show a 5.2 percent growth over 1990. As European currencies generally weakened against the US dollar in 1991, this translates to a slightly stronger ECU growth of 7.9 percent. Compare this with a growth rate in 1990 of 7.3 percent in US dollars or, because European currencies greatly strengthened against the US dollar in 1990, a 7.8 percent decline in ECUs. In summary, the local currency growth rate in 1991 is a substantial improvement over that of 1990. Yet in absolute terms, 1991 was not such a great year.

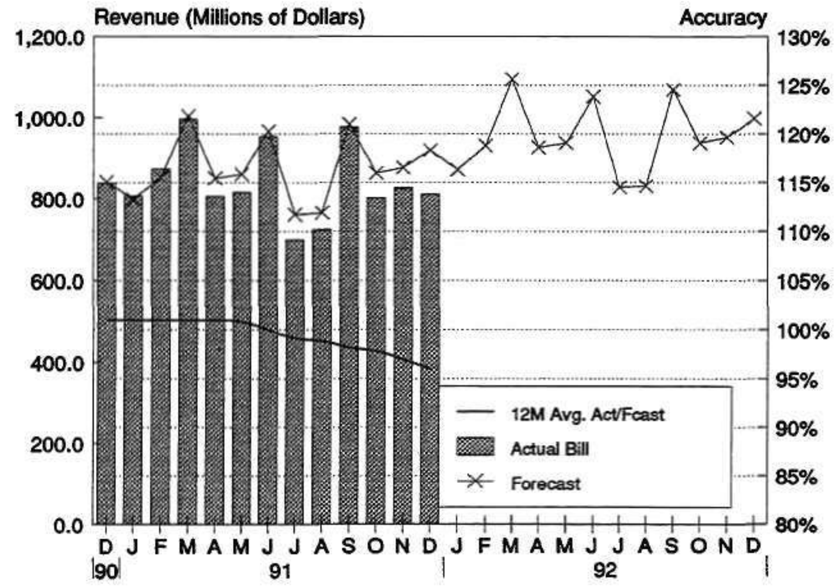
The WSTS quarterly billings profile of 1991 shows that, as usual, there was a cycle of growth and decline throughout the year. The first quarter saw sharp growth, driven by telecoms and PC manufacturers placing large contracts at the beginning of the year. This was

Figure 2
Total Semiconductor Three-Month Average Bookings



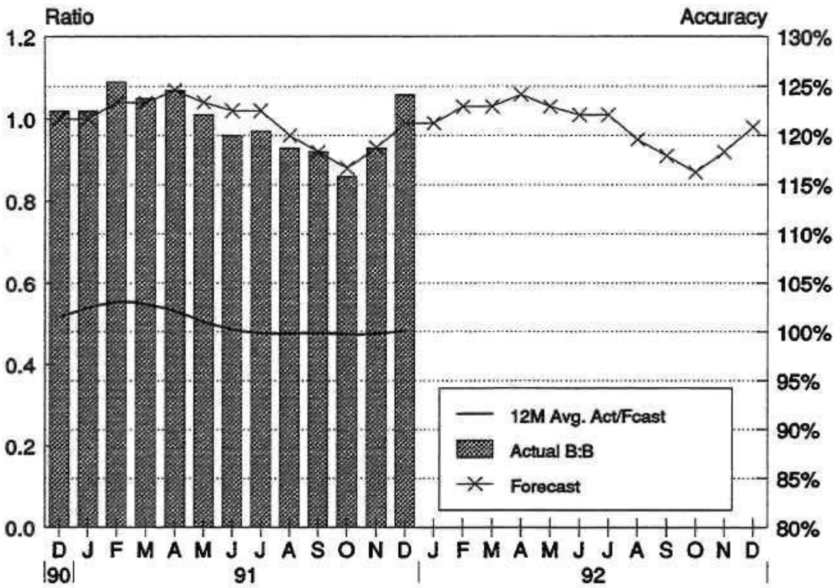
Note: Last two months are preliminary.
Source: WSTS, Dataquest (January 1992)

Figure 3
Total Semiconductor Actual Billings



Note: Last two months are preliminary.
Source: WSTS, Dataquest (January 1992)

Figure 4
Total Semiconductor Book-to-Bill



Note: Last two months are preliminary.
Source: WSTS, Dataquest (January 1992)

partly due to a traditionally seasonal time of purchase, partly due to economic uncertainty as a result of the end of the Gulf war; and partly due to DRAM purchasing in anticipation of forthcoming increases in EC reference prices. Germany in particular was a strong market, because of semiconductor purchasing in the telecoms and consumer segments.

The second quarter saw a decline in billings, as the first-quarter billings bonanza subsided. The initial optimism of equipment manufacturers following the end of the Gulf war was replaced by worldwide economic pessimism. Inventories began building up, and procurement went on an early summer holiday. In particular, the PC market slipped into decline.

The billings decline continued into the third quarter, until some bookings from the first quarter started showing up as billings in August. This billings growth continued into September. However, the third quarter could not avoid being an overall decline on the second quarter, leading to further pessimism in the industry.

Fourth-quarter billings started off poorly, and remained relatively flat through to December, as a result of the sharp bookings decline in the second and third quarters. This means 1991 ended with a whimper in terms of billings.

By *Byron Harding*
Mike Glennon

European ASIC Market: the Growth of Standard Products

LSI Logic and VLSI Technology are two of the leaders in the European ASIC market. These two companies have taken differing approaches to this market, with LSI Logic choosing gate arrays as the preferred implementation method, while VLSI Technology has chosen to use cell-based ICs (CBICs). Both implementations have their benefits and drawbacks.

The leadership positions these companies enjoyed in their respective products, though, has been steadily eroded in recent years, as more competitors entered the fast-growing ASIC market. This additional competition affected the companies' sales growth and profits. The two companies strengthened their business, while still retaining their ASIC roots, by developing products in each other's key areas. LSI Logic branched out into standard cells, while VLSI Technology developed gate array products. However, both companies reached a point where they realized they must diversify into standard products in order to sustain their high growth and boost profitability. This move offered the companies a greater chance of finding a niche in the standard product market, and exploiting it profitably.

This article looks at the impact in Europe of the two companies' evolving strategies, and highlights their case as an example for all specialist ASIC companies.

LSI Logic

LSI Logic has used gate arrays as the main implementation method for ASIC. The company's total European revenue is shown in Table 2, and 81 percent of this was for gate array in 1991. Over the past four years the company's gate array revenue has grown at nearly 20 percent per year, but it has not been able to keep pace with the European gate array market growth. LSI's market share has consequently declined over the period 1987 to 1990 (Table 3).

However, the company has managed to grow its share of the European total ASIC market, on account of its CBIC products, and this has offset the decline in gate array market share. Although this is not LSI Logic's primary product, representing only 17 percent of the company's European revenue, it has provided a boost for LSI's European ASIC revenue.

Table 2
European ASIC and Microcomponent Revenue
(Millions of Dollars)

	1987	1988	1989	1990
Europe				
Total ASIC	793	982	1,182	1,380
Gate Array	261	358	407	487
CBIC	151	220	314	453
Microcomponent	805	1,212	1,469	1,836
LSI Logic				
Total ASIC	44	59	69	83
Gate Array	40	52	58	69
CBIC	4	7	11	14
Microcomponent	0	0	6	2
VLSI Technology				
Total ASIC	17	25	37	43
Gate Array	2	3	8	12
CBIC	15	22	29	31
Microcomponent	3	5	17	28

Source: Dataquest (January 1992)

The company has also introduced a range of microcomponent products into Europe within the past two years, and the revenue for these products has added to the company's total revenue. This is only a small contribution, though, representing only 2 percent of its total European revenue in 1990.

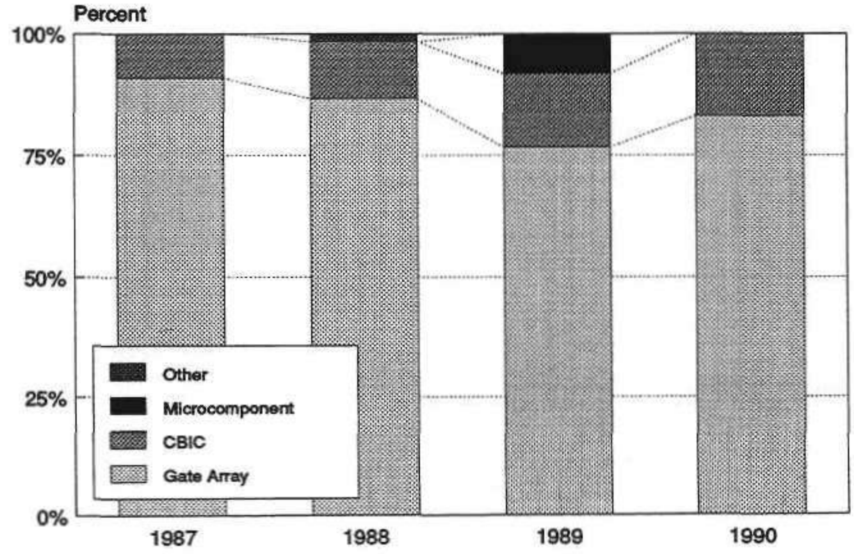
The profile of LSI Logic's product revenue is therefore heavily biased towards gate arrays, and Figure 5 shows the share each product category has of the company's total revenue. Although the share taken by CBIC has grown over the past four years, gate array is still over

Table 3
European ASIC and Microcomponent Market Share (Percent)

	1987	1988	1989	1990
LSI Logic				
Total ASIC	5.5%	6.0%	5.8%	6.0%
Gate Array	15.3%	14.5%	14.3%	14.2%
CBIC	2.6%	3.2%	3.5%	3.1%
Microcomponent*	0.0%	0.0%	0.4%	0.1%
VLSI Technology				
Total ASIC	2.1%	2.5%	3.1%	3.6%
Gate Array	0.8%	0.8%	2.0%	2.5%
CBIC	9.9%	10.0%	9.2%	6.8%
Microcomponent*	0.4%	0.4%	1.2%	1.5%

* LSI Logic's microcomponent revenue is mainly RISC microprocessors.
VLSI Technology's microcomponent revenue is mainly PC chip sets.
Source: Dataquest (January 1992)

Figure 5
LSI Logic Product Share of Total European Revenue



Source: Dataquest (January 1992)

75 percent of the European revenue for the company.

LSI Logic's European revenue has grown above average, but most of the company's worldwide revenue comes from other regions. Its European revenue in 1990 was only 14 percent of the company's worldwide revenue, whereas its North American revenue was nearly 71 percent. As the North American market is strongly influenced by data processing applications, this large share has a significant influence on the type of products developed by the company.

VLSI Technology

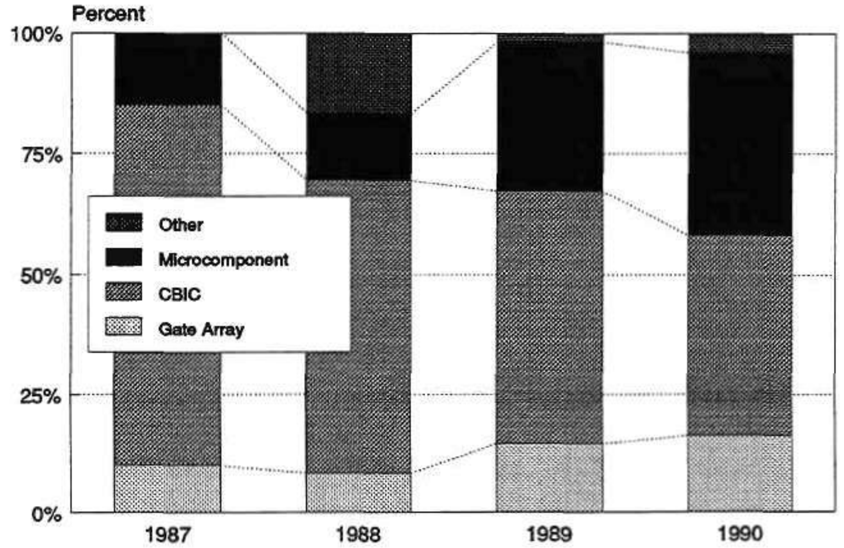
VLSI Technology has chosen cell-based ICs as the preferred implementation method for its ASIC products. The company's European revenue is shown in Table 2, and in 1990 CBIC represented 44 percent of the company's total revenue. However, the company has lost share of the European CBIC market, despite having an annual growth of 27 percent for its CBIC revenue over the period 1987 to 1990. The European CBIC market over the same period grew at over 44 percent.

Similarly to LSI Logic, VLSI has also increased its share of the European ASIC market, due to well-above-average growth for its gate array revenue. This has provided sufficient support to give above-average growth to the company's European ASIC revenue.

The company has also chosen to implement standard products, and has focused on PC chip sets as the key product area. VLSI's biggest revenue gains come from this area, as can be seen from Table 2. These products have built on the company's CBIC expertise, using CBIC technology to implement the functions efficiently. As a result of the standard product revenue, VLSI has a more balanced revenue portfolio (Figure 6). The company's European CBIC revenue, previously its mainstay with more than 75 percent of the total revenue in 1987, has declined to less than 50 percent of the total by 1990.

VLSI Technology is also a US-based company, and its European revenue was 22 percent of its worldwide revenue in 1990. Again, the heavy influence of data processing applications in its domestic market affects the type of products it makes. The company is developing more telecoms-oriented devices, though, and these may be more suited to the European market.

Figure 6
VLSI Technology Product Share of Total European Revenue



Source: Dataquest (January 1992)

Dataquest Perspective

The two companies have chosen different product strategies for the ASIC market. LSI Logic has focused on gate array products, and VLSI Technology on CBICs. In Europe the gate array market has been bigger than the CBIC market for some time, so the growth potential for LSI Logic has been greater. However, the CBIC market in Europe is now growing at a faster rate, and Dataquest forecasts this market to overtake the European gate array market in revenue in 1991.

This should be good news for VLSI Technology, but it isn't. The growth in Europe for the CBIC market is from the increase in the use of mixed signal CBICs. Cell-based designs are used where it is not possible to use a gate array to implement the required function effectively. The improvements in design tools are allowing CBICs to mix analog and digital cells together, and give the required performance for the system. VLSI Technology is weak in mixed signal ASICs, and its design tools are not focused towards mixed signal design. The major area of growth for the company in the European ASIC market is therefore limited. This is apparent from its declining share of Europe's CBIC market (Table 3).

The European ASIC market offers limited growth to the two companies, because of their large market share. But both companies have introduced standard products, and by entering new areas such as the standard product market, they will increase their growth potential. In addition, the ASIC market is very competitive, with many suppliers. As the standard product market is larger, there is a greater chance of finding a niche in this market and exploiting it. VLSI Technology has succeeded here more than LSI Logic, partly because it developed standard products earlier. VLSI also entered this market at a period of high growth in the industry.

The risks associated with standard products are much greater. The responsibility for the correct functioning of the design lies with the supplier—unlike ASIC, where the responsibility lies with the customer. Thus, the suppliers have to go through product engineering for these products, which is an expensive and time-consuming task. Typical product engineering costs can easily reach $500,000, and the process can take six months to a year. For some products the lifetime can be as short as 18 months, and thus there is a much bigger risk associated with making a mistake in development. In addition, The expertise for the product applications often does not exist inside an ASIC company, so this expertise may have to be brought into the company.

These issues are all new to ASIC-only suppliers. The broad-line semiconductor companies, which have other semiconductor products as well as ASIC, understand the costs and risks associated with standard product development. These companies tend to use ASICs to complement their standard products, and vice versa. They are well placed to take advantage of the change of emphasis in product requirements. The broad-line suppliers also have a wider expertise in chip design, using internally developed cell libraries with greater performance and smaller size as part of their standard product design. The ASIC suppliers are more likely to use their commercially available cell libraries for product design. These libraries have compromised performance and size to provide a "bullet-proof" library for any customer to use.

The move into standard products by ASIC suppliers is overcoming potential growth limitations apparent in the ASIC market. These companies are using some of their applications expertise as a way of entering the standard product market, with ASIC-based products. The strategies of LSI Logic and VLSI Technology have differed in the past, but both companies are now adopting a similar one to ensure their fabrication plants run at full capacity. But, these companies are moving into new markets, with new products, and this is always a risky approach to take. There are already suppliers in these markets who have greater expertise, and may pose a significant threat to the two ASIC suppliers.

By Mike Glennon

New Fab Activity in Europe Slows

The number of new fabrication facilities (fabs) being constructed in Europe over the past 18 months has fallen, and many of the projects already under way are progressing more slowly than was originally planned. Only three new fab projects were started in 1991, and it is unlikely that any new projects will be started in 1992. Adverse economic conditions, combined with restructuring in the computer industry, have led to excess semiconductor manufacturing capacity worldwide, particularly for DRAM. Thus, reduced fab activity in Europe is a reflection of the scene worldwide.

Background

The late 1980s in Europe saw a boom in the construction of new semiconductor fabrication facilities. In 1987, Dataquest recorded 102 fabs in Europe; by 1990 the number had increased to 124, an increase of more than 20 percent over 1987. The single most important factor causing semiconductor companies to consider investment in Europe was their customers' needs. Electronic equipment companies were strengthening their operations in Europe in preparation to take advantage of a post-1992, unified European market. They were applying pressure to their foreign semiconductor suppliers to come to Europe to provide them with locally designed and manufactured products.

Survey Results

In December last year Dataquest conducted a survey of semiconductor companies in order to analyse new fab activity in Europe. The results are displayed in Table 4. During 1991 four new

Table 4
New Fabrication Facilities In Europe

Company	Location	Capability*	Status
ABB-Hafo	Jarfalla, Sweden	ASICs; CMOS/SOS; 1.0 µm; 4-inch	In production
Fujitsu	Newton Aycliffe, England	4M DRAM; CMOS; 0.8 µm; 6-inch	In production
Hitachi	Landshut, Germany	4M DRAM; CMOS; 0.5 µm; 8-inch	Installing equipment, production 2H92
IBM/Siemens	Corbeilles, France	16M DRAM; CMOS; 0.5 µm; 8-inch	Qualifying line, production 2Q92
Intel	Leixlip, Dublin, Ireland	32-bit MPUs; CMOS; 0.6 µm; 8-inch	Under construction, production 1993
Mietec	Oudenaarde, Belgium	ASICs; BiCMOS; 0.8 µm; 6-inch	Foundations laid, production 1993
Mitsubishi	Aachen, Germany	Memory; CMOS; 0.5 µm; 8-inch	Under construction, production end 1993
NEC	Livingston, Scotland	4M DRAM; CMOS; 0.7 µm; 6-inch	Extension to existing fab, in production
SGS-Thomson/CNET	Grenoble, France	Digital CMOS; 0.8 µm; 8-inch A/D CMOS; 0.8 µm; 8-inch A/D BiCMOS; 0.8 µm; 8-inch	R&D facility, under construction, production 1992
Texas Instruments	Avezzano, Italy	4M DRAM; CMOS; 0.8 µm; 6-inch	Phase 1 completed, production 1Q92

* Product; technology; minimum feature size; wafer size
Source: Dataquest (January 1992)

fabs entered production: ABB-Hafo's ASIC fab in Sweden; Fujitsu's 4M DRAM fab in England; NEC's new 4M DRAM module at its factory in Scotland; and Texas Instruments' 4M DRAM factory in Italy. The survey revealed that only three new projects started last year. These were the joint IBM/Siemens 16M DRAM venture in France, Mietec's ASIC facility in Belgium, and the SGS-Thomson/CNET R&D fab in France. The other three projects—those of Hitachi, Intel and Mitsubishi—were started between 1989 and 1990 and have since been delayed as the companies considered the products they planned to make. In Hitachi's and Mitsubishi's cases this change was brought about by delays in the market uptake of 4M DRAMs. Intel's deliberations resulted in a decision to pull forward plans to build its most advanced processors in Europe on 8-inch wafers, rather than 6-inch.

The most important point to arise from the survey is that Dataquest was unable to identify any new projects in the offing for 1992. The new fab activity listed in Table 4 is all that will take place in 1992. This is reflected by the fact that in 1989 Dataquest was providing consultancy and advice to some 16 semiconductor companies on locating fabs in Europe. Today, this has decreased to less than a handful. This dearth of activity is not confined to Europe; it is indicative of a worldwide slowdown in capital investment by the semiconductor industry. The cause lies in the worldwide economic slowdown, combined with changes in the structure of the computer industry. Most new fab activity worldwide and in Europe over the past three years has been aimed at DRAMs—6 of the 10 fabs listed in Table 4 are DRAM facilities. Cutbacks in computer manufacture at a time when the semiconductor industry was gearing up for the 4M DRAM has resulted in overcapacity. It is important to note here that overcapacity does not exist in Europe. The region is a substantial net importer of semiconductors, including DRAMs. Indeed, we estimate that the trade deficit in DRAMs would still exist even if all the new DRAM plants, listed in the table, were to increase production to full capacity as quickly as possible.

The implied slowdown in the level of capital expenditure in Europe indicated by this European fab survey is compared with the worldwide situation in Table 5. Forecast capital expenditure for Europe is expected to grow in 1992, though only by 3 percent. The activity listed in

Table 5
Worldwide Semiconductor Capital Spending Forecast
(Millions of Dollars)

	1990	1991	1992	1993	1994	1995	CAGR (%) 1990-1995
North America	4,088	4,097	3,821	4,352	4,787	5,217	5%
Percent Change	6%	0%	-7%	14%	10%	9%	
Japan	5,425	6,382	5,828	6,586	7,442	7,744	7%
Percent Change	-1%	18%	-9%	13%	13%	-22%	
Europe	1,512	1,631	1,688	1,984	2,322	2,554	11%
Percent Change	25%	8%	3%	18%	17%	10%	
Asia/Pacific-ROW	1,495	2,084	2,543	2,825	3,248	3,573	19%
Percent Change	-22%	39%	22%	11%	15%	10%	
Total	12,519	14,194	13,879	15,747	17,799	19,090	9%
Percent Change	0%	13%	-2%	13%	13%	7%	

Source: Dataquest (January 1992)

Table 4 will support that growth. This is to be compared with a decline in the level of capital investment in Japan and North America, which will result in an overall drop in worldwide capital investment.

Dataquest Perspective

New fab activity in Europe has decreased considerably over the past 18 months. However, the activity level has not been affected by prevailing market conditions as much as it has in Japan and North America. Indeed, Dataquest notes that in the cutbacks in fab investment announced by Japanese and North American companies recently, the tendency has been to spare European projects and make the cuts elsewhere. There is still a recognition of the strategic importance of investment in Europe. With the increase in the customer base in Europe, semiconductor manufacturers must be prepared to provide the local support required.

By Jim Eastlake

In Future Issues

As well as our regular features, "European Pricing Update" and "State of the Industry," watch out for these articles in forthcoming issues of *Dataquest Perspective:*

- European Procurement Survey
- Company R&D and expenditure analysis
- Country market forecast
- Semiconductor tariffs

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Research *Newsletter*

PRELIMINARY 1991 EUROPEAN SEMICONDUCTOR MARKET SHARE ESTIMATES: INTEL LEAPFROGS THE PACK

INTRODUCTION

Dataquest has completed its preliminary estimates of calendar year 1991 European semiconductor market shares. The highlights of the year are:

- European-owned and North American–owned companies have performed below the market average, therefore losing share in the European market. Japanese-owned and Asia/Pacific-owned companies have gained share. This is a complete reversal of the trends seen in 1990, and demonstrates the transience of fortune in the semiconductor market.
- Intel has achieved the largest growth of the top 10 vendors in Europe, with a 22 percent increase in semiconductor sales in 1991 over 1990. This has enabled Intel to leapfrog SGS-Thomson and Siemens in the IC rankings, to become the second-largest IC supplier after Philips. This growth has been driven mainly by its successful microprocessor business.
- The European semiconductor market has increased from $10,661 million in 1990 to $11,366 million in 1991, resulting in a 6.6 percent growth. However, the strengthening of European currencies against the US dollar in 1991 means that the annual growth measured in European Currency Units (ECUs) is 10.3 percent. This is an improvement on 1990, which saw an ECU decline of 6.2 percent over 1989. The major growth sectors have been MOS microcomponent and logic ICs. The impressive growth of these product markets has far outweighed the weakness of the markets for bipolar ICs, analog ICs, and discretes.
- The five largest European-owned companies all slipped down in the worldwide 1991 rankings. The strengths and weaknesses of suppliers by base region are discussed in this newsletter.

TOP 10 SEMICONDUCTOR VENDORS

Dataquest's preliminary estimates reveal that the top 10 semiconductor suppliers in Europe in 1991 were the same as in 1990. However, as Table 1 shows (at the end of the newsletter), Intel gained one position at the expense of Texas Instruments (TI) through exceptional growth in its microprocessor business.

Philips remains the leading semiconductor supplier in Europe with sales of $1,172 million. This represented a sales growth of 1.5 percent over 1990 which, as the European market grew by 6.8 percent, means Philips lost market share. The major categories making up the company's product range were analog ICs representing 34 percent of its total sales, discretes representing 29 percent, and MOS microcomponents representing 10 percent. This product mix has evolved in order to support sales to consumer applications, which comprised 53 percent of Philips' sales in 1991. As the consumer segment was flat, inevitably Philips' semiconductor sales were flat, but 1991 should be viewed as a year of consolidation for Philips following its excellent performance in 1990.

Siemens retained second place in the European market rankings with sales of $958 million—a decline of 0.6 percent over 1990. MOS memory, specifically DRAM, represented 23 percent of Siemens' total sales, and was the company's largest product line. Here its sales declined by 8 percent due to weak demand from

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computer manufacturers. Like Philips, Siemens' sales were also affected by a flat consumer segment. Sales to consumer applications represented 18 percent of Siemens' business in Europe; the slowdown affected its analog and discretes sales.

SGS-Thomson's European sales declined by 2.3 percent in 1991 to $887 million. Analog and discrete products represent 64 percent of the company's European sales, so with flat industrial and consumer application markets, inevitably SGS-Thomson's overall sales were flat.

Motorola retained fourth place in Europe in 1991 despite a sales growth of only 0.7 percent, with estimated sales of $770 million. A decline of 5.3 percent in the company's discretes revenue, which represented 26 percent of its total European business, was offset by an 8.6 percent growth in microcomponent sales, accounting for 33 percent of total sales. Motorola's star product last year was SRAM. Preliminary estimates suggest that strong SRAM sales helped offset a substantial decline in the company's DRAM sales, so stabilizing its MOS memory business.

Intel grew its European business by 22 percent in 1991, reaching $760 million. This outstanding performance enabled the company to displace Texas Instruments from fifth place in the European ranking. As indicated in the section on product trends, a substantial increase in the average selling price (ASP) of microprocessors used in PCs aided Intel's growth. Microprocessors represented 53 percent of the company's European sales in 1991, and grew by 38 percent over 1990. This offset an 8 percent decline in its MOS memory revenue, caused by a substantial drop in EPROM sales, though it is important to note that the company's flash memory business grew very well. If Intel can achieve 22 percent sales growth when PC production is flat, it has the potential to achieve far higher growth when the PC market recovers.

Texas Instruments was displaced by one place to sixth in the European ranking last year, with estimated sales totalling $629 million, a decline of one percent on 1990. The weak MOS memory market affected the company, as sales of DRAMs and EPROMs accounted for 27 percent of its European revenue. Its other business lines in MOS microcomponents, ASICs, analog ICs and discretes all grew well. Excellent sales growth in single-chip digital signal processor (DSP) business, and in its graphics chip business, are particularly worthy of note.

NEC did a commendable job in 1991 by growing its European business by 8 percent to $452 million. This was nearly two percentage points above the European market average growth rate—commendable because 41 percent of the company's European business is in DRAMs and SRAMs. A slight gain in MOS memory market share was, no doubt, due in part to the company's ability to manufacture DRAMs in Europe. The other key product area was microcomponents, which represented 37 percent of European sales; here success in NEC's microcontroller products drove business. The company also grew its bipolar logic and MOS ASIC businesses well above the European average.

Toshiba's European sales grew by 4 percent in 1991, to $509 million. Sales of DRAMs and SRAMs account for 44 percent of the company's European sales, so a flat memory market had a big impact on its overall business. In fact, the company's MOS memory sales declined by 7 percent in 1991. Counterbalancing this decline, the company grew its MOS microcomponent and discretes businesses. Microcomponents (mainly MCUs), which represented 12 percent of European sales, grew by 13 percent over 1991, while discretes, representing 13 percent of European sales, increased by 18 percent on the previous year.

National Semiconductor retained ninth place in the European ranking with flat sales of $408 million. The company's biggest business in Europe was analog ICs, accounting for 48 percent of its total European sales last year. While National grew analog sales above the market average, its overall performance was impacted by a 19 percent decline in bipolar logic, and a 15 percent decline in MOS memory (mainly EPROM) sales, which together accounted for 21 percent of European revenue, and thus pinned the company's growth back.

After sharing tenth place in the European ranking with AMD last year, **Hitachi** established a clear place among Europe's top 10 vendors in 1991. A 17 percent growth in sales boosted revenue to $318 million for the year. This was a particulary impressive performance bearing in mind that 58 percent of its European sales came from MOS memory. Hitachi grew its DRAM and SRAM sales by 20 percent over 1990, well above market average, and also grew its other major business area, MOS microcomponents (mainly MCU), representing 28 percent of European sales, by 13 percent.

TOP 20 HIGH-AND-LOW GROWTH COMPANIES

Aside from the top 10 companies in Europe whose performances are analysed above, there were some company performances particularly worthy of note among other leading suppliers to the market. Figure 1 ranks the top 20 vendors to the European semiconductor market by growth rate. From this it can be seen that Oki, Samsung, Mitsubishi and Analog Devices increased their share of the European market quite considerably.

Oki achieved the highest growth among Europe's top 20 in 1991, increasing sales by 82.5 percent. While some of this growth was organic, inclusion of sales channels that were previously not recorded led to the very large growth figure. This factor aside, the company's MOS memory business did benefit from the fact that it had local assembly and testing in Europe.

Samsung achieved second-highest growth of Europe's top 20 vendors last year. The company's enormous corporate capability was brought to bear in Europe, and the company established itself on the preferred vendor list of many major customers.

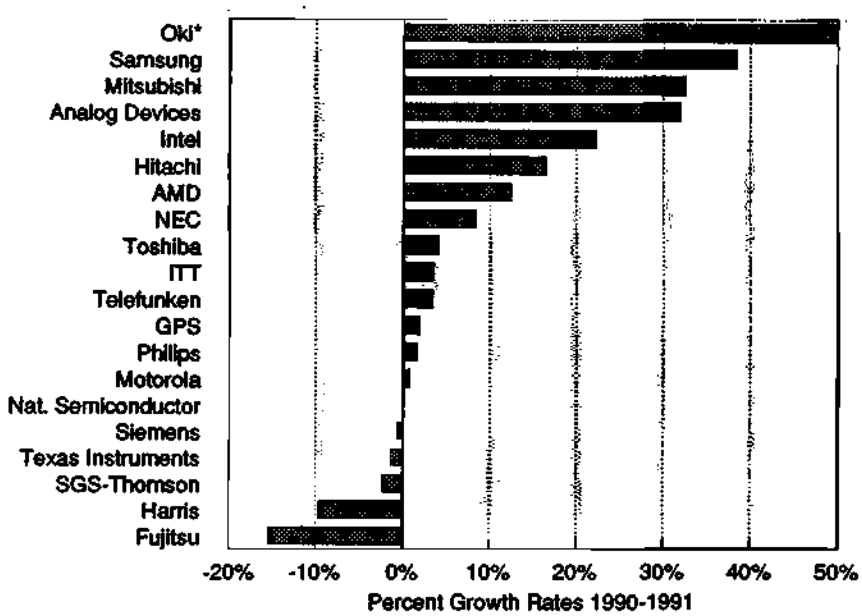
Mitsubishi's 33 percent growth in sales was achieved through focusing on major accounts. The company grew its MOS memory business through increased penetration of computer manufacturers, particularly in the area of workstations. However, Mitsubishi's discretes business declined due to weakness in the UK satellite receiver businesss.

Analog Devices declined one position in the ranking last year, to nineteenth place, despite growing its revenue by 32 percent. However, much of this growth was attributable to the inclusion of Precision Monolithics Inc. (PMI) revenue in the total Analog Devices number for the first time. PMI's European sales in 1990 were $29 million.

The other company outside the European top 10 to achieve above-average growth was **Advanced Micro Devices** (AMD), which grew its European business by 12.5 percent. Microprocessors, CMOS PLDs and analog telecoms ICs were the key to this performance. Growth in microprocessors came about through the release last year of AMD's line of Intel-compatible 32-bit microprocessors. The rise in CMOS PLDs was in line with the exceptional market growth that this product category experienced last year. It helped sustain AMD's dominance of the PLD market. AMD's considerable growth in telecom ICs was indicative of the strength of the European telecoms market last year.

Companies which returned a below-average growth among Europe's top 20 last year included **Fujitsu** (-15.5 percent), **Harris** (-9.6 percent) and **GEC Plessey Semiconductors** (GPS) (1.8 percent). Fujitsu's European business was particularly

FIGURE 1
Top 20 Semiconductor Suppliers, European Growth Rates 1990-1991



*Oki = 82.5 percent
Source: Dataquest (January 1992)

affected by the weak MOS memory market last year. However, its opening of a new European DRAM fabrication facility in November 1991 will do much to grow its market share in the future.

Harris Semiconductor's decline was assisted by weak market conditions in the market for discretes and analog ICs. GPS' lack-lustre year reflected the fact that it lost share in the telecoms segment in Europe. Its main customer in telecoms was GEC Plessey Telecommunications, which is currently going through a degree of restructuring that affected order rates. Also, the company's products are designed into applications that are still a couple of years away from volume production, so 1991 proved to be a slow year for it.

European Product Trends

The European semiconductor market grew by 6.6 percent in 1991, when measured in US dollars. This is a slowdown from the previous year, which saw a 9.3 percent growth in dollars, as shown in Table 2. However, the exchange rate between the dollar and the ECU has fluctuated over the past few years. In 1990, the ECU strengthened against the dollar, while in 1991 it lost some ground. The net effect has been that local currency growth of the European semiconductor market measured in ECUs has followed a quite different path. Table 3 shows that in 1991, the market grew by 10.3 percent in ECUs, which was a substantial improvement over the decline of 6.2 percent seen in 1990. This highlights the importance of looking at the European market in its own currencies in order to see the real trends, undistorted by fluctuating international exchange rates. Figure 2 provides a graphical representation of dollar and ECU growth rates.

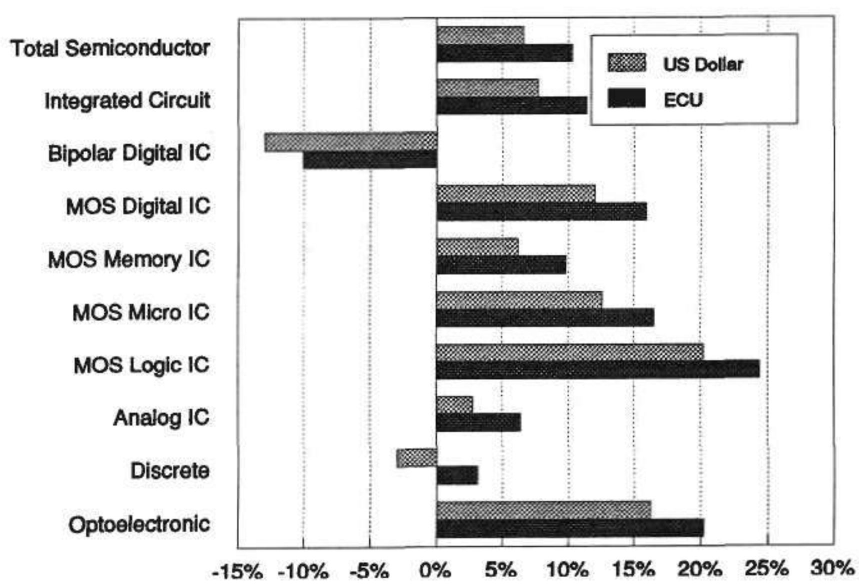
High-Growth Products

Dataquest preliminary estimates reveal that the product categories that achieved above-average growth in 1991 compared with 1990 were MOS logic, growing 20 percent in dollars, optoelectronic semiconductors, growing by 16 percent, and MOS microcomponents, growing by 13 percent.

In MOS logic, strong growth in the MOS ASIC category fuelled the market. MOS ASIC now accounts for approximately 65 percent of MOS logic. Demand for cell-based ASICs was particularly strong, due to healthy demand from European telecoms equipment manufacturers. However, the product category that exhibited the biggest growth rate in 1991 was again MOS programmable logic, though from a small base.

FIGURE 2

Preliminary European Semiconductor, Market Growth by Product Sector, 1990-1991



Source: Dataquest (January 1992)

The high growth in MOS microcomponents came from a big increase in microprocessor revenue. Here the key application was the personal computer (PC). The strong growth in microprocessor revenue was due mainly to a large increase in the ASP, rather than an increase in unit shipments. The number of PCs produced in Europe in 1991 showed little increase on 1990, but the PCs produced incorporated more powerful processors, which were more expensive; therefore microprocessor revenue increased. Microcontroller (MCU) sales also grew well in 1991. Here, healthy demand from TV and VCR manufacturers at the beginning of the year, combined with a significant product mix change from 4-bit MCUs to 8-bit MCUs, and from 8-bit MCUs to 16-bit MCUs, increased revenue considerably.

In the optoelectronic semiconductor market the product categories that exhibited good growth were LED lamps/displays, optocouplers and laser diodes. However, this high growth was due in part to our former underestimation of the size of Siemens' optoelectronics business. This aside, there was strong demand from European telecoms manufacturers for optocouplers and fiber-optic components through the year.

Low-Growth Products

Our preliminary estimates show that the product categories exhibiting below-average growth in 1991 were MOS memory, which grew by 6.2 percent in dollars over 1990; analog ICs, which grew by 2.8 percent; discretes, which declined by 0.3 percent; and the bipolar digital category, which declined by 13.0 percent.

The MOS memory market showed little recovery this year, following its significant decline in 1990. DRAM sales grew slightly above the average for MOS memory. A low growth in DRAM bits consumed, caused by a flat PC market, was offset by an increase in the overall DRAM ASP, as 4M DRAM shipments increased as a percentage of the total DRAM market. Also, the European Commission's DRAM reference price agreement with Japanese manufacturers helped to prevent excessive price erosion in 1M and 4M DRAMs. Elsewhere in MOS memory, the SRAM market was flat due to massive price erosion in the slow SRAM category, and the EPROM market declined as ASPs dropped through increased price competition.

Low growth in analog components reflected the weak conditions in the industrial and consumer application markets in 1991. As the economic slowdown spread from the United Kingdom and Sweden to France, Italy and the rest of Europe, demand from industrial applications, characterized by sales through distribution, slowed. Also the economic malaise impacted consumer spending and affected sales of products such as TVs, VCRs and domestic appliances. Therefore, sales of analog ICs were affected.

The same scenario applies to discretes. Sales of transistors and diodes were weak, illustrated by book-to-bill ratios below unity for the second half of 1991.

The weakest product area in Europe last year was bipolar digital ICs. The continued decline both in bipolar memories and logic devices is indicative of the continued shift to CMOS and BiCMOS technologies, which are quickly replacing bipolar solutions.

Product Rankings

Company strength in specific product areas can be seen by reviewing the preliminary market share rankings for the main product categories. Tables 4 to 12 give these product rankings.

In the integrated circuit market (Table 4), Philips retains first place despite growing revenue by only 1.6 percent, which is six percentage points below the average for ICs. The impact of Intel's high growth in microprocessor is highlighted; it displaced both SGS-Thomson and Siemens, climbing to second place. Elsewhere in the table, the poor performance of the MOS memory market can be seen in the low growths of companies such as Siemens, TI, NEC and Toshiba.

The demise of bipolar technology can be seen clearly in Table 5. Texas Instruments continues to dominate the category with its commanding presence in standard TTL logic, and like its competitors, saw revenue fall for yet another year. The positive aspect here is that bipolar logic is becoming a very profitable business as competition diminishes. Note that NEC's growth of 7.7 percent is an anomaly, as we have previously underestimated the size of the company's European bipolar gate array sales.

In the MOS digital market, Table 6 shows that Intel stretched its commanding lead, again through growth in microprocessors and other microcomponents, while DRAM and SRAM vendors tended to show lower growth. The notable exception was Samsung, which consolidated its place in the top 10 with a 37.5 percent sales growth.

The reason behind Samsung's success can be seen in Table 7. The company grew its MOS memory business by 34.2 percent, enabling it to displace Siemens and Toshiba from their joint number-one position in Europe. This performance was achieved through a broad DRAM portfolio with particular strength in 1M DRAMs.

In MOS microcomponents, Intel's sales of $663 million was over two-and-a-half times that of its nearest competitor, Motorola, as Table 8 shows. While the majority of vendors in the top 10 were experiencing double-digit growth, Europe's big three companies (Philips, Siemens and SGS-Thomson) had flat or declining sales. The key factor here was the weakness of the consumer segment in Europe.

The MOS logic ranking given in Table 9 reveals that most companies had a good sales year in 1991. Philips led the pack again, though with a modest 10.9 percent growth by comparison with others in the top 10. However, ITT's growth highlights the fact that MOS logic poses particular difficulties in product definition and classification; "MOS ASIC" and "other MOS logic" now comprise most of MOS logic. There is confusion here between digital and mixed-signal components, and between standard products and those designed for one customer. The underlying trend is clear, though. Gate arrays and cell-based ICs (CBICs) grew well last year, as can be seen in the sales growth of GEC Plessey Semiconductors, LSI Logic, Texas Instruments and others.

The analog IC rankings given in Table 10 reveal the poor state of the industrial and consumer segments last year. The two notable exceptions to the flat or declining sales of top vendors were Analog Devices and Mietec. Analog Devices grew through its acquisition of PMI, but Mietec, part of Alcatel, grew organically; it had another exceptional year with strong sales growth in mixed-signal ASICs and telecoms ICs.

As in the analog market, most discrete semiconductor suppliers experienced little sales growth in 1991 (Table 11). The exceptions in the top 10 were Eupec, Toshiba and Telefunken. Philips retained first place despite flat sales. Only $5 million separates the next three vendors, SGS-Thomson, Siemens and Motorola. The change in rankings depended on which company's sales declined most.

In the optoelectronics market, as Table 12 shows, Siemens retained a substantial lead over its competition, though as already noted, Dataquest had previously underestimated the size of Siemens' optoelectronics business. The largest growth in the top 10 was achieved by Sharp, which grew sales by 275 percent. This was achieved through substantial growth in its optocoupler sales.

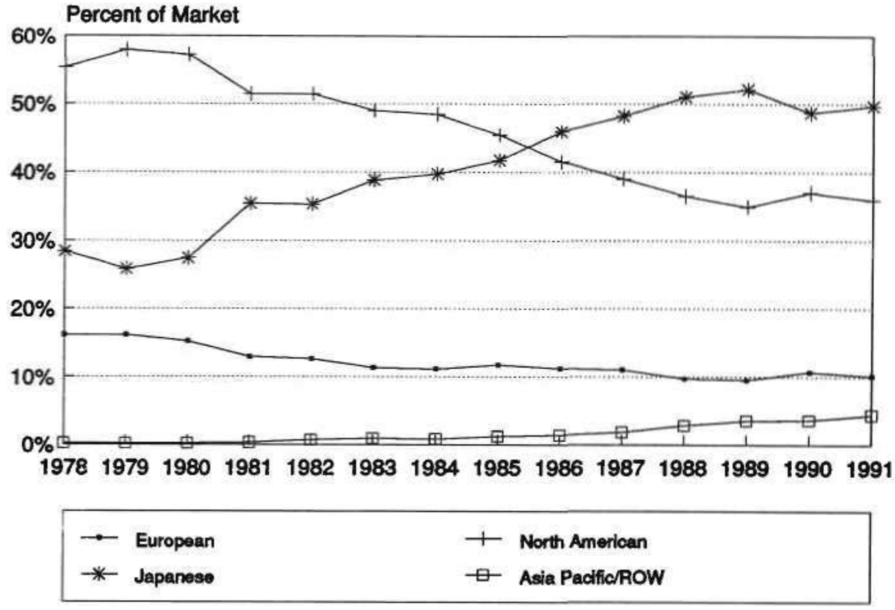
European Companies Worldwide, Market Share Decreases

Europe's leading semiconductor companies achieved little or no sales growth in their own domestic market in 1991. This inevitably impacted their position in the worldwide semiconductor market. Table 12 shows the worldwide sales and rankings of the 20 European semiconductor vendors tracked by Dataquest. The top 5 companies account for $5,518 million, or 84 percent, of European companies' accumulated worldwide sales. The table shows that they grew their revenues at between 2 and 3 percent. As the worldwide semiconductor market grew by 11.5 percent, it is clear that European companies lost share of the world market. The column on the far right of the table indicates the change in world ranking. It can be seen that Europe's leading supplier, Philips, lost 1 place, dropping to tenth-largest vendor worldwide, displaced by Matsushita. Indeed, all 5 of Europe's leading vendors dropped in the world rankings.

Below the big 5 there were some commendable European performances. Eupec, Semikron, Thomson Composants Militaires et Spatiaux (TMS), Eurosil, European Silicon Structures (ES2), and TAG all gained multiple places worldwide. The success of these companies indicates a European strength in discretes and specialized ASICs.

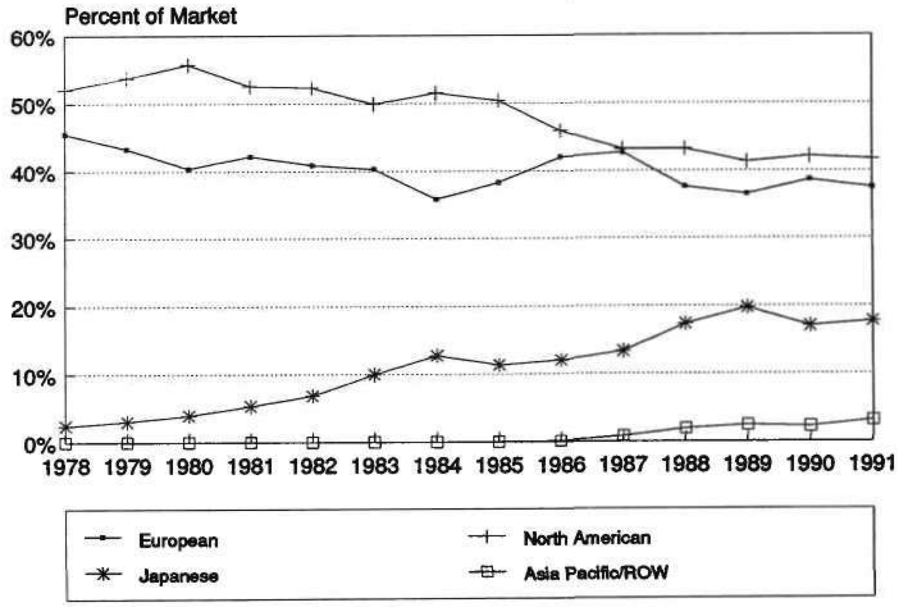
However, overall, Figure 3 reveals that European companies reversed market share gains they had made in 1990. European companies' worldwide market share fell to 10.1 percent, from 10.7 percent in the previous year. The figure also reveals that North American companies lost share, while Japanese and Southeast Asian companies regained some of the ground they lost in 1990.

FIGURE 3
Worldwide Semiconductor Market Share, by Supplier Base Region



Source: Dataquest (January 1992)

FIGURE 4
European Semiconductor Market Share, by Supplier Base Region



Source: Dataquest (January 1992)

VENDOR MARKET SHARE IN EUROPE

The worldwide picture with European and North American vendors losing market share, and Japanese and Southeast Asian companies gaining share, was repeated in the European market. Figure 4 shows that North American companies controlled the largest share of the European market in 1991, though their share decreased from 42.1 percent in 1990 to 41.7 percent last year. European companies' share of their own market declined from 38.6 percent in 1990 to 37.5 percent in 1991. This share was lost to Japanese companies, which increased their share by 0.7 percentage points to 17.7 percent. Likewise, Southeast Asian companies' share (mainly Samsung) grew by 0.9 percentage points to 3.1 percent in 1991.

To understand why changes in overall market share come about, the technique of product portfolio analysis is useful. Table 14 shows the share of the major product markets—MOS memory, analog IC, and so on—that were controlled in Europe last year by each of the four main regional supplier bases—North America, Japan, Europe, and Southeast Asia.

The table shows that European and North American companies have a substantial presence in bipolar digital ICs, analog ICs, and discrete and optoelectronic semiconductors. These are mature, low-growth product categories. By comparison, Japanese and Southeast Asian companies have established their major European presence in MOS digital products, particularly memories and microcomponents. These are relatively young, high-growth product areas. Many Japanese and Southeast Asian companies are also in the process of establishing a presence in Europe. They are forming business relationships and generally increasing their base, and thus market share. With this in mind it is easier to understand the long-term trends illustrated in Figure 4.

Jim Eastlake
Byron Harding

Notes to Tables 1 and 4 Through 12

Column 1 shows market share rank in 1990.
Column 2 shows market share rank in 1991.
Column 3 shows change in rank between 1990 and 1991.
Column 4 shows name of ranked company.
Column 5 shows ranked companies' estimated sales in 1990.
Column 6 shows ranked companies' preliminary estimated sales in 1991.
Column 7 shows ranked companies' sales growth between 1990 and 1991.
Column 8 shows ranked companies' cumulative sales.
Column 9 shows ranked companies' percentage market share.
Column 10 shows ranked companies' cumulative percentage market share.

TABLE 1
Preliminary Estimated 1991 European Total Semiconductor Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Components	1,155	1,172	1.5	1,172	10.3	10.3
2	2	0	Siemens	964	958	-0.6	2,130	8.4	18.7
3	3	0	SGS-Thomson	908	887	-2.3	3,017	7.8	26.5
4	4	0	Motorola	765	770	0.7	3,787	6.8	33.3
6	5	1	Intel	622	760	22.2	4,547	6.7	40.0
5	6	-1	Texas Instruments	637	629	-1.3	5,176	5.5	45.5
7	7	0	Toshiba	490	509	3.9	5,685	4.5	50.0
8	8	0	NEC	417	452	8.4	6,137	4.0	54.0
9	9	0	National Semiconductor	408	408	0.0	6,545	3.6	57.6
10	10	0	Hitachi	273	318	16.5	6,863	2.8	60.4
10	11	-1	AMD	273	307	12.5	7,170	2.7	63.1
14	12	2	Samsung	190	263	38.4	7,433	2.3	65.4
11	13	-2	ITT	232	240	3.4	7,673	2.1	67.5
12	14	-2	GPS	217	221	1.8	7,894	1.9	69.4
13	15	-2	Telefunken	213	220	3.3	8,114	1.9	71.3
17	16	1	Mitsubishi	135	179	32.6	8,293	1.6	72.9
16	17	-1	Harris	166	150	-9.6	8,443	1.3	74.2
15	18	-3	Fujitsu	174	147	-15.5	8,590	1.3	75.5
18	19	-1	Analog Devices	103	136	32.0	8,726	1.2	76.7
29	20	9	Oki	57	104	82.5	8,830	0.9	77.6
			North American Others	1,286	1,343	4.4	10,173	11.8	89.5
			Japanese Others	268	300	11.9	10,473	2.6	92.1
			European Others	660	806	22.1	11,279	7.1	99.2
			Rest of World Others	48	87	81.2	11,366	0.8	100.0
			Total All Companies	10,661	11,366	6.6		100.0	
			Total North American	4,492	4,743	5.6		41.7	
			Total Japanese	1,814	2,009	10.7		17.7	
			Total European	4,117	4,264	3.6		37.5	
			Total Rest of World	238	350	47.1		3.1	

Source: Dataquest (January 1992)

TABLE 2
Preliminary Estimated 1991 European Semiconductor Shipments by Product Category (Millions of US Dollars)

Product Sector	Final Sales 1989	Final Sales 1990	Prelim. Sales 1991	Growth 1989-90	Growth 1990-91
Total Semiconductor	**$9,755**	**$10,661**	**$11,366**	**9.3%**	**6.6%**
Total Integrated Circuit	7,794	8,326	8,968	6.8%	7.7%
Bipolar Digital	640	577	502	-9.8%	-13.0%
Bipolar Memory	72	58	47	-19.4%	-19.0%
Bipolar Microcomponent	NA	21	21	NA	0.0%
Bipolar Logic	568	498	434	-12.3%	-12.9%
MOS Digital	5,458	5,403	6,054	-1.0%	12.0%
MOS Memory	2,548	2,154	2,288	-15.5%	6.2%
MOS Microcomponent	1,469	1,836	2,067	25.0%	12.6%
MOS Logic	1,441	1,413	1,699	-1.9%	20.2%
Analog	1,696	2,346	2,412	38.3%	2.8%
Discrete	1,594	1,915	1,910	20.1%	-0.3%
Optoelectronic	367	420	488	14.4%	16.2%

NA = Not Applicable
Source: Dataquest (January 1992)

TABLE 3
Preliminary Estimated 1991 European Semiconductor Shipments by Product Category (Millions of ECUs)

Product Sector	Final Sales 1989	Final Sales 1990	Prelim. Sales 1991	Growth 1989-90	Growth 1990-91
Total Semiconductor	**8,974**	**8,422**	**9,286**	**-6.2%**	**10.3%**
Total Integrated Circuit	7,170	6,577	7,327	-8.3%	11.4%
Bipolar Digital	589	456	410	-22.6%	-10.1%
Bipolar Memory	66	46	38	-30.3%	-17.4%
Bipolar Microcomponent	0	17	17	NA	0.0%
Bipolar Logic	523	393	355	-24.9%	-9.7%
MOS Digital	5,021	4,268	4,946	-15.0%	15.9%
MOS Memory	2,344	1,702	1,869	-27.4%	9.8%
MOS Microcomponent	1,351	1,450	1,689	7.3%	16.5%
MOS Logic	1,326	1,116	1,388	-15.8%	24.4%
Analog	1,560	1,853	1,971	18.8%	6.4%
Discrete	1,466	1,513	1,560	3.2%	3.1%
Optoelectronic	338	332	399	-1.8%	20.2%

NA = Not Applicable
Source: Dataquest (January 1992)

TABLE 4
Preliminary Estimated 1991 European Integrated Circuit Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Components	789	802	1.6	802	8.9	8.9
4	2	2	Intel	622	760	22.2	1,562	8.5	17.4
2	3	-1	SGS-Thomson	705	685	-2.8	2,247	7.6	25.0
3	4	-1	Siemens	672	626	-6.8	2,873	7.0	32.0
5	5	0	Texas Instruments	606	598	-1.3	3,471	6.7	38.7
6	6	0	Motorola	553	569	2.9	4,040	6.3	45.0
9	7	2	NEC	387	420	8.5	4,460	4.7	49.7
7	8	-1	Toshiba	405	408	0.7	4,868	4.5	54.2
8	9	-1	National Semiconductor	401	402	0.2	5,270	4.5	58.7
10	10	0	AMD	273	307	12.5	5,577	3.4	62.1
11	11	0	Hitachi	261	305	16.9	5,882	3.4	65.5
13	12	1	Samsung	186	257	38.2	6,139	2.9	68.4
12	13	-1	GPS	187	193	3.2	6,332	2.2	70.6
16	14	2	ITT	121	180	48.8	6,512	2.0	72.6
18	15	3	Mitsubishi	99	149	50.5	6,661	1.7	74.3
17	16	1	Analog Devices	103	136	32.0	6,797	1.5	75.8
15	17	-2	Harris	138	119	-13.8	6,916	1.3	77.1
14	18	-4	Fujitsu	149	117	-21.5	7,033	1.3	78.4
26	19	7	Oki	57	104	82.5	7,137	1.2	79.6
21	20	1	Mietec	84	102	21.4	7,239	1.1	80.7
			North American Others	904	1,001	10.7	8,240	11.2	91.9
			Japanese Others	195	213	9.2	8,453	2.4	94.3
			European Others	393	438	11.5	8,891	4.9	99.1
			Rest of World Others	36	77	113.9	8,968	0.8	100.0
			Total All Companies	8,326	8,968	7.7		100.0	
			Total North American	3,721	4,072	9.4		45.4	
			Total Japanese	1,553	1,716	10.5		19.1	
			Total European	2,830	2,846	0.6		31.7	
			Total Rest of World	222	334	50.5		3.7	

Source: Dataquest (January 1992)

Table 5
Preliminary Estimated 1991 European Bipolar Digital IC Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Texas Instruments	138	128	-7.2	128	25.5	25.5
2	2	0	AMD	86	81	-5.8	209	16.1	41.6
3	3	0	National Semiconductor	73	59	-19.2	268	11.8	53.4
4	4	0	Philips Components	59	55	-6.8	323	11.0	64.4
5	5	0	Motorola	47	43	-8.5	366	8.6	73.0
7	6	1	Siemens	42	36	-14.3	402	7.2	80.2
8	7	1	NEC	26	28	7.7	430	5.6	85.8
6	8	-2	GPS	45	21	-53.3	451	4.2	90.0
9	9	0	Fujitsu	15	9	-40.0	460	1.8	91.8
10	10	0	STC	10	7	-30.0	467	1.4	93.2
11	11	0	Telefunken	7	6	-14.3	473	1.2	94.4
12	12	0	Hitachi	5	5	0.0	478	1.0	95.4
12	13	-1	SGS-Thomson	5	3	50.0	481	0.6	96.0
13	13	0	Toshiba	2	3	-40.0	484	0.6	96.6
13	14	-1	AT&T	2	2	-60.0	486	0.4	97.0
12	14	-2	Raytheon	5	2	0.0	488	0.4	97.4
-	15	NA	IDT	-	1	NA	489	0.2	97.6
14	15	-1	Matsushita	1	1	0.0	490	0.2	97.8
14	15	-1	Mitsubishi	1	1	0.0	491	0.2	98.0
			North American Others	8	5	-37.5	496	1.0	98.8
			European Others	0	6	NA	502	1.2	100.0
			Total All Companies	577	502	-13.0		100.0	
			Total North American	359	321	-10.6		63.9	
			Total Japanese	50	47	-6.0		9.4	
			Total European	168	134	-20.2		26.7	

NA = Not Applicable
Source: Dataquest (January 1992)

TABLE 6
Preliminary Estimated 1991 European MOS Digital IC Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Intel	622	760	22.2	760	12.6	12.6
2	2	0	Siemens	464	438	-5.6	1,198	7.2	19.8
3	3	0	Motorola	391	421	7.7	1,619	7.0	26.8
5	4	1	NEC	357	387	8.4	2,006	6.4	33.2
4	5	-1	Toshiba	374	373	-0.3	2,379	6.2	39.4
7	6	1	Texas Instruments	343	362	5.5	2,741	6.0	45.4
8	7	1	Philips Components	325	338	4.0	3,079	5.6	51.0
6	8	-2	SGS-Thomson	350	314	-10.3	3,393	5.2	56.2
9	9	0	Hitachi	250	292	16.8	3,685	4.8	61.0
10	10	0	Samsung	184	253	37.5	3,938	4.2	65.2
11	11	0	AMD	166	198	19.3	4,136	3.3	68.5
22	12	10	ITT	46	152	230.4	4,288	2.5	71.0
12	13	-1	National Semiconductor	146	148	1.4	4,436	2.4	73.4
16	14	2	Mitsubishi	84	138	64.3	4,574	2.3	75.7
15	15	0	GPS	86	111	29.1	4,685	1.8	77.5
13	16	-3	Fujitsu	130	104	-20.0	4,789	1.7	79.2
20	16	4	Oki	57	104	82.5	4,893	1.7	80.9
17	17	0	LSI Logic	83	100	20.5	4,993	1.7	82.6
18	18	0	Matra-MHS	82	88	7.3	5,081	1.5	84.1
19	19	0	VLSI Technology	74	85	14.9	5,166	1.4	85.5
14	20	-6	Harris	87	60	-31.0	5,226	1.0	86.5
			North American Others	385	456	18.4	5,682	7.5	93.9
			Japanese Others	122	120	-1.7	5,802	2.0	95.8
			European Others	172	188	9.3	5,990	3.1	98.9
			Rest of World Others	23	64	178.3	6,054	1.1	100.0
			Total All Companies	5,403	6,054	12.0		100.0	
			Total North American	2,343	2,742	17.0		45.3	
			Total Japanese	1,374	1,518	10.5		25.1	
			Total European	1,479	1,477	-0.1		24.4	
			Total Rest of World	207	317	53.1		5.2	

Source: Dataquest (January 1992)

TABLE 7
Preliminary Estimated 1991 European MOS Digital Memory IC Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
2	1	1	Samsung	184	247	34.2	247	10.8	10.8
1	2	-1	Toshiba	243	225	-7.4	472	9.8	20.6
1	3	-2	Siemens	243	224	-7.8	696	9.8	30.4
5	4	1	Hitachi	154	184	19.5	880	8.0	38.4
4	4	0	NEC	177	184	4.0	1,064	8.0	46.4
3	5	-2	Texas Instruments	181	171	-5.5	1,235	7.5	53.9
5	6	-1	SGS-Thomson	154	138	-10.4	1,373	6.0	59.9
9	7	2	Mitsubishi	73	120	64.4	1,493	5.2	65.1
7	8	-1	Intel	84	86	2.4	1,579	3.8	68.9
8	9	-1	Motorola	76	74	-2.6	1,653	3.2	72.1
6	10	-4	Fujitsu	99	72	-27.3	1,725	3.1	75.2
10	11	-1	AMD	61	68	11.5	1,793	3.0	78.2
13	12	1	Oki	34	67	97.1	1,860	2.9	81.1
12	13	-1	Micron Technology	46	36	-21.7	1,896	1.6	82.7
15	14	1	Matra-MHS	32	32	0.0	1,928	1.4	84.1
16	15	1	Philips Components	29	31	6.9	1,959	1.4	85.5
17	16	1	Cypress	28	30	7.1	1,989	1.3	86.8
22	16	6	Goldstar	8	30	275.0	2,019	1.3	88.1
14	17	-3	National Semiconductor	33	28	-15.2	2,047	1.2	89.3
19	18	1	Sharp	24	27	12.5	2,074	1.2	90.5
18	19	-1	Sony	26	24	-7.7	2,098	1.0	91.5
20	20	0	IDT	18	22	22.2	2,120	1.0	92.5
			North American Others	67	105	56.7	2,225	4.6	97.2
			Japanese Others	64	28	-56.2	2,253	1.2	98.5
			European Others	5	6	20.0	2,259	0.3	98.7
			Rest of World Others	11	29	163.6	2,288	1.3	100.0
			Total All Companies	2,154	2,288	6.2		100.0	
			Total North American	594	620	4.4		27.1	
			Total Japanese	894	931	4.1		40.7	
			Total European	463	431	-6.9		18.8	
			Total Rest of World	203	306	50.7		13.4	

Source: Dataquest (January 1992)

TABLE 8
Preliminary Estimated 1991 European MOS Digital Microcomponent IC Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Intel	528	663	25.6	663	32.1	32.1
2	2	0	Motorola	233	253	8.6	916	12.2	44.3
3	3	0	NEC	151	167	10.6	1,083	8.1	52.4
4	4	0	SGS-Thomson	126	107	-15.1	1,190	5.2	57.6
6	4	2	Texas Instruments	99	107	8.1	1,297	5.2	62.8
5	5	0	Philips Components	112	103	-8.0	1,400	5.0	67.8
8	6	2	Hitachi	77	87	13.0	1,487	4.2	72.0
7	7	0	Siemens	83	83	0.0	1,570	4.0	76.0
9	8	1	Toshiba	56	63	12.5	1,633	3.0	79.0
11	9	2	AMD	47	58	23.4	1,691	2.8	81.8
10	10	0	National Semiconductor	50	55	10.0	1,746	2.7	84.5
13	11	2	VLSI Technology	28	43	53.6	1,789	2.1	86.6
14	12	2	Matra-MHS	24	29	20.8	1,818	1.4	88.0
15	13	2	ITT	21	23	9.5	1,841	1.1	89.1
-	13	NA	Matsushita	-	23	NA	1,864	1.1	90.2
16	14	2	Oki	19	20	5.3	1,884	1.0	91.2
18	15	3	Zilog	17	19	11.8	1,903	0.9	92.1
12	16	-4	Harris	31	18	-41.9	1,921	0.9	93.0
17	17	0	Western Digital	18	16	-11.1	1,937	0.8	93.8
20	18	2	Mitsubishi	10	15	50.0	1,952	0.7	94.5
19	19	0	Fujitsu	12	11	-8.3	1,963	0.5	95.0
21	20	1	Rockwell	9	9	0.0	1,972	0.4	95.4
22	20	2	TMS	8	9	12.5	1,981	0.4	95.8
			North American Others	64	75	17.2	2,056	3.6	99.5
			Japanese Others	2	3	50.0	2,059	0.1	99.6
			European Others	9	5	-44.4	2,064	0.2	99.9
			Rest of World Others	2	3	50.0	2,067	0.1	100.0
			Total All Companies	1,836	2,067	12.6		100.0	
			Total North American	1,145	1,339	16.9		64.8	
			Total Japanese	327	389	19.0		18.8	
			Total European	362	336	-7.2		16.3	
			Total Rest of World	2	3	50.0		0.1	

NA = Not Applicable
Source: Dataquest (January 1992)

Table 9
Preliminary Estimated 1991 European MOS Digital Logic IC Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Components	184	204	10.9	204	12.0	12.0
2	2	0	Siemens	138	131	-5.1	335	7.7	19.7
14	3	11	ITT	25	124	396.0	459	7.3	27.0
5	4	1	GPS	75	104	38.7	563	6.1	33.1
4	5	-1	LSI Logic	81	96	18.5	659	5.7	38.8
3	6	-3	Motorola	82	94	14.6	753	5.5	44.3
5	7	-2	Toshiba	75	85	13.3	838	5.0	49.3
7	8	-1	Texas Instruments	63	84	33.3	922	4.9	54.2
8	9	-1	AMD	58	72	24.1	994	4.2	58.4
6	10	-4	SGS-Thomson	70	69	-1.4	1,063	4.1	62.5
7	11	-4	National Semiconductor	63	65	3.2	1,128	3.8	66.3
10	12	-2	VLSI Technology	43	42	-2.3	1,170	2.5	68.8
9	13	-4	Harris	53	38	-28.3	1,208	2.2	71.0
12	14	-2	NEC	29	36	24.1	1,244	2.1	73.1
11	15	-4	Austria Mikro Systeme	37	32	-13.5	1,276	1.9	75.0
14	16	-2	ES2	25	30	20.0	1,306	1.8	76.8
13	17	-4	Matra-MHS	26	27	3.8	1,333	1.6	78.4
15	18	-3	Hewlett-Packard	21	23	9.5	1,356	1.4	79.8
15	19	-4	ABB-HAFO	21	21	0.0	1,377	1.2	81.0
16	19	-3	Eurosil	19	21	10.5	1,398	1.2	82.2
16	19	-3	Fujitsu	19	21	10.5	1,419	1.2	83.4
16	19	-3	Hitachi	19	21	10.5	1,440	1.2	84.6
17	19	-2	Mietec	18	21	16.7	1,461	1.2	85.8
19	20	-1	Cypress	13	18	38.5	1,479	1.1	86.9
			North American Others	102	127	24.5	1,606	7.5	94.5
			Japanese Others	11	35	218.2	1,641	2.1	96.5
			European Others	41	50	21.9	1,691	2.9	99.5
			Rest of World Others	2	8	300.0	1,699	0.5	100.0
			Total All Companies	1,413	1,699	20.2		100.0	
			Total North American	604	783	29.6		46.1	
			Total Japanese	153	198	29.4		11.7	
			Total European	654	710	8.6		41.8	
			Total Rest of World	2	8	300.0		0.5	

Source: Dataquest (January 1992)

Table 10
Preliminary Estimated 1991 European Analog IC Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Components	405	409	1.0	409	17.0	17.0
2	2	0	SGS-Thomson	350	368	5.1	777	15.3	32.3
3	3	0	National Semiconductor	182	195	7.1	972	8.1	40.4
4	4	0	Siemens	166	152	-8.4	1,124	6.3	46.7
7	5	2	Analog Devices	97	129	33.0	1,253	5.3	52.0
5	6	-1	Texas Instruments	125	108	-13.6	1,361	4.5	56.5
6	7	-1	Motorola	115	105	-8.7	1,466	4.4	60.9
9	8	1	Mietec	66	81	22.7	1,547	3.4	64.3
10	9	1	Telefunken	65	68	4.6	1,615	2.8	67.1
11	10	1	GPS	56	61	8.9	1,676	2.5	69.6
12	11	1	Harris	51	59	15.7	1,735	2.4	72.0
13	12	1	Burr-Brown	49	43	-12.2	1,778	1.8	73.8
14	13	1	Sony	38	42	10.5	1,820	1.7	75.5
19	14	5	Austria Mikro Systeme	22	38	72.7	1,858	1.6	77.1
16	15	1	Rockwell	32	32	0.0	1,890	1.3	78.4
18	15	3	Toshiba	29	32	10.3	1,922	1.3	79.7
15	16	-1	Ericsson	35	30	-14.3	1,952	1.2	80.9
20	17	3	AMD	21	28	33.3	1,980	1.2	82.1
8	17	-9	ITT	75	28	-62.7	2,008	1.2	83.3
17	18	-1	Allegro Microsystems	30	24	-20.0	2,032	1.0	84.3
21	19	2	Siliconix	18	18	0.0	2,050	0.7	85.0
24	20	4	Sanyo	13	16	23.1	2,066	0.7	85.7
			North American Others	224	240	7.1	2,306	10.0	95.6
			Japanese Others	57	61	7.0	2,367	2.5	98.1
			European Others	18	28	55.5	2,395	1.1	99.3
			Rest of World Others	15	17	13.3	2,412	0.7	100.0
			Total All Companies	2,346	2,412	2.8		100.0	
			Total North American	1,019	1,009	-1.0		41.8	
			Total Japanese	129	151	17.1		6.3	
			Total European	1,183	1,235	4.4		51.2	
			Total Rest of World	15	17	13.3		0.7	

NA = Not Applicable
Source: Dataquest (January 1992)

Table 11
Preliminary Estimated 1991 European Discrete Semiconductor Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Philips Components	340	340	0.0	340	17.8	17.8
3	2	1	SGS-Thomson	203	202	-0.5	542	10.6	28.4
4	3	1	Siemens	202	198	-2.0	740	10.4	38.8
2	4	-2	Motorola	208	197	-5.3	937	10.3	49.1
6	5	1	Eupec	78	89	14.1	1,026	4.7	53.8
7	6	1	International Rectifier	69	73	5.8	1,099	3.8	57.6
8	7	1	Semikron	66	67	1.5	1,166	3.5	61.1
10	8	2	Toshiba	56	66	17.9	1,232	3.5	64.6
11	9	2	Telefunken	54	62	14.8	1,294	3.2	67.8
9	10	-1	General Instrument	65	61	-6.2	1,355	3.2	71.0
5	11	-6	ITT	111	60	-45.9	1,415	3.1	74.1
13	12	1	ABB-IXYS	47	47	0.0	1,462	2.5	76.6
12	13	-1	Powerex	50	37	-26.0	1,499	1.9	78.5
14	14	0	Mitsubishi	36	29	-19.4	1,528	1.5	80.0
15	15	0	GPS	30	28	-6.7	1,556	1.5	81.5
16	15	1	Harris	24	28	16.7	1,584	1.5	83.0
16	16	0	NEC	24	27	12.5	1,611	1.4	84.4
20	17	3	Fujitsu	20	24	20.0	1,635	1.3	85.7
17	18	-1	Siliconix	23	23	0.0	1,658	1.2	86.9
18	19	-1	Fagor	22	20	-9.1	1,678	1.0	87.9
19	19	0	Texas Instruments	21	20	-4.8	1,698	1.0	88.9
20	20	0	TAG	20	19	-5.0	1,717	1.0	89.9
			North American Others	51	44	-13.7	1,761	2.3	92.1
			Japanese Others	67	68	1.5	1,829	3.6	95.7
			European Others	20	73	265.0	1,902	3.8	99.6
			Rest of World Others	8	8	0.0	1,910	0.4	100.0
			Total All Companies	1,915	1,910	-0.3		100.0	
			Total North American	622	543	-12.7		28.4	
			Total Japanese	203	214	5.4		11.2	
			Total European	1,082	1,145	5.8		59.9	
			Total Rest of World	8	8	0.0		0.4	

NA = Not Applicable
Source: Dataquest (January 1992)

TABLE 12
Preliminary Estimated 1991 European Optoelectronics Semiconductor Rankings

1990 Rank	1991 Rank	Change in Rank	Ranked Companies	1990 Sales ($M)	1991 Sales ($M)	1990-91 Annual Growth (%)	1991 Cum. Sum ($M)	1991 Market Share (%)	1991 Cum. Sum (%)
1	1	0	Siemens	90	134	48.9	134	27.5	27.5
2	2	0	Telefunken	68	75	10.3	209	15.4	42.9
3	3	0	Hewlett-Packard	61	53	-13.1	262	10.9	53.8
4	4	0	Toshiba	29	35	20.7	297	7.2	61.0
5	5	0	Philips Components	26	30	15.4	327	6.1	67.1
6	6	0	Honeywell	20	20	0.0	347	4.1	71.2
12	7	5	Sharp	4	15	275.0	362	3.1	74.3
7	7	0	TMS	14	15	7.1	377	3.1	77.4
8	8	0	Texas Instruments	10	11	10.0	388	2.3	79.7
9	9	0	AT&T	8	8	0.0	396	1.6	81.3
9	9	0	Matsushita	8	8	0.0	404	1.6	82.9
10	10	0	ABB-HAFO	6	7	16.7	411	1.4	84.3
11	11	0	Fujitsu	5	6	20.0	417	1.2	85.5
12	12	0	Hitachi	4	5	25.0	422	1.0	86.5
10	12	-2	NEC	6	5	-16.7	427	1.0	87.5
12	13	-1	Motorola	4	4	0.0	431	0.8	88.3
12	14	-2	Harris	4	3	-25.0	434	0.6	88.9
13	14	-1	Sanyo	2	3	50.0	437	0.6	89.5
14	15	-1	Zetex	1	2	100.0	439	0.4	89.9
-	16	NA	Mitsubishi	-	1	NA	440	0.2	90.1
-	16	NA	Rohm Electonics	-	1	NA	441	0.2	90.3
			North American Others	42	29	-31.0	470	5.9	96.3
			European Others	0	10	NA	480	2.0	98.4
			Rest of World Others	8	8	0.0	488	1.6	100.0
			Total All Companies	420	488	16.2		100.0	
			Total North American	149	128	-14.1		26.2	
			Total Japanese	58	79	36.2		16.2	
			Total European	205	273	33.2		55.9	
			Total Rest of World	8	8	0.0		1.6	

NA = Not Applicable
Source: Dataquest (January 1992)

Table 13
Preliminary Estimated 1991 Worldwide Total Semiconductor Rankings of European-Owned Suppliers
(Millions of US Dollars)

Company	Sales 1990	World Rank 1990	Sales 1991	World Rank 1991	Growth 1990-91	Change in Rank 1990-91
Philips	$2,011	9	$2,072	10	3.0%	-1
SGS-Thomson	1,463	12	1,490	15	1.8%	-3
Siemens	1,227	16	1,250	17	1.9%	-1
GPS	390	26	402	29	3.1%	-3
Telefunken	295	31	304	32	3.1%	-1
Eupec	96	62	109	58	13.5%	4
Semikron	106	59	108	57	1.9%	2
Mietec	92	63	105	62	14.1%	1
Matra-MHS	100	60	104	64	4.0%	-4
AMS	59	80	70	79	18.6%	1
Ericsson	56	84	65	83	16.1%	1
ABB-IXYS	58	82	54	86	-6.9%	-4
TMS	45	93	51	89	13.3%	4
Eurosil	39	100	44	95	12.8%	5
ABB-HAFO	42	97	38	98	-9.5%	-1
ES2	27	114	34	104	25.9%	10
TAG	25	117	31	108	24.0%	9
Fagor	30	109	29	112	-3.3%	-3
Zetex	24	118	26	118	8.3%	0
STC	24	119	18	125	-25.0%	-6

Source: Dataquest (January 1992)

TABLE 14
Preliminary Estimated 1991 European Semiconductor Shipments by Product Category by Supplier Base Region

Product Sector	NA	Jap.	Eur.	A/P	Total
Total Semiconductor	**41.7%**	**17.7%**	**37.5%**	**3.1%**	**100.0%**
Total Integrated Circuit	45.4%	19.1%	31.7%	3.8%	100.0%
Bipolar Digital	63.9%	9.4%	26.7%	0.0%	100.0%
Bipolar Memory	55.3%	27.7%	17.0%	0.0%	100.0%
Bipolar Microcomponent	100.0%	0.0%	0.0%	0.0%	100.0%
Bipolar Logic	63.1%	7.8%	29.1%	0.0%	100.0%
MOS Digital	45.3%	25.1%	24.4%	5.2%	100.0%
MOS Memory	27.1%	40.7%	18.8%	13.4%	100.0%
MOS Microcomponent	64.8%	18.8%	16.3%	0.1%	100.0%
MOS Logic	46.1%	11.7%	41.8%	0.4%	100.0%
Analog	41.8%	6.3%	51.2%	0.7%	100.0%
Discrete	28.4%	11.2%	59.9%	0.5%	100.0%
Optoelectronic	26.2%	16.2%	55.9%	1.7%	100.0%

NA = North American Companies
Jap. = Japanese Companies
Eur. = European Companies
A/P = Asia/Pacific Companies
Source: Dataquest (January 1992)