SEMICONDUCTORS APPLICATION MARKETS EUROPE
Volume I

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January - December 1994 February 10, 1995

How to Use This Index

This is the 1994 index of key industry terms, companies, and products for *I.C. Europe*. Entries are followed by the month of publication and the page number(s). Product names are listed under the company that manufactures or publishes the product. General information about a company itself is found under the full company name. Each citation indicates only the beginning page of a discussion of a topic (the range of page numbers is not cited).

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Dataquest

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December 2, 1994

Dear Client

I.C. Europe—November 1994, ICEE-EU-NL-9411

Due to a printing error, several pages were transposed in the copy of this document that has just been mailed to you. Enclosed here is a corrected version. Please discard the earlier version. We apologise for any inconvenience.

Your sincerely

For Document Production

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I.C. EUROPE

A Monthly Report on European High Technology Industries

November 1994

In This Issue

I.C. Europe is a monthly report on European high-technology industries. The information is compiled and published by Dataquest's UK-based European Semiconductor Group research team with contributions from Paris, San Jose, and Tokyo.

State of the Industry

The WSTS flash three-month average bookings for the month of October were $1,816 million. This represents the 26th consecutive billion-dollar booking month and the highest level of bookings seen in this current boom period. This preliminary figure shows a 3.7 percent rise on the final level for September.

The three-month average billings for October were $1,740 million, resulting in a book-to-bill ratio of 1.04. This has increased by 6 percent from September's level, which was a record-ever billings value of $1,646 million. Figure 1 illustrates the 3-month average bookings and billings in Europe; and the book-to-bill ratio for the last 13 months.

The 3-month and 12-month average growths for bookings and billings are shown in Figures 2 and 3 respectively. The 12-month average growth in bookings has turned upwards again over the past few months, following the shorter-term 3-month trend. The 12-month line is now moving towards 28 or 29 percent above the level reached in 1993. Considering that the level in 1993 was more than 40 percent ahead of 1992 illustrates both the strength and length of the current boom.

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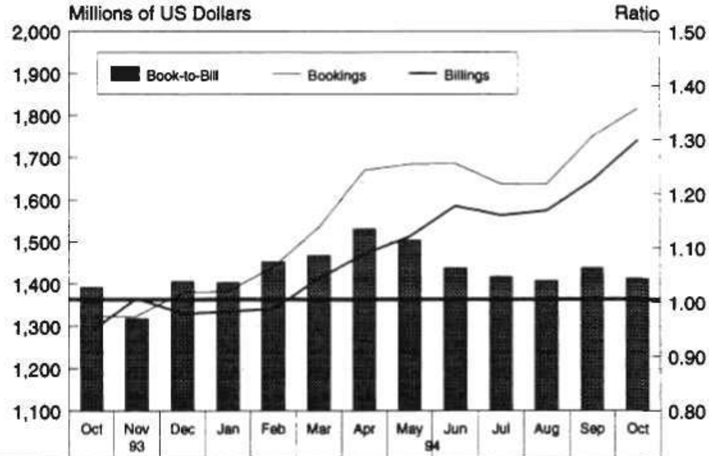
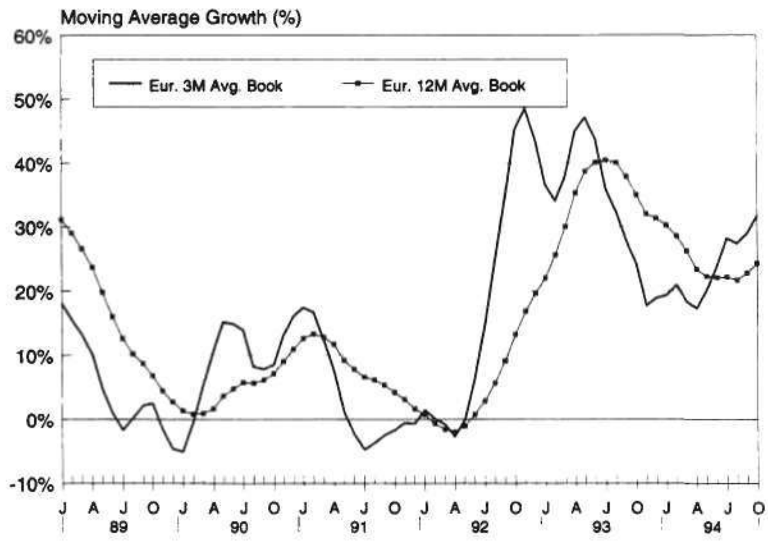
Figure 1
European Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Oct	Nov 93	Dec	Jan	Feb	Mar	Apr	May 94	Jun	Jul	Aug	Sep	Oct
Book-to-Bill	1.03	0.97	1.04	1.04	1.07	1.09	1.14	1.11	1.06	1.05	1.04	1.06	1.04
Bookings	1,324	1,324	1,380	1,382	1,440	1,535	1,670	1,684	1,685	1,637	1,636	1,750	1,816
Billings	1,289	1,366	1,330	1,335	1,341	1,413	1,471	1,512	1,585	1,563	1,574	1,646	1,740

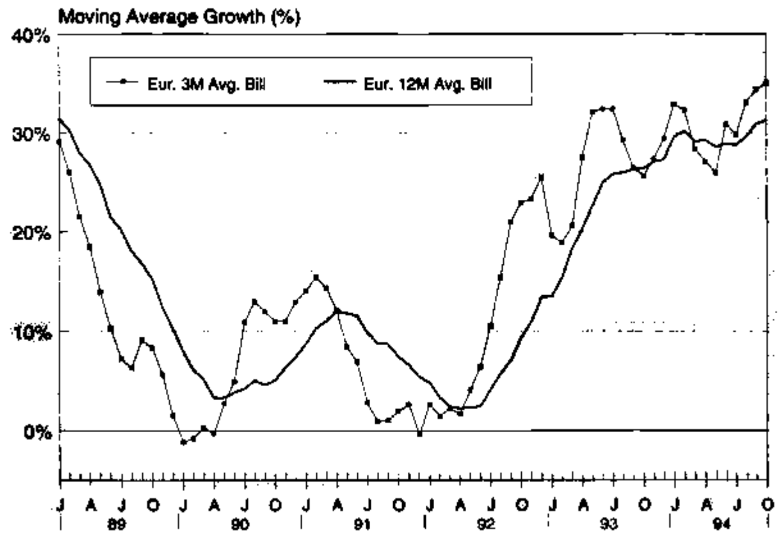
Note: Last two months are preliminary.
Source: WSTS, SIA

Figure 2
European Total 3-Month and 12-Month Semiconductor Bookings Growth



Source: WSTS, SIA, Dataquest (November 1994)

Figure 3
European Total 3-Month and 12-Month Semiconductor Billings Growth



Source: WSTS, SIA, Dataquest (November 1994)

Order books for the first quarter of 1995 are now almost full, and there seems to be no reduction in the strength of demand from equipment manufacturers.

Billings are also showing strong upwards growth, with the 12-month line breaking 30 percent during September. Currently, the 12-month growth suggests that 32 or 33 percent may be the outlook for the end of year.

Dataquest Perspective

The trend for the semiconductor market in Europe seems to be a never-ending increase in strength as 1994 progresses. Dataquest expects the final quarter of the year to be the strongest so far; thus, growth should accelerate as the year draws to an end. Clearly, the health of PC sales is a vital component in the demand for semiconductors during the fourth quarter, with the traditionally strong Christmas demand sure to push PC vendors towards building as many machines as possible. We have already seen some sub-$2,000 Pentium-based PCs in Europe, and this is sure to push a new wave of users to upgrade from 386 and 486SX machines.

Dataquest expects another good year for semiconductor demand in 1995—though not as strong as 1993 or 1994. Windows 95, the next Windows single-user package, should be delivered by the middle of the year, although Dataquest expects that large-volume demand may not happen until 1996.

Other segments are also strengthening in Europe—especially automotive and consumer. Demand for new cars is set to grow in Europe this year, after a couple of years of decreasing sales. The new wave of digital consumer equipment should burst onto the scene in the next two years, and European producers are well situated to take advantage of this surge. Mobile telecommunications will also continue its rapid growth, with Europe maintaining its center of excellence in production.

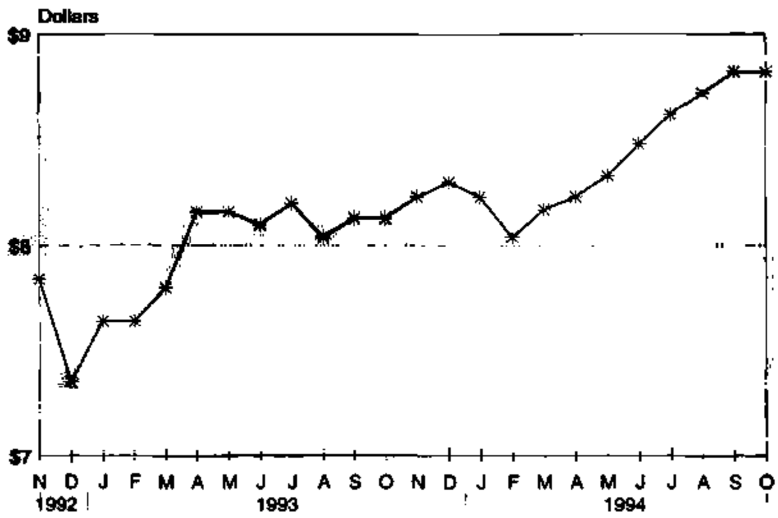
Historical Pricing Trends

This section of I.C. Europe *looks at historical pricing trends for a key semiconductor component; this month the focus is on 1M SRAM (128K×8).*

The 1M slow (greater than 70ns) SRAM was launched in 1989, at a time when the semiconductor market was in recession. The slower-speed SRAMs form the majority of demand for individual densities, and the 1M SRAM is expected to be no exception. However, there is a definite trend towards higher speeds, and the actual share that slow SRAMs represent of total SRAM will decline.

Figure 4 illustrates the price trends for 1M SRAM since November 1992. The price has increased gradually since this time, totalling a 14 percent price rise. There are a number of reasons behind this rise.

Figure 4
Historical Pricing Trends in Europe
128K×8 SRAM 70ns (100,000 Units Minimum Price)



Source: Dataquest (November 1994)

One reason is that the switchover from 256K to 1M has been delayed. This delay was caused by the launch time of the 1M corresponding with a downturn in demand, and the slow acceptance of the 1M from SRAM users. Suppliers of 256K devices have been plentiful and competition has been strong, keeping prices very competitive. Typical users of slow SRAM produce equipment with long life cycles, so the need to upgrade is mostly driven by bit price. The 256K has been the better bit price, so users have moved up slowly to the 1M.

Knock-on effects from DRAM shortages have also affected the price of the 1M SRAM. Suppliers of DRAM and SRAM have moved production on 0.8 µm lines from SRAM (1M) to DRAM (4M) since the average selling price (ASP) and, therefore, profit is higher. This has produced shortages for 1M SRAMs.

From a low base, Dataquest is seeing demand increase for the 1M slow device from many areas. Typically, this is from consumer applications, and there are definite signs of recovery in the sector. This will inevitably lead to further shortages as users increase their demands.

Semiconductor Pricing and Analysis

Table 1 shows European semiconductor booking trends for orders of 1,000 and 10,000 and volume orders.

Standard Logic

There are no significant changes in standard logic. The main difference is that the shortage appears to be finally over, with lead times near four to six weeks for small-outline (SO) and PDIP packages.

Analog

There are no changes in analog prices or lead times.

Microcomponents

Prices given for Pentium processors continue to be evasive, and we believe that a large percentage of Pentium shipments are on boards. We anticipate strong price declines for the Pentium, as the competition for the x86 socket is increasing. SGS-Thomson is now promoting its 486 family of products in Europe, joining the other suppliers.

PowerPC pricing is also unchanged, but demand is still strong. The main customer is Apple, of course, and demand for the PowerMac should increase as Christmas approaches.

Memory

The memory market continues its remarkable growth, with the order books of many suppliers filling up for the first quarter of 1995. Business levels are still running ahead of production on key 4M DRAM devices, and the complete 16M DRAM family. Supply restraints on SRAM devices are adding to delivery problems, and the high-speed market competition is fierce. Nonvolatile business levels seem strong, especially for flash memory.

DRAM

Supply is still lagging behind demand for the DRAM families as a whole. Suppliers are adding capacity now, especially for the 16M part, in an effort to keep pace with the still booming demand from the electronic data processing sector.

The 1M DRAM demand is beginning to fall away as the vast majority of users have upgraded to either 4M and 16M. The residual demand is typically in telecoms equipment, which has equipment life cyles greater than 10 years.

The 4M density continues to be the DRAM powerhouse in terms of business levels. PC producers are continuing to demand large quantities, especially for fourth-quarter production ahead of the expected Christmas rush.

Bit pricing crossover for some types of 16M have been reached, and mainstream users are now increasing their demand. The key issue for many PC producers is the availability of ×8 and ×16 devices for modules because of granularity issues. Many producers wish to upgrade in blocks of 4MB in each module, and the best solution is two pieces of 1M×16 DRAM. However, these devices are in short supply, and this situation is likely to continue throughout 1995. Dataquest estimates that ×16 production will represent only 20 percent of the volume shipments from suppliers through 1995, although many are trying to increase ×16 output as fast as possible.

SRAM

The SRAM market is still buoyant, with users still seeking low pricing where available. The mainstream slow SRAM market (greater than 70ns) is a target for newer entrants to the SRAM market from Korea and Taiwan, whereas the fast devices are being looked at by US and Japanese suppliers. Dataquest expects delivery situations to worsen, especially for 1M SRAM as the year draws to an end.

Flash

Flash pricing is reducing continually, and delivery problems are a thing of the past. Competition to Intel and AMD is still relatively limited, but Dataquest expects this to change dramatically in the next two years.

EPROM

EPROM business levels are stable apart from product mix changes. The life of the EPROM market is now limited, as flash begins to eat away at design slots. However, Dataquest still expects some growth in the European market next year.

Table 1
European Semiconductor Pricing October 1994
All Prices in US Dollars (including import duty where relevant)

Product	Package	Units	No. Price	Volume (percent)	10K Adder (percent)	Lead Time 1K Adder (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.46	10%	15%	8-10
74F244	PDIP	100K	0.29	10%	15%	4-6
Analog						
78L05	TO92	100K	0.16	10%	10%	16-24
Microcomponents						
80386DX-40	PQFP	5K	20.00	0%	10%	2-6
80486SX-25	PQFP	5K	18.00	0%	5%	4
80486DX-33	CPGA	5K	220.00	-5%	5%	4-6
Pentium P5-60		5K	550.00	-5%	15%	4-16
Power PC601		5K	280.00	-5%	10%	4-6
DRAM						
1M×1-70 (1M)	SOJ	100K	4.90	5%	15%	18
1M×4-60 (4M)	SOJ	100K	13.30	5%	15%	12-14
4M×1-60 (4M)	SOJ	100K	13.30	5%	15%	12-16
512K×8-70 (4M)	SOJ	100K	15.30	5%	15%	12-16
256K×16-70 (4M)	SOJ	100K	15.40	5%	15%	18
4M×4-70 (16M)	SOJ	10K	53.50	0%	15%	12-16
2M×8-70 (16M)	SOJ	10K	63.00	0%	15%	18
1M×16-60 (16M)	SOJ	10K	63.00	0%	15%	18
(1M×4)×8-80 (4M)	SIMM	50K	110.00	5%	15%	16
128×8-80 VRAM	SOJ	100K	6.90	5%	15%	12
Flash						
2M-17 (256K×8)	PDIP	10K	10.50	0%	30%	14
4M-17 (512K×8)	PDIP	10K	14.35	0%	30%	16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	4.90	10%	20%	14-16
SRAM						
256K-25 (64K×4)	PDIP	20K	4.00	5%	15%	12
1M-20 (128K×8)	PDIP	20K	14.40	5%	15%	14
1M-70 (128K×8)	PDIP	50K	9.15	5%	10%	14

Source: Dataquest (November 1994 Estimates)

Current Exchange Rates

1 US dollar =
- 0.623 pounds
- 1.529 deutsche marks
- 5.258 French francs
- 0.804 ECU

Industry Highlights

Researchers and analysts in Dataquest's European Semiconductor Group routinely gather intelligence on the European semiconductor market. Some of this information is published electronically on a weekly basis via Dataquest's Semiconductor On-line Service DQ-Monday. The following key European industry events review the past four weeks, and are selected on the basis of their perceived industry impact.

SGS-Thomson Joint Venture in China

SGS-Thomson is set to form a joint venture with China's ShenZhen SEG High Tech Industrial (SHC) to invest $77 million to set up a design and assembly operation in Futian free-trade zone of Shenzen in south China. The joint venture is to be named SGS-Thomson-SEG (STS), with SGS-Thomson holding 60 percent of the operation. ShenZhen SEG High Tech Industrial is part of ShenZhen Electronics Group (SEG), which is owned and controlled by the municipal government of ShenZhen on the mainland of China close to Hong Kong.

Construction of the 24,000 m^2 plant will start before the end of this year, with test and assembly starting in early 1996. When fully operational, the plant will handle up to 1 million parts a day.

This is the first time that SGS-Thomson has set up a joint venture where a separate legal entity will be formed. SGS-Thomson says it has no plans to set up a fab in China in the short or medium term. There will be 20 design engineers to service the Chinese market with custom and semi-custom parts.

ES2 in 0.5-micron Deal with Siemens

European Silicon Structures (ES2) and Siemens has signed a licensing deal that will allow ES2 to use Siemens' 0.5 µm CMOS manufacturing process, which was developed under a JESSI program. ES2 will be able to refine its CMOS process by adding a third metal layer onto the devices. The first Siemens process devices are expected in the second half of 1995 and will be manufactured at Rousset in France.

Samsung Invests $700 Million in Europe

Samsung has announced that it is to make an initial investment of $700 million for a facility to manufacture microwave ovens and color monitors at Wynyard in the United Kingdom. A second phase will include facilities for color-picture tubes, PCs and semiconductor production.

Phase one will see the construction of a monitor plant with a capacity of 1 million sets a year and a second plant with a capacity of 1.3 million microwave ovens a year. Production is scheduled to start in August 1995. Samsung will also expand its current TV production facility in nearby Teesside, where it produced 700,000 sets in 1993. The second phase will include a fax plant with production quantity 250,000 a year, picture-tube plant with a capacity of 3 million a year, and a 8-inch semiconductor facility.

Although semiconductor fab construction is scheduled in phase two, plans have not been finalized clearly yet. This would be the first wafer fabrication plant for a Korean company in Europe. With Samsung's traditional strength in memory (especially DRAMs), the plant may be developed to produce 16M and 64M DRAMs, and possibly SRAMs or nonvolatile memory.

When both phases are completed by 1999, the plants should generate $2 billion in turnover. Samsung will establish its R&D and training centers within the base.

Samsung is believed to have been granted in the region of $90 million in regional grants and loans, together with indirect aid; the support is equivalent to 20 percent of Samsung's investment.

News Round-Up

Philips has announced its third-quarter results for the period ending September 1994, with the first three quarters up 2 percent over the same period in 1993, or 6 percent disregarding the effects of consolidation changes and exchange rate movements. The components and semiconductor sector reports a 18 percent growth on the back of strong semiconductor and picture-tube demand. Philips also gained approximately $42 million from the partial flotation of Taiwan Semiconductor Manufacturing Company.

Siemens AG's earnings have fallen 17 percent to $1.09 billion from a year earlier. Sales and orders in Germany were weak, but worldwide group sales rose 3.5 percent. Higher-than-expected costs to cover job cuts dragged earnings down.

Philips Composants of Caen, France is to move over to mini-environment cleanrooms. An order for $4.2 million has been placed with Asyst for automated mini-environmental systems to make bipolar and MOS devices of 6-inch wafers.

Texas Instruments has sold its memory test and assembly operation in Rieti, Italy to EEMS SpA. The plant will continue to package chips for Texas instruments.

Finnish chip maker **Micronas** is to establish a test facility in Glenrothes, Scotland at a cost of just under $3 million. The company will use the Scottish facility for testing telecommunications devices manufactured in Switzerland.

SGS-Thomson has announced plans to raise up to $480 million through the issue of shares on the New York and Paris stock exchanges. Under the terms of the issue, 21 million shares will be offered. Just over 13.6 million will be offered to investors in the United States and Canada, with the balance being offered in other countries. The shares are to be priced at between $21 and $23 each.

The French has launched its privatization of **Bull**. A statement from the French economy minister and industry minister said that the goverment's objective was to give Bull a "private, coherent and stable" shareholding structure which would allow it to strengthen its industrial strategy.

So far **NEC**, which holds 4.4 percent of Bull, has said that it wants to increase its stake, while **AT&T** is offering to invest in Bull with a local partner, **Quadral SA**, owner of the electronics concern Cie. des Signaux et d'Equipments Electroniques. They would jointly invest up to 40 percent of Bull.

Smart Modular Technologies, a US developer of memory modules, is to set up a factory in the United Kingdom next year with an investment of about $2 million. "We will begin manufacturing memory modules to start with, then memory cards and then more complex devices like communication products—fax modems and so on," said John Walsh, general manager of Smart Modular Technologies Europe.

Nokia is investing $39 million in its cellular phone manufacturing location in Salo, Finland.

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I.C. EUROPE

A Monthly Report on European High Technology Industries

October 1994

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State of the Industry

The WSTS flash three-month average bookings for the month of September were $1,705 million. This is a 4.2 percent growth over last month's restated $1,638 million. Actual billings for September were $1,932 million, a 28 percent rise on August's restated $1,511 million. The massive rise in billings is typical for September, as it is the last month of a quarter.

The three-month average book-to-bill ratio has recovered slightly from August's 1.04. This is unusual for this time of year, as all the indicators suggested the ratio was heading downwards, and was likely to fall below 1 in October or November. We still believe this is the case, and we expect September's data to be restated to reflect the underlying return to seasonality in the bookings and billings data. The unexpected rise in bookings has contributed to the rise in the ratio: bookings normally fall in September. Figure 1 shows the past 13 months' bookings and billings, and the book-to-bill ratio for the European semiconductor market.

Despite the rise in book-to-bill ratio we still believe the market is returning to more normal behavior. The flash data are often restated, and we expect that this month's data will be no exception. The underlying

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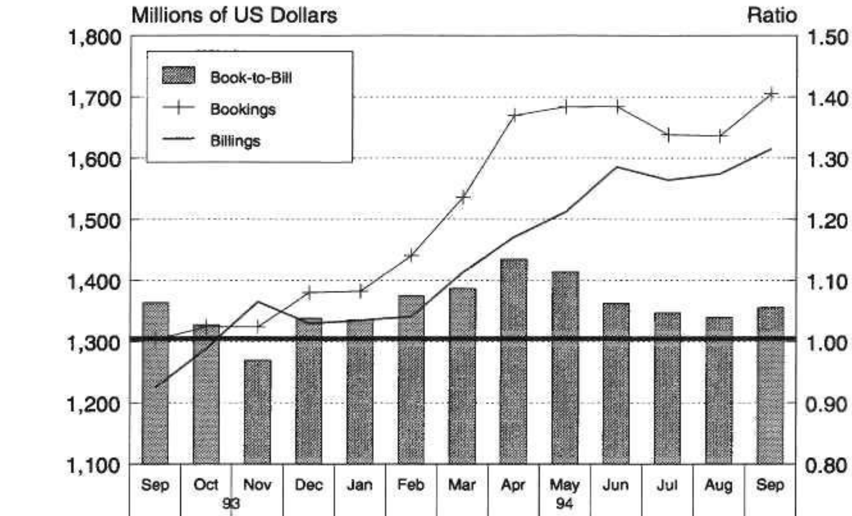
Figure 1
European Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Book-to-Bill	1.06	1.03	0.97	1.04	1.04	1.07	1.09	1.14	1.11	1.06	1.05	1.04	1.06
Bookings	1,303	1,324	1,324	1,380	1,382	1,441	1,536	1,670	1,684	1,684	1,638	1,636	1,705
Billings	1,225	1,289	1,365	1,330	1,335	1,341	1,413	1,471	1,512	1,585	1,564	1,574	1,615

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

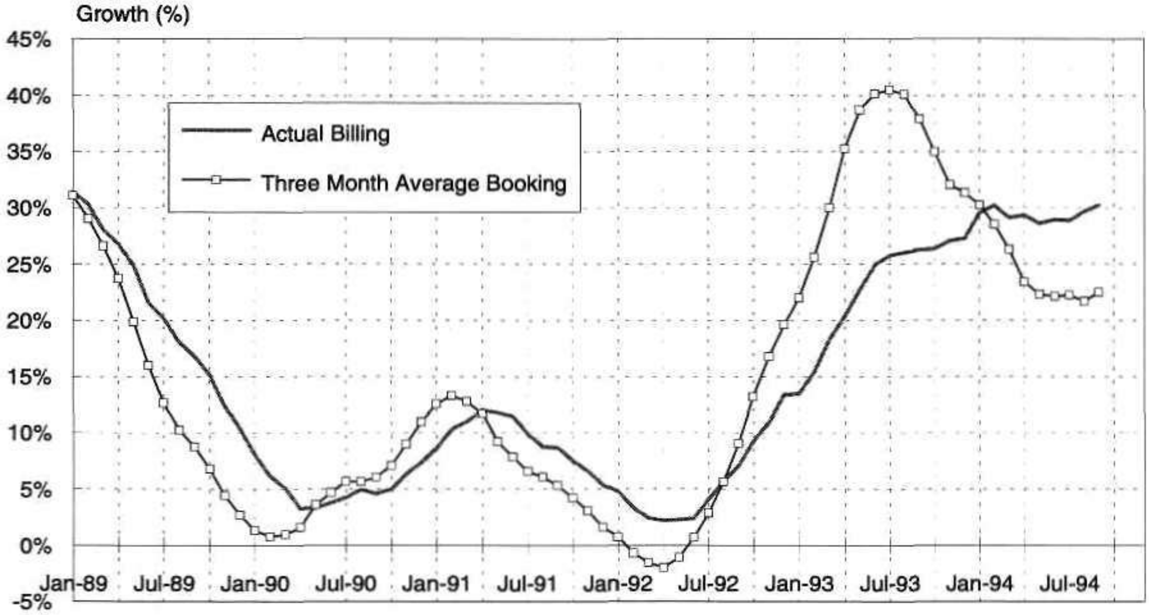
growth is showing remarkable stability (see Figure 2). Average billings growth is settling at about 30 percent, and bookings growth is settling at about 22 percent. Billings are able to maintain growth ahead of bookings because of the higher bookings growth seen at the end of 1993.

The stability is related to strong demand and a reasonable shortfall in capacity. This shortfall is continuing to lift prices, which causes an apparent increase in demand. In the longer term, though, the capacity limitations will be overcome, as suppliers build new plants. When this happens, prices will fall, giving a negative effect on market growth. We expect capacity to approach demand in the third to fourth quarters of 1995.

In applications, the PC is still driving the recovery, but demand is increasing in the consumer segment. There appears to be an improvement in consumer confidence—and this is resulting in improved sales in this application. This is apparent in the component sector in increased analog and discrete sales. However, much of the growth in discrete products is again because of the rise in average prices. Discrete, too, is suffering from component shortages, and the price rises associated with this.

At the regional level, the United Kingdom is benefiting from the strong PC sector, but Germany is also showing very strong growth. The growth is especially strong in discretes and optoelectronics.

Figure 2
European Total Semiconductor Rolling Average Growth (Three-Month Average)



Source: WSTS, SIA

Dataquest Perspective

How long can this recovery continue? Much of the growth is related to price increases, with the average price across all components rising from, typically, 40 cents to nearly 60 cents over a period of about two years. This is adding about 15 percentage points to growth per year. The remainder is from unit growth. Unit growth is a truer reflection of underlying demand, and price increases suggest a mismatch between supply and demand.

Additional capacity is being put in place, and this should begin to have an effect on the market by mid-1995. When this occurs, of course the effect will be to reduce prices and push market growth down. Whether this decline is sufficient to overcome unit demand growth and drop the dollar growth to zero remains to be seen, but we believe that growth in Europe will be about 18 percent for 1995.

The stranglehold that the PC has had on the market may be slipping as consumer demand improves. This is after a long, fallow period for consumers, and will be a welcome return for companies such as Philips and SGS-Thomson. Demand is still for mainstream products such as TV sets and video recorders, but this is for high-end products which are rich in features such as stereo sound and video-plus programmers.

Historical Pricing Trends

This section of I.C. Europe *looks at historical pricing trends for a key semiconductor component; this month the focus is on the 256K × 16 DRAM 80ns.*

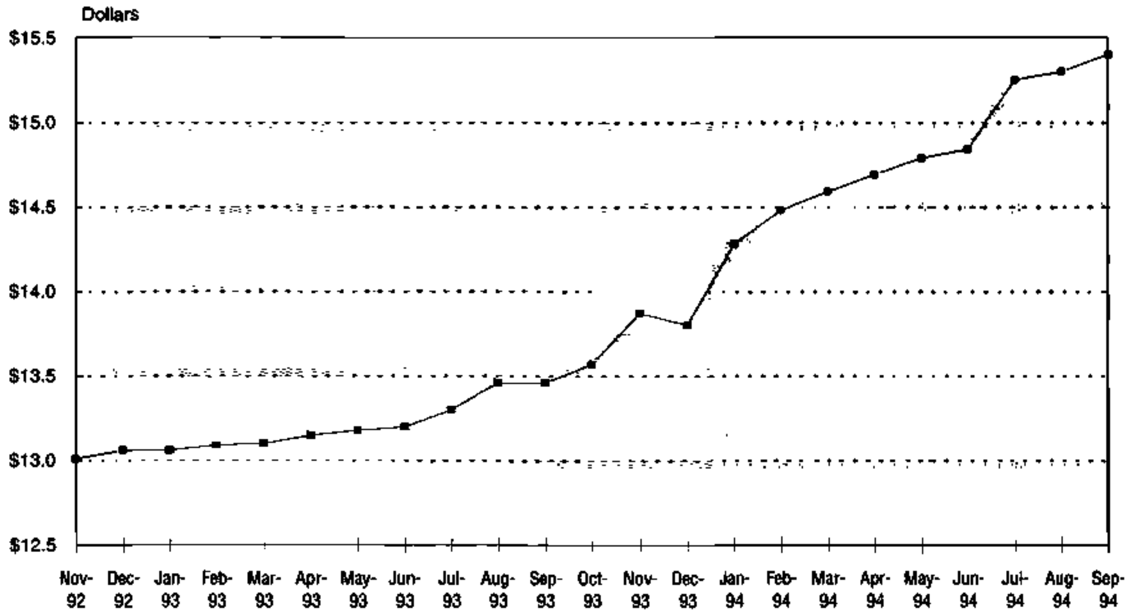
The largest volume shipments ever seen in the DRAM market have been recorded during 1994 for the 4M DRAM. The 4M has taken advantage of the rapid rise to health of the PC market from late 1992, and has ridden the demand wave ever since. Average selling prices (ASPs) have been flat or rising since then, and demand for 4M has easily outstripped production levels.

The 4M generation has also been successful because of the great variety of devices available. In the mid-1980s the 64K DRAM, then in the cycle of volume shipments, had only 4 variations. The 4M currently has more than 300 different choices combining different packages, voltages and access times. However, within the many devices, there is a definite trend towards wider-organization devices.

The 256K×16 device is currently in volume production and demand is growing very quickly. Many system designers are using the parts in video subsystems and also for main memory in PCs; and as the end market for PCs is so strong at the moment, demand is running a long way ahead of demand. Even with the rapid production increases being seen from many DRAM suppliers, Dataquest expects that there will be undersupply for the part for most of 1995.

Figure 3 illustrates the historical pricing for the device since late 1992. With very few exceptions, there has been a constant rise in ASPs in Europe. The device has appreciated by 18 percent in this time frame, and Dataquest feels that the price for the device will continue to rise for at least the next three quarters.

Figure 3
Historical Pricing Trends in Europe
256K×16 DRAM 80ns (100,000 Minimum Price)



Source: Dataquest (October 1994 Estimates)

Semiconductor Pricing and Analysis

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

Standard Logic

There are no significant changes in standard logic. The main difference is that the shortage appears to be finally over, with lead times near four to six weeks for small-outline (SO) and PDIP packages.

Analog

There are no changes in analog prices or lead times.

Microcomponents

This month sees the introduction of the Pentium P5 and the PowerPC601. This brings the processor price tracking more up to date with current demand.

Prices for the Pentium are difficult to find, with prices ranging from $350 to more than $600. We believe that the average price is nearer $550 for the component, but this is likely to fall dramatically in the short term.

Table 1
European Semiconductor Pricing September 1994
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (percent)	1K Adder (percent)	Lead Time (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.46	10%	15%	8-10
74F244	PDIP	100K	0.29	10%	15%	4-6
Analog						
78L05	TO92	100K	0.16	10%	10%	16-24
Microcomponents						
80386DX-40	PQFP	5K	20.00	0%	10%	2-6
80486SX-25	PQFP	5K	18.00	0%	5%	4
80486DX-33	CPGA	5K	220.00	-5%	5%	4-6
Pentium P5-60		5K	550.00	-5%	15%	4-16
Power PC601		5K	280.00	-5%	10%	4-6
DRAM						
1M×1-70 (1M)	SOJ	100K	4.90	5%	15%	18
1M×4-60 (4M)	SOJ	100K	13.30	5%	15%	12-16
4M×1-60 (4M)	SOJ	100K	13.30	5%	15%	12-16
512K×8-70 (4M)	SOJ	100K	15.20	5%	15%	12-16
256K×16-70 (4M)	SOJ	100K	15.30	5%	15%	18
4M×4-70 (16M)	SOJ	10K	54.30	0%	15%	12-16
2M×8-70 (16M)	SOJ	10K	63.00	0%	15%	18
1M×16-60 (16M)	SOJ	10K	63.00	0%	15%	18
(1M×4)×8-80 (4M)	SIMM	50K	110.00	10%	15%	16
128×8-80 VRAM	SOJ	100K	6.80	5%	15%	12
Flash						
2M-17 (256K×8)	PDIP	10K	10.70	0%	30%	14-16
4M-17 (512K×8)	PDIP	10K	14.45	0%	30%	14-16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	4.90	10%	20%	14-16
SRAM						
256K-25 (64K×4)	PDIP	20K	4.05	5%	15%	12
1M-20 (128K×8)	PDIP	20K	14.50	5%	15%	14
1M-70 (128K×8)	PDIP	50K	9.10	5%	10%	14

Source: Dataquest (October 1994 Estimates)

Intel has just announced a 75-MHz Pentium, and this is expected to sell at about $350—although this price estimate is based on information from an unconfirmed source.

PowerPC sales are continuing well—especially considering that the price is considerably lower than Intel's Pentium. The real battle for processor market share is likely to be limited to these two suppliers, with the remainder fighting among themselves for what is left of the market. However, many suppliers are waiting in the wings with their "Pentium killers," and this is likely to maintain pressure on Intel's prices

Memory

There still seems to be little sign of any end to the buoyant market for memory products that has been seen in Europe since the end of 1992. Dataquest is expecting that there will be an increase in business levels as the year draws to an end, as PC producers look to the traditionally largest quarter—the fourth quarter—to bring another wave of customers. One of the triggers that consumers may be waiting for is the sub-$2,000 Pentium-based PC machine to arrive in the European market. A number of machines are approaching this level, and the barrier may be broken before Christmas.

Dataquest has changed the line-up of products that it tracks monthly across the regions of the world. Several DRAM devices have been added to replace older parts that are now not in the mainstream of the memory business. Flash memory has been changed to reflect the 4M density, and SRAM has now been switched to look at mainly 1M devices.

DRAM

The supply and demand imbalance has remained evident in the European DRAM arena. Dataquest expects this situation to remain until at least mid-1995, though some devices within the overall 4M and 16M families may go into oversupply sooner.

The 1M density is still holding its pricing levels, but the overall supply and demand scenario is decreasing quickly. Suppliers are unwilling to produce the device, even though profit levels are good at this stage of the product life cycle, unless it is being used for some older modules.

The 4M density remains the major part of the DRAM demand, with larger OEMs still demanding more than current allocation levels. Shortages are particularly evident on the wider organizations, with exceptional problems being seen for ×16 parts. Even though suppliers are tending to move production from the ×8 devices, the demand for video and other applications is increasing at a faster rate. Dataquest expects the 256K×16 to remain in shortage throughout 1995.

Demand is growing for 16M in Europe, as the bit price cross-over point is becoming closer for some organizations. The bulk of both production and demand is still being seen for the 4M×4 parts, though users are eagerly awaiting increased volumes of ×8 and ×16 devices, for both discrete and module-based applications. Suppliers are cautiously increasing production levels, forced on by the seemingly unrelenting demand from the marketplace.

SRAM

The SRAM arena is still competitive, with the mix of suppliers, densities, speeds and packages providing a bewildering choice to customers. One of the largest demand factors still seems to be the faster SRAMs for cache applications, although Dataquest is beginning to see signs of the consumer market re-emerging in Europe and around the world.

Flash

Flash supply and demand seems to be reaching manageable levels, although overall growth levels for flash this year may not reach the heady growths expected. It seems that some users that switched back to EPROM throughout the supply difficulties for flash in 1992 and 1993 may still be using EPROM as their device solution. Other users may well not have made the move to flash, the new technology, preferring to remain with the multisourced, older technology EPROM.

EPROM

Demand levels have remained strong overall for EPROM devices, though there are definite signs of users migrating to larger densities.

Current Exchange Rates

1 US dollar =

0.634 pounds
1.557 deutsche marks
5.312 French francs
0.813 ECU

Industry Highlights

Researchers and analysts in Dataquest's European Semiconductor Group routinely gather intelligence on the European semiconductor market. Some of this information is published electronically on a weekly basis via Dataquest's Semiconductor On-line Service DQ-Monday. The following key European industry events review the past four weeks, and are selected on the basis of their perceived industry impact.

GEC Plessey Semiconductors

GEC Plessey Semiconductors (GPS) has announced the expansion of its state-of-the art, CMOS semiconductor plant at Roborough, Plymouth, England. This will involve an investment of approximately £100 million. The present clean room at Roborough was originally built to allow for future expansion from 1,100 to 2,800 m^2. The use of a novel "mini-environment" concept will make it possible for GPS to directly relate output to demand, and thus eliminate or at least considerably reduce delays in the start of production.

Wafer handling systems, such as standard mechanical interface (SMIF), will be used to automate the handling process within the protected environment. Coupled with enhanced computer-integrated manufacturing (CIM), this will virtually eliminate misprocessing; significantly reduce cycle time variations; and give greater line balance control, enabling improvement in output. The first phase of the program will be complete in 1996, and will create more than 150 additional jobs. GPS expects the Plymouth plant to be one of the most advanced semiconductor facilities in the world.

Dataquest considers that this is a further indication of GEC's confidence in the company. GPS has products that are aimed at applications with the potential for very high volumes, such as wireless communications and global positioning systems. This investment will take the company a long way towards its goal of being prepared and positioned correctly to meet future customer demand from high-growth areas of its business.

Shin-Etsu Handotai

Shin-Etsu Handotai has announced that it is to invest £20 million to increase capacity at its silicon wafer plant in Livingston, Scotland. Production should rise to 200,000 wafers a month in 1995 from the current 130,000 a month, reaching 330,000 a month in 1996. At present, production is of 4-inch and 6-inch wafers, but the company plans to start production of 8-inch wafers. Shin-Etsu's main customer is NEC Livingston, which announced a $800 million investment last month.

IBM and Philips Join Forces

IBM and Philips Electronics have signed a letter of intent to form a joint venture to manufacture semiconductor wafers at IBM's facility in Böblingen near Stuttgart, Germany. The two companies are also discussing the possibility of additional technology cooperation in the future, focused primarily on embedded DRAM applications.

Philips and IBM will form a separate entity, with the joint venture assuming assets and employees from IBM's Böblingen facility. Currently, the plant employs some 800 people and manufactures 4M DRAM chips on 8-inch wafers. The new joint venture would supply products solely to IBM and Philips, manufacturing 4M DRAM wafers for IBM and 0.8 µm logic products for Philips. Over time, the two companies plan to upgrade the facility to a 0.5 µm process.

This seems to be an all-win situation for both companies. For Philips it solves some capacity problems in the short term by providing access to a 0.8 µm facility producing 8-inch wafers. These wafers could then be used by Philips to produce advanced logic circuits. For IBM, the agreement should help to fill the factory with demand that they have had problems meeting.

In the longer term, Philips may look to license IBM's technologies in other areas, especially 16M, where the end products could be used in various products in multimedia and other consumer devices.

TI announces ABS Deal in Europe with Teves

Texas Instruments (TI) has announced a deal to supply Teves with a range of customized microcontrollers based on TI's PRISM methodology, for the manufacture of antilock braking systems (ABS). The deal was signed on behalf of Alfred Teves AG by its parent company, ITT Automotive Europe GmbH, headquartered in Frankfurt, Germany. Under the agreement, TI is expected to ship more than 8 million of its 8-bit and 16-bit cMCU370 customized microcontrollers annually by 1997. Currently, Intel provides ITT with its main microcontroller, and this deal means that TI could displace Intel's slot in the new Teves MK20 ABS, or future-generation ABS.

TI's PRISM methodology integrates logic, memory and power elements on a single chip. This helps TI reduce the design cycle time for new applications. ABS is one of many automotive applications at which TI is targeting PRISM; other success areas for Texas Instruments in Europe include airbags, engine, cruise, car multiplexing (VAN) and body controls.

The new Teves MK20 ABS with antiskid control (ASR) integrated as a module can be upgraded by an engine drag movement control (MSR), which enables engine braking to be controlled automatically. The new ABS will start production in Europe, and a short time later also in the United States and Japan for the world car market. Dataquest estimates total European ABS production at nearly 6 million units, with other suppliers of ABS including Bosch, Siemens, Bendix and Lucas—main competitors of ITT-Automotive/Alfred Teves.

This agreement is the result of six years of collaboration by TI's automotive microcontroller development center in Nice, France and ITT Automotive in Frankfurt. For ITT Automotive, Texas Instruments had previously developed frequency divider ICs and a linear custom device for signal conditioning (SCIC), which is now in high-volume production, through to ITT's first microcontroller unit integrating SCIC.

Trafficmaster to Expand Motorway Traffic Monitoring Network in United Kingdom

Trafficmaster plc, the UK company that offers visual motorway traffic information systems in the United Kingdom, is to expand its road networks to cover all motorways in England, Scotland and Wales on December 7 this year. Since its introduction in September 1990, trafficmaster now covers the whole of England's M25 motorway—the Greater London ring-road highway—and the nine motorways linking with the M25. The network comprises a series of motorway beacons roughly 3 km apart that detect slow-moving traffic by sending signals back to the central control site at its National Traffic Data Centre. These signals are then relayed to the drivers' mobile in-car display system.

The system unit includes an antenna, a monochrome liquid crystal display (LCD)/radio receiver that displays motorway trouble spots and can broadcast additional limited text information about the type of congestion. From early next year, the company will offer additional radio information of local traffic information, and plans to incorporate smart-card technology for access to systems providing broadcast/narrowcast services such as radio paging and messaging. Smart cards will also be used to provide software upgrades. Currently, less than 50,000 systems are estimated to be in use. This represents the first commercially available, nationwide navigation system in the United Kingdom. Trafficmaster has also designed and filed for patent its Passive Target Flow Management system, which monitors the number plates of passing vehicles to detect the flow of traffic. The system uses cameras that time-stamp number plates, and could be used as part of a management system to control traffic speed.

Dataquest Strengthens Its Presence in Asia

Dataquest and ResearchAsia, the leading provider of Asia/Pacific country-level market research and consulting services to information technology companies throughout Asia/Pacific, have announced an agreement for Dataquest to acquire the business of ResearchAsia.

"The capabilities of ResearchAsia will enable Dataquest to provide extensive country-specific market intelligence across all major business regions and information technology markets of the world," said Judith Hamilton, president and CEO of Dataquest.

ResearchAsia was founded in 1978 as a Hong Kong–based consulting company. Today, in addition to its initial consulting services, ResearchAsia offers market-tracking subscription services on nine Asia/Pacific countries and provides quarterly data on information technology markets from PCs to printers. ResearchAsia also conducts country-level studies on the acquisition and use patterns of these products by private and corporate users in vertical markets and across the full spectrum of information technology industries.

Dataquest has strengthened and solidified its presence in Asia through this acquisition and formally created a new Asia/Pacific region within its global structure as a response to the increasing demand for market information on Asia/Pacific markets. The ResearchAsia operations and services will be merged with the existing Dataquest offices in the region under the Dataquest company and product name, with the Asia/Pacific regional headquarters to be located in Hong Kong. ResearchAsia has offices in Hong Kong, Bangkok, Seoul, Singapore and Taipei, and affiliates in Beijing and cities across Australia.

News Round-Up

Standard Microsystems Corporation (SMC) has entered into a cooperative wafer fab alliance with **AT&T**, to provide additional submicron fab capacity to AT&T, and this guarantees a portion of fab output to SMC. In this five-year agreement, SMC will purchase wafer fab equipment—steppers, etchers and metrology equipment—for installation in AT&T's MOS line in Madrid, Spain. The line is capable of producing 0.9 µm to 0.45 µm.

Virgin Group's PC subsidiary, **Virgin Euromagnetics**, has announced a firm partnership with **ICL** on the manufacture of PCs. Virgin had been playing with the PC market for little over a year, but it now feels that it needs a stable partnership—previously, it badged machines from ICL, IBM, Intel and others.

Digital Equipment has announced that is it to transfer assembly of its PCs from its board site in Ayr, Scotland to an assembly operation at nearby Irvine. Boards will continue to be made at Ayr.

Siemens Nixdorf Informationssysteme (SNI) is to buy a 10 percent stake in **Escom**, the Germany PC assembler; SNI will then supply 80 to 90 percent of Escom's desktop and portable computers.

SGS-Thomson has announced that its net revenue for the second quarter of 1994 increased to $672.4 million, a 27.8 percent increase over the same period last year; all product groups increased sales over last year.

Calluna, the Scottish disk drive designer and manufacturer, has announced that it is to seek flotation on the United Kingdom's unlisted securities market—hoping to raise £10 million to £12 million.

Solectron is to invest $15.5 million to expand its manufacturing plant in Dunfermline, Scotland; this brings the total investment in the facility to more than $26 million since Solectron acquired the plant from Philips in October 1993.

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I.C. EUROPE

A Monthly Report on European High Technology Industries

September 1994

In This Issue

I.C. Europe is a monthly report on European high-technology industries. The information is compiled and published by Dataquest's UK-based European Semiconductor Group research team with contributions from Paris, San Jose, and Tokyo.

State of the Industry

The WSTS flash three-month average bookings for the month of August were $1,625 million, a 0.7 percent decline over July's restated $1,638 million. July was restated upwards by 2.6 percent over last month's preliminary figure. Considering that August can typically be a slow booking month due to vacations across Europe, the numbers are a sign of the continued strength of the semiconductor market in Europe.

The flash actual billing figure for August was $1,404 million, which increased the three-month average book-to-bill ratio to 1.06 from last month's level of 1.05. Figure 1 shows the European three-month average bookings and billings; and the book-to-bill ratio for the past 13 months. The actual billings level is almost flat on last month's, and is in line with expected billings models.

With bookings rates slowing, it seems inevitable the ratio will fall below 1 in the coming months. However, the industry has braced itself for a particularly frantic lead-up to the Christmas market (especially from PC makers), and this could keep bookings levels in front of billings for the rest of the year.

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Program: I.C. EUROPE
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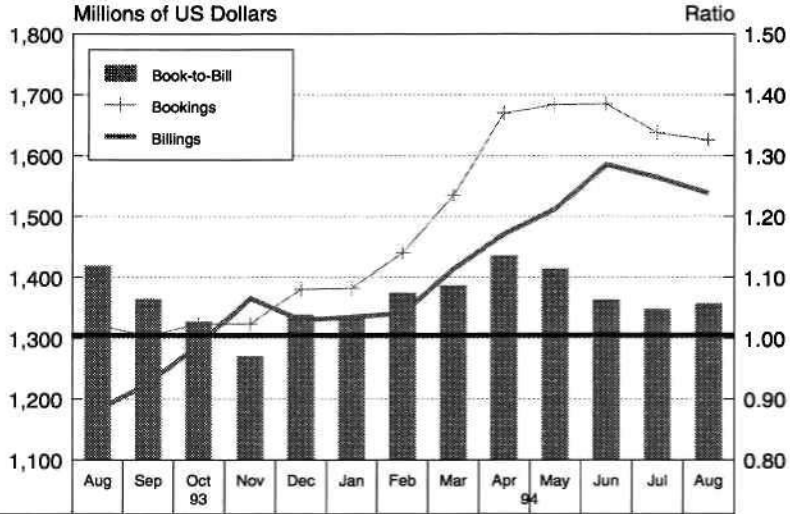
Publication Date: September 1994

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



	Aug	Sep	Oct 93	Nov	Dec	Jan 94	Feb	Mar	Apr	May	Jun	Jul	Aug
Book-to-Bill	1.12	1.06	1.03	0.97	1.04	1.04	1.07	1.09	1.14	1.11	1.06	1.05	1.06
Bookings	1,322	1,303	1,324	1,324	1,380	1,382	1,440	1,535	1,670	1,684	1,685	1,638	1,625
Billings	1,182	1,225	1,289	1,366	1,330	1,335	1,341	1,413	1,471	1,512	1,585	1,564	1,538

Source: WSTS, SIA

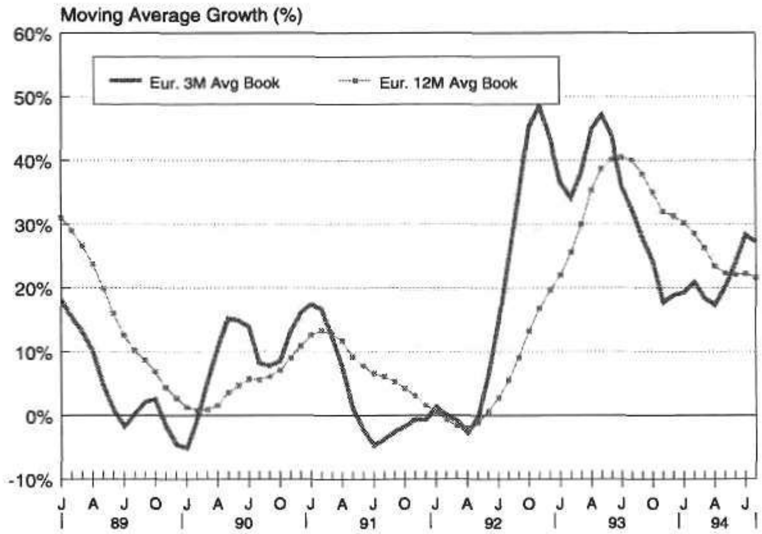
Figure 2 shows the 3-month and 12-month growth for semiconductor bookings. The actual level of bookings is still well above the level for the same period of 1993, but the graph clearly illustrates that the rate of growth is slowing towards 20 percent, whereas it peaked this year at 30 percent. It should be remembered, however, that the extraordinary bookings growth levels of the past two years were bound to slow, as the market boom that began in the second half of 1992 cools off.

The rate of growth of 12-month semiconductor billings has flattened over the last few months and will probably end the year at 25 to 27 percent above 1993. The 3-month average line seems to have turned back up again, so this could push the 12-month line up to higher levels towards year-end.

At the moment there seems to be little evidence of the overall strength of the market coming to an end. Even though the rate of billings growth is slowing, it should be remembered that the growth is 25 percent above 1993, which in turn was 27 percent above 1992. Dataquest expects that the final quarter of the year should continue the strong trend that has been seen in the first three quarters.

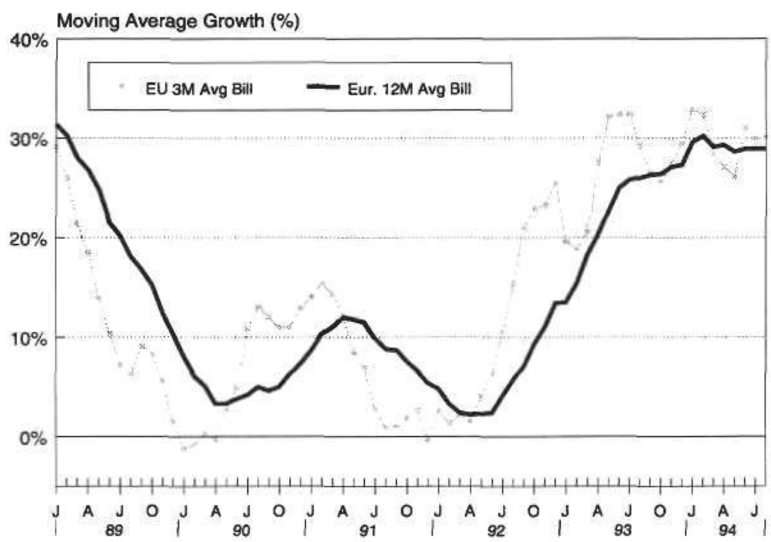
PC production is expected to grow considerably between the third and fourth quarters of this year, increasing demand for many semiconductor devices, especially memory, microcomponents and logic devices. The

Figure 2
European Total 3-Month and 12-Month Semiconductor Bookings Growth



Source: WSTS, SIA, Dataquest (September 1994)

Figure 3
European Total 3-Month and 12-month Semiconductor Billings Growth



Source: WSTS, SIA, Dataquest (September 1994) communications segment seems strong, and the uptake of the GSM mobile standard across Europe has surpassed all expectations. Dataquest is also seeing evidence of increasing activity in the consumer segment in the second half of the year, and automotive is expected to continue its strong growth for the complete year.

For next year, 1995, Dataquest expects the current market situation to prevail until at least midyear. Key memory devices, especially the 16M DRAM, will still be in shortage, and Intel will still be seeking to ramp up the acceptance of Pentium at important PC producers. The key to growth in 1995 will be the level of erosion of average sales prices (ASPs) for key products, since Dataquest expects unit sales to remain relatively constant.

Historical Pricing Trends

This section of I.C. Europe *looks at historical pricing trends for a key semiconductor component, this month the focus is on the 4M×4 16M DRAM (70ns).*

During 1994, the key density of DRAM continues to be the 4M. It reached its peak shipment volume in the second quarter of this year, and this was the highest shipment quantity for any DRAM in one quarter.

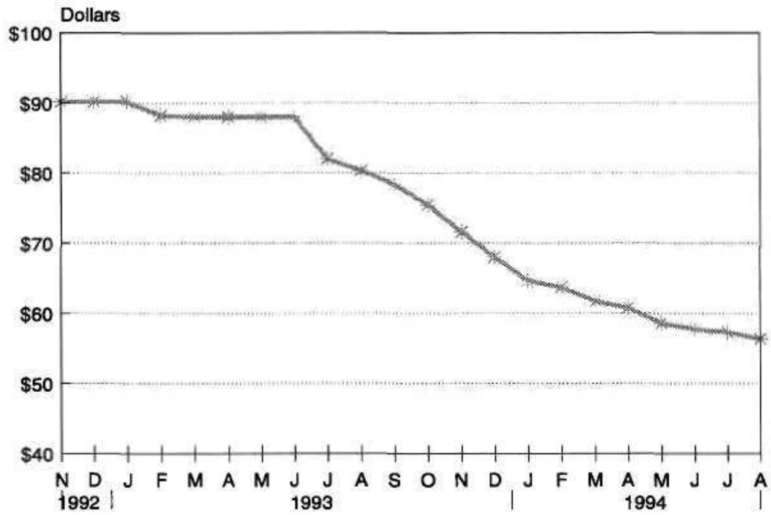
However, it is the level of activity for 16M that will decide the outlook for 1995. Already some DRAM suppliers have begun ramping down 4M DRAM production levels and are bringing capacity for 16M DRAM on line as quickly as possible.

At this stage it is important to consider production investment levels for the years 1991 and 1992, since they have had a profound effect on the early months of the 16M. During these years the semiconductor industry worldwide was in recession, profits for memory producers were very slim and, consequently, investment in new production lines for the 4M and 16M DRAM was low.

Figure 4 illustrates the pricing history for 16M since the end of 1992, when the device was in its infancy. Prices remained relatively constant throughout the first months of 1992, since both production volumes and demand from leading-edge consumers were small. If production quantities were then to be ramped up as had been seen in preceding DRAM densities, the ASP would decline more quickly during 1993 and 1994 than the curve that is seen here. But many of the major DRAM producers were still very reluctant to invest the very large sums needed to bring production on quickly.

The erosion seen in the ASP is mainly because of suppliers trying to move users from 4M to 16M. In order to do this, pricing levels for 16M must be four times the 4M to produce an attractive proposition to users. This has occurred for some organizations of 16M during the third quarter of 1994. However, Dataquest expects the four-times crossover for 1M×16 devices to be delayed until the first quarter of 1995.

Figure 4
Historical Pricing Trends for Europe
4M×4 DRAM 70ns (100,000 Units Minimum Price)



Source: Dataquest (September 1994)

The number of users for the 16M DRAM is increasing fast and the difference between demand and supply is widening as the year draws to a close. Dataquest estimates that demand may be 30 percent above production levels by the end of the year.

Pricing levels for the 16M DRAM should decline, but only slowly for the first half of 1995. Production levels will grow, but suppliers are being extremely cautious and are examining demand levels very closely before increasing output.

Semiconductor Pricing and Analysis

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

Standard Logic

There has been no change to pricing levels in this month's survey.

Analog

There has been no change to pricing levels for this month.

Microcomponents

Microcomponent pricing has stayed constant in this month's survey.

Table 1
European Semiconductor Pricing August 1994
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (percent)	1K Adder (percent)	Lead Time (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.46	10%	15%	10-16
74F244	PDIP	100K	0.29	10%	15%	10-16
Analog						
78L05	TO92	100K	0.16	10%	10%	16-24
IMSG176D 35-MHz Video DAC		100K	1.30	15%	25%	8-12
Microcomponents						
80386SX-25	PQFP	5K	15.00	0%	5%	4
80386DX-40	PQFP	5K	25.00	0%	10%	2-6
80486DX-33	CPGA	5K	220.00	-5%	5%	10-14
68040-25	CPGA	5K	190.00	-5%	10%	10-14
R3000-25	CPGA	5K	75.00	-5%	15%	4-10
DRAM						
1M×1-80 (1M)	SOJ	100K	4.90	5%	15%	18
4M×1-80 (4M)	SOJ	100K	13.10	5%	15%	12-14
512K×9-80 (4M)	SOJ	100K	15.20	5%	15%	12-16
256K×16-80 (4M)	SOJ	100K	15.10	5%	15%	18
4M×4-70 (16M)	SOJ	10K	56.20	0%	15%	10-12
(4M×1)×2+1M-80	SIMM	50K	34.90	5%	15%	16
128×8-80 VRAM	SOJ	100K	6.80	5%	15%	12
Flash						
1M-17 (128K×8)	PDIP	10K	4.90	0%	30%	14-16
2M-17 (256K×8)	PDIP	10K	11.10	0%	30%	14-16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	5.00	10%	20%	14-16
SRAM						
256K-70 (32K×8)	PDIP	50K	3.20	5%	10%	14
256K-25 (64K×4)	PDIP	20K	4.15	5%	15%	14
1M-70 (128K×8)	PDIP	50K	9.00	5%	10%	14

Source: Dataquest (September 1994 Estimates)

Memory

The strength of the memory market has continued through the traditionally slow summer months. PC producers are still demanding ever-increasing DRAM quantities, and other memory devices are also faring well. Continued high demand for SRAM for cache applications is producing shortages across some device types, and the prospect of increased demand from the consumer segment in Europe during the rest of 1994 is sure to increase the pressure on deliveries.

DRAM

DRAM pricing has remained relatively flat for the month of August. Dataquest is still seeing the switch in demand towards wider-word-width devices, and this will be especially evident when the 16M DRAM becomes the major DRAM device during 1995/1996. This stability is forecast to last well into 1995, provided PC production levels stay strong.

Production quantities of 1M DRAMs are shrinking further, increasing the pressure for late adopters to switch to 4M or even 16M. Since these customers are in markets where the end equipment life cycle is long, it is difficult to make the upgrades in good time.

The 4M DRAM is now reaching its peak worldwide production quantities, with in excess of 80 million devices being produced. However, it is still evident that demand is running ahead of supply, with many major PC producers still requiring additional allocation to produce their machines. Sales of PCs seem to be on target to reach Dataquest's 16 percent unit growth forecast for 1994 over 1993.

Demand for 16M DRAMs is also running well above supply levels and Dataquest has estimated that there will be a 25 percent gap between supply and demand by the end of this year.

SRAM

SRAM pricing is still very competitive at the slower end of the market, with many suppliers still fighting for the largest dollar-value part of the market in Europe. Suppliers of fast and very fast SRAMs can sell all of their devices, and prices are staying fairly steady. Niche suppliers are managing to concentrate their marketing efforts to keep hold of their markets, though newer entrants from the Far East are beginning to sell all types of SRAM successfully in Europe.

Flash

The continued decline in price is due to the increase in supply available from Intel and other suppliers. Users are still returning to flash devices after the supply problems of 1993, and this is keeping demand levels healthy.

EPROM

There has been no change to EPROM pricing this month

Exchange Rates

1 US dollar =
0.646 pounds
1.543 deutsche marks
5.290 French francs
0.810 ECU

Industry Highlights

Researchers and analysts in Dataquest's European Semiconductor Group routinely gather intelligence on the European semiconductor market. Some of this information is published electronically on a weekly basis via Dataquest's Semiconductor On-line Service DQ-Monday. The following key European industry events review the past four weeks, and are selected on the basis of their perceived industry impact.

NEC Opts for Scotland

NEC has finally announced, after much speculation (see *I.C. Europe*, July 1994), that it is to establish its new fab next to its existing facility in Livingston, Scotland. The total investment is $800 million, split $200 million on construction costs and $600 million on manufacturing equipment.

The new fab will manufacture 64M DRAMs, 16M DRAMs and ASICs using 0.35 µm process. A total of 20,000 8-inch wafers per month will be produced. Construction of the new plant will begin in April 1995 with completion in March 1996 and full production scheduled to begin in October 1996.

At the moment NEC has six plants within Japan; these are Kumamoto, Hiroshima, Kanagawa, Shiga, Yamagata, and Yamaguchi, and although production at most of these plants has been increased, this year the limit of expansion has been reached. Outside of Japan, NEC has a plant in the United States at Roseville, California, and the other in Livingston, Scotland.

Expanding an existing location was always the obvious choice; the Californian plant—which is the biggest—was not seen as such an attractive option because NEC would not want to concentrate such a large portion of its foreign production in one location. One main reason that Japan was not even in the running for this investment is the high value of the yen; this also makes overseas investment much more attractive.

NEC has cited a number of reasons for its decision to opt for Scotland, including the following:

- NEC already has facilities for 64M DRAM production in Japan and a leading-edge semiconductor plant in the United States; therefore, by building this plant in Europe, NEC will be closer towards a more balanced global strategy.

- NEC Semiconductors (UK) Ltd has claimed an outstanding record for high efficiency and excellent production yields—currently, Livingston is the most productive of all NEC's semiconductor plants, producing 4M DRAMs with a production level of 2.5 million units per month.
- There is a large demand in Europe for memory products fuelled by the demand from personal computers.

Another point that may have influenced NEC's decision is the aid it will receive from the regional development agency, Locate in Scotland, although both parties say that Locate in Scotland is only putting up a "modest" amount of the investment.

It is understood that NEC plans to use its latest plant in Kyushu, number 8 line, as the blueprint for the new development. The Kyushu plant is set to manufacture 16M DRAMs along with SRAMs and RISC processors.

NEC Semiconductors (UK) Ltd was established in January 1981 as NEC's European semiconductor manufacturing center and in October 1982, assembly of 64K DRAMs commenced. In 1987, NEC was the first Japanese company to operate a fully integrated semiconductor facility (wafer fabrication, assembly and test) in Europe. At present, Livingston's existing facilities produce 4M DRAMs, with production levels at 2.5 million units per month.

Ericsson Opens $100 Million Submicron Fab

H.M. King Carl XVI Gustaf of Sweden has officially inaugurated Ericsson's new $100 million semiconductor plant in Kista, near Stockholm, Sweden, to produce specialized microelectronics components for telecommunications equipment. The plant is equipped with processes from Texas Instruments (TI), with which Ericsson has had a strategic agreement since 1987.

Under the terms of its agreement with TI, Ericsson benefits from TI's semiconductor know-how and technology, and shares with TI its expertise in designing specialized microcircuits for telecoms applications.

The new 6,500 m^2 submicron semiconductor fab has 1,650 m^2 of Class 1 clean-room facilities. With an initial production of 10,000 six-inch wafers a year, the plant will produce 0.5 μm very large-scale integration (VLSI) circuits, with the scope to upgrade this to 0.35 μm technology in the future. Initially, CMOS devices will be made at the plant; later, BiCMOS wafer production will be added.

The new submicron wafer fabrication facility will manufacture specialized VLSI circuits for use in Ericsson products and systems, from telephone switches to cellular phones. It will also serve as a flexible, fast-prototyping facility to shorten development times for new circuits, and as a means for the development of semiconductor technology.

Motorola Expands East Kilbride for the Third Time

Motorola has announced an expansion of its semiconductor fabrication plant in East Kilbride, Scotland, the third expansion by Motorola at this site in three years. It is estimated that 15 to 20 percent of Motorola's worldwide wafer starts each year come from the plant. The additional $384 million investment will lead to an additional 250 jobs, taking the total to about 2,550 employees by the end of 1996. The new lines added to the fab will be making embedded versions of the PowerPC and customized 32-bit microprocessors, digital signal processors (DSPs), and advanced telecommunications devices.

East Kilbride is one of Motorola's premier manufacturing plants, and Motorola recognizes its contribution with its third investment in as many years. With the shortage of many devices showing no letup until at least the third quarter of 1995, Motorola needs to increase its manufacturing capabilities to meet the demands of its customer base. This problem exists for many semiconductor vendors and is explored more fully in the recently published report from Semiconductors Europe, *Procurement/Customer Satisfaction Survey Results 1994*, SEMI-EU-UW-9401.

AMD Dresden Plant Not a Certainty

Germany's federal economics minister, Günter Rexrodt, has claimed that AMD is almost certain to decided to locate its new submicron facility in Dresden, in the eastern German state of Saxony, with construction starting early next year. However, an official statement by AMD says this is not the case. "We have held preliminary discussions with Saxony officials," said an AMD official, adding that the company was pursuing other possibilities and had not reached a firm decision. An AMD statement says that: "Given the current growth in the microprocessor market ..., we believe there is a real possibility that we will need another large manufacturing facility," but AMD points out that its new $1 billion facility in Texas had only recently started silicon throughput, and any new construction is unlikely to start before late 1995 at the earliest. Meanwhile, Mr. Rexrodt's statement may have had something to do with his CDU Party holding onto power in the local state elections, which were only two weeks away; such an announcement would have been a big boost for his party's chances.

Ericsson's Interim Report

Ericsson has reported that net sales rose 33 percent to SKr 36,514 million in the first six months of 1994. Consolidated pretax income for the period improved 78 percent to SKr 2,290 million (Table 2). The Radio Communications business area reported an increase for the business area as a whole of slightly more than 60 percent during the first half of the year, while the main areas of systems and terminals for mobile telephony rose a full 80 percent. Ericsson reports that its Components area had a strong increase in net sales and order bookings. All business units contributed to this improvement. Ericsson's largest single market is the

Table 2
Ericsson Sales by Business Area
(Millions of Swedish Kronor)

Business Area	Jan.-June 1994	Jan.-June 1993
Public Telecommunications	11,528	10,043
Radio Communications	17,145	10,654
Business Networks	6,013	5,631
Components	3,275	2,528
Defence Systems	1,470	1,127
Other Operations	774	729
Less: Intersegment Sales	-3,691	-3,318
Total	36,514	27,394

Source: LM Ericsson

United States, with 11 percent of total net sales, followed by Sweden, Italy, the United Kingdom and China, which has now become the fifth-largest market with a 6 percent share of net sales.

TV and Monitor Production Hit by Glass Shortage

The *Financial Times* reports that picture tube manufacturers are facing a shortage of the specialist glass used in the production of CRT—and this shortage could reduce TV and monitor production worldwide.

Win de Kleuver, chief executive of Philips Components, has said that world demand for tubes would be 160 million in 1993, but CRT makers were able to produce only 150 million because of the glass shortage. The deficit had been caused by the glass manufacturers' lack of investment during the recession—they are now finding it hard to increase capacity to match demand. About a quarter of world capacity is currently off-line, as manufacturers are currently carrying out plant refurbishment.

Psion Revenue

Psion, the UK-based portable computer manufacturer, has announced its half-year results for the period ending June 30, 1994 with turnover up 57 percent to £28.28 million and pretax profits up 173 percent to £2.92 million on the same period last year.

The acclaimed Series 3 and Series 3a palmtop computers showed a 105 percent jump in sales, with strong demand from Europe, although Psion claims that sales in the US market were limited by the reorganization of retailers following the failure of the Apple Newton.

In the last six months Psion has brought in-house all surface-mount board manufacturing after an investment of £2.4 million at its Greenford, London manufacturing site. The Series 3 and Series 3a are now being manufactured at a rate of 24,000 units a month.

GPS and the Game of Chinese Whispers

Rumors that GEC has placed its semiconductor division, GEC Plessey Semiconductors (GPS), up for sale have circulated widely recently. Rockwell has even been suggested as a possible suitor. It is Dataquest's belief that this is not the case. GEC Plessey Semiconductors has a number of very important new products and technologies which we believe will position the company for strong growth over the next five years. Also, by all accounts the company is profitable. It is understood that the company has been considering investing in additional fab capacity (who hasn't?), and thus has been reviewing its financial plan. This was probably the source of the rumors.

GEC Plessey had worldwide sales of $290 million in 1993. It is strong in application-specific products for disk drives and wireless communications, including wireless LANs, where it has a number of important design wins. It is a licensee of the ARM RISC microprocessor, a leader in semiconductor solutions for satellite-based global positioning systems and a major supplier of prescalers for use in TVs; it makes teletext ICs and gate arrays, and has ASIC solutions for central office line cards.

Star Microelectronics

Star Micronics' 5,000 m^2 matrix printer facility in Tredegar, South Wales, is set to close. Since opening in April 1988, with financial aid from the Welsh Development Agency, the size of the facility has increased threefold. However, the decline in the demand for dot matrix printers has been reflected in the output of this plant, which was estimated to be 314,000 units. The dot matrix market in Europe between 1993 and 1998 will show a compound annual growth rate of minus 12.9 percent.

News Round-Up

Digital Equipment has sold its 7.9 percent stake in **Olivetti**, reportedly at a heavy loss. Originally, Digital had taken a 4 percent stake in Olivetti during 1992 and then increased it to 7.9 percent. The deal was originally designed to give Digital a broader market for its products and provide the Italian company with financial help.

AST Computer has officially opened its manufacturing site at the National Technology Park in Limerick, Ireland. The 32,000 m^2 plant has a capacity of 500,000 machines a month and produces all desktop and server ranges for Europe.

VLSI Vision, based in Scotland, says that a credit-card-size camera, which has been on trial with companies for some months, can take black-and-white snapshots or sequences of stills and incorporate them into documents on a PC. Applications include insurance companies wishing to quickly add photos to their damage reports; main office/in the field correspondence; and sports analysis, that is, a golfer's swing. The company is said to be developing video systems for Donnelly Corp. that are intended eventually to replace rearview mirrors in cars.

Microsoft has announced the shipment of its first keyboard, the "Natural Keyboard." This is Microsoft's second move into the computer hardware market, the first being the mouse. Microsoft is working collaboratively with Key Tronic Corp., an independent keyboard manufacturer. The keyboard is designed with ergonomics and function in mind. The keypads are split and rotated outward to promote proper wrist position while the user's arms and shoulders are aided by this design because of its width and angles. An adjustable front edge enables different chair and desk positions. A built-in palm rest provides the user with a surface upon which to rest. The suggested retail price for the keyboard is $99. The keyboard will be offered this autumn bundled with computers from Dell Computer and Zenith Data Systems.

Olivetti has announced that it expects to break even this year at the operating level, but has said that no estimation has been made of the net profit or loss for the year. The company added that the Olivetti group of companies was producing between 800,000 and 850,00 PCs a year worldwide, close to what it believes is the critical mass of 1 million units on which it can be profitable.

Bull is seeking clarification on **NEC**'s intentions on "all aspects of their ongoing relationship." The speculation is that NEC might raise its 4.43 percent stake to something close to control as the government sell-off of Bull approaches.

PC manufacturer **Aquarius Systems International** (ASI) of Thüringer, Germany has signed an agreement with venture-capital company Thüringer Industriebeteiligungs GmbH (TIB), for TIB to invest DM 20 million in ASI.

Olivetti has formally launched Advanced Telecommunications Modules Ltd (ATML), based in Cambridge, England. ATML will develop, manufacture and sell low-cost asynchronous transfer mode–based products for multimedia applications.

Sharp has announced the ultimate in convenience cooking with its neural network technology microwave oven. The microwave, designed at Sharp's laboratories in Oxford, England, utilizes a single humidity sensor which recognizes food characteristics such as temperature and quantity from the level of humidity as the food is heated. This information is then used to determine accurately how long and at what power level the food must be heated to obtain perfect results. The sole production to meet European demand will come from Sharp's Wrexham, Wales plant.

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I.C. EUROPE

A Monthly Report on European High Technology Industries

August 1994

In This Issue

I.C. Europe is a monthly report on European high-technology industries. The information is compiled and published by Dataquest's UK-based European Semiconductor Group research team with contributions from Paris, San Jose and Tokyo.

State of the Industry

The WSTS flash three-month-average bookings for the month of July were $1,584 million, a 6.0 percent decline over June's restated $1,686 million. June was restated upwards by 1.8 percent over last month's preliminary figure.

The flash actual billing figure for July was $1,283 million, dropping the three-month-average book-to-bill ratio to 1.04. Figure 1 shows the European three-month-average bookings and billings, and the book-to-bill ratio for the past 13 months.

The booking and billing data is showing the normal seasonal behavior, as the forecast model data shows in Figures 2 and 3. This predicts booking and billing decline as part of the slowdown normally seen at this time of year. The book-to-bill actual and forecast model data are closely aligned, and a close look at Figure 4 suggests the ratio will fall below 1 in September or October. Last year's market growth was so strong that there was little, if any, indication of a midsummer slump in the market. This year, though, market behavior is closer to normal.

This potential fall below 1 suggests the market may be declining, but a look at the long-term growth rates for booking and billing shows that

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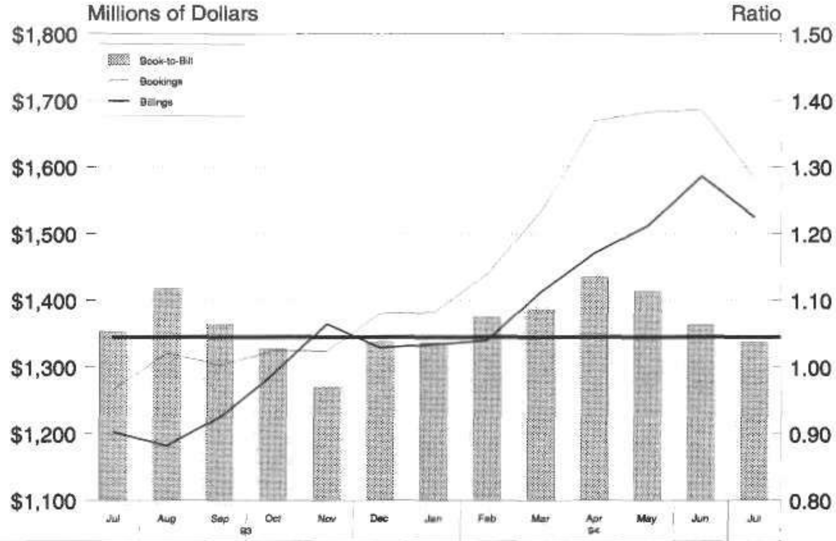
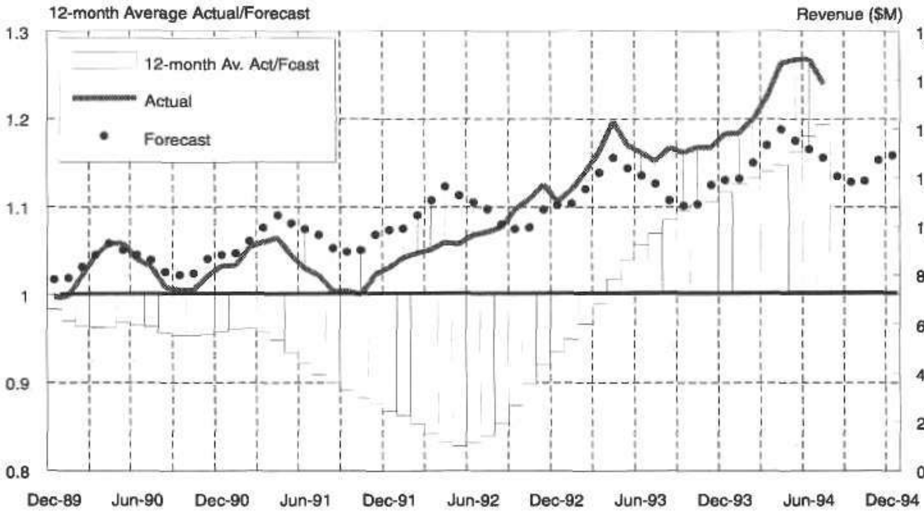
Figure 1
European Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Jul	Aug	Sep 93	Oct	Nov	Dec	Jan	Feb	Mar	Apr 94	May	Jun	Jul
Book-to-Bill	1.05	1.12	1.06	1.03	0.97	1.04	1.04	1.07	1.09	1.13	1.11	1.06	1.04
Bookings	$1,267	$1,321	$1,303	$1,324	$1,324	$1,380	$1,382	$1,440	$1,534	$1,669	$1,683	$1,688	$1,583
Billings	$1,203	$1,182	$1,225	$1,289	$1,365	$1,329	$1,334	$1,340	$1,413	$1,471	$1,512	$1,586	$1,525

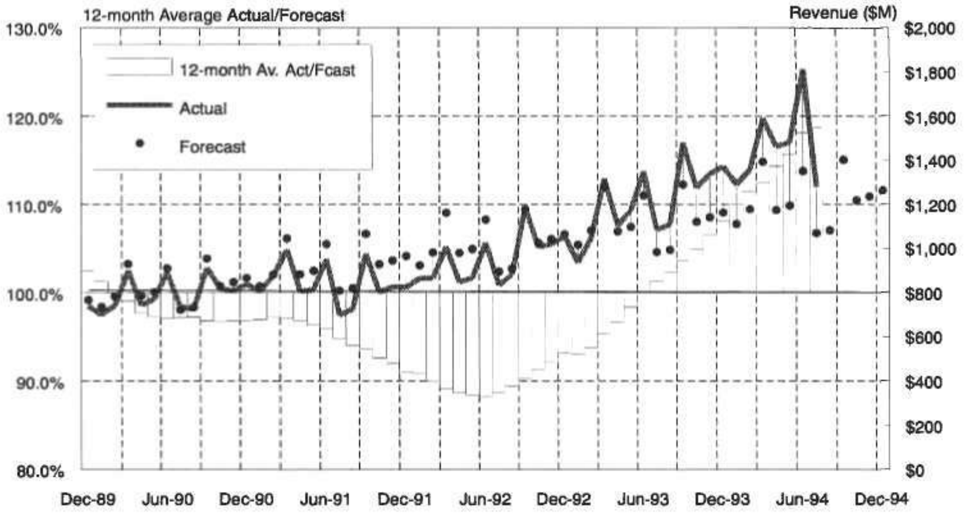
Source: WSTS, SIA

Figure 2
European 12-Month Moving Average Semiconductor Booking and Billing Growth



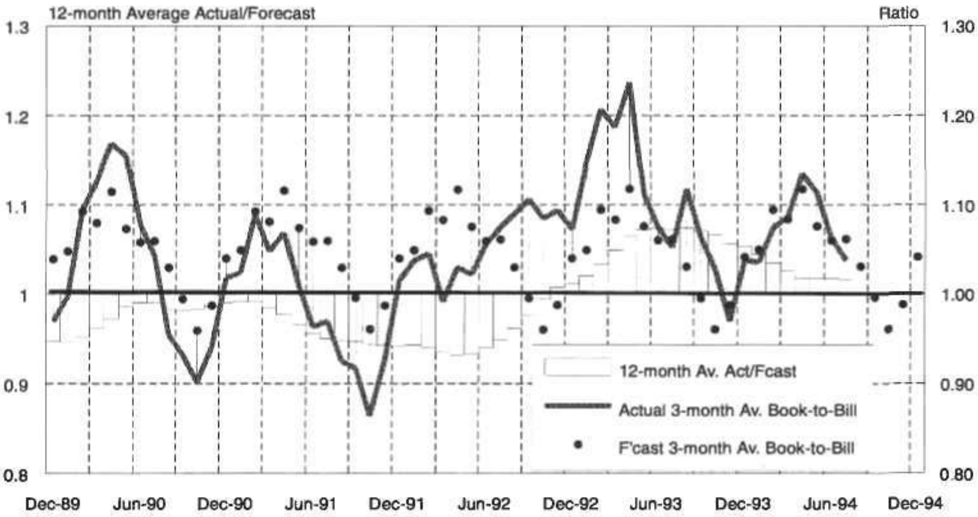
Source: WSTS, SIA, Dataquest (August 1994)

Figure 3
European 3-Month Moving Average Semiconductor Booking and Billing Growth



Source: WSTS, SIA, Dataquest (August 1994)

Figure 4
Total Semiconductor European 3-Month Book-to-Europe Bill



Source: WSTS, SIA, Dataquest (August 1994)

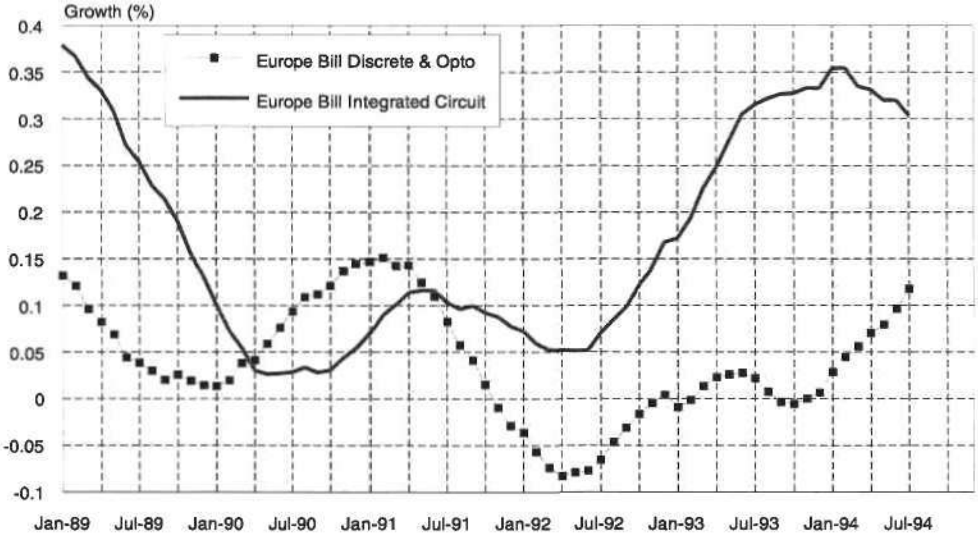
this is not yet the case. Both booking and billing are hovering at about 25 percent for the year—reasonable growth for most companies. However, the graphs suggest that the market may be at a turning point. The short-term indicator of three-month average growth is less stable, giving a degree of uncertainty in the market. This deserves a closer look at the product data.

The discrete market, in particular, is currently showing dramatic growth, with 12-month average booking and billing growth both heading towards 20 percent. This is in part due to strong unit demand, but also to average price increases from shortages of components. We believe there is a significant shortfall in discrete capacity, and this will continue to keep prices high for some time. The book-to-bill ratio for discretes is well ahead of the norm for this time of year. Typically, the ratio should be about 1.00 but is actually 1.18.

For integrated circuits as a whole, the picture is less rosy. Growth has been slowing for several months, as is clear in Figure 5. However, this is from a peak of about 50 percent for 12-month average growth for bookings, seen in July 1993. The book-to-bill ratio for integrated circuits is moving dangerously close to 1 though, and may dip below 1 next month.

There is less up-to-date detail for other components: bipolar digital, analog, memory, microcomponents and logic, but existing detail suggests that the growth in the market is moving away from being PC-driven and more towards a general component recovery.

Figure 5
12-Month Rolling Average Growth



Source: WSTS, SIA, Dataquest (August 1994)

Memory growth is accelerating, with 12-month average growth for billing heading towards 60 percent. Microcomponent growth is not so strong though, with 12-month average booking growth falling to below 20 percent and billing growth falling to 30 percent. However, this apparent weakness is against the phenomenal growth seen last year for both memory and microcomponents: microcomponent rolling 12-month average growth peaked at 90 percent in July 1993, so an additional growth of 30 percent is formidable, indeed.

Logic is less dependent on the PC and so reflects more of the behavior of the remainder of the digital market. Here, billing growth is stabilized at about 15 percent to 20 percent. However, growth is normally accelerating or decelerating, so this hints that we are entering a transition phase for the logic market.

Analog 12-month average billing growth is also reasonably stable, settling at about 20 percent. This, too, normally cycles between accelerating or decelerating growth, hence this protracted period of stability also suggests that a change may be on the way.

Finally, bipolar digital has shown a dramatic change in 12-month average booking growth, and billings growth is at about zero. This is due to the shortages seen as a result of the mismatch between supply and demand for small outline (SO) packages. The high growth seen last year, as a result of the shortages, has now been overtaken by a return to normality.

Dataquest Perspective

The winds of change are appearing in the semiconductor market, as many of the longer-term product growth indicators are stable—an unusual occurrence. It is no secret that the PC has been the driving force behind Europe's growth for the past 18 to 24 months, and this is reflected in the memory and microcomponent revenues. The changing fortunes of the other product areas indicate a stronger market as a whole. This is not limited to the other key industry in Europe, namely telecommunications. Analog component growth is related to telecoms' business strengths, but a considerable amount of the latest strength is in digital communications. In addition, the stable logic market suggests across-the-board recovery. Analog components also find use in a wide range of consumer products, as do discretes; equally, the high discretes growth suggests that consumer products, too, are finding their markets growing.

Caution should be urged though (as always): the consumer market may be undergoing a spike in growth. The Olympic Games and the World Cup Football Championships increased sales of TV sets and video recorders, from which the increase in analog sales could have resulted; if so, we should see a fall-off of business in the second half of this year.

Overall business is still strong, and the expectation among most business managers contacted by Dataquest, is for a good second half with most report order books in good shape to the end of the year.

Historical Pricing Trends

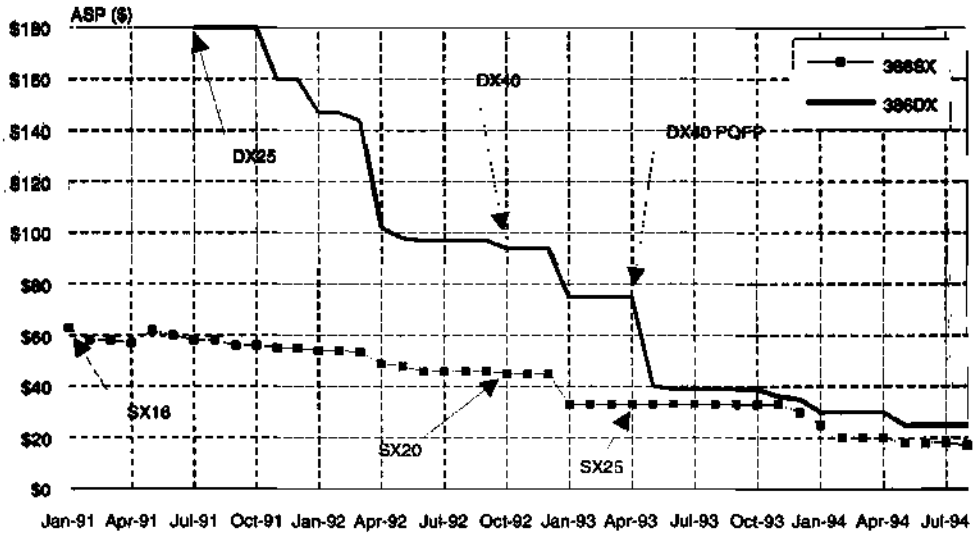
This section of I.C. Europe looks at historical pricing trends for a key semiconductor component. This month the focus is on the 386 processor.

The 386 is now at the end of its life as a PC processor, such that unit shipments of 386-based PCs represented just over 2 percent of all PC shipments for Europe in the second quarter of 1994. In this respect it is useful to take a final look at price trends for the device before it is replaced in our monthly price survey by a more up-to-date device.

As is always the case for processors, the device has been upgraded for speed as the manufacturing process improves, and as yield enhancements allow faster devices. We have tracked product upgrades as the speed of the processor changes, and have maintained the price for the most popular part.

There are no surprises in price movements for the high-end and low-end processor, as the device has followed a straightforward decline, caused by strong demand from the market and little competition at the early introduction for the device. This was the first device which Intel tried to protect as a sole-sourced product, as a result it is only in the later period of the product's life that larger declines occurred. These declines appeared as Intel prepared the market for the introduction of the 486 processor, and attempted to fight off competition from other suppliers. The main source of competition in the early years was solely from Advanced Micro Devices, but the company was joined later by Cyrix, Texas Instruments and SGS-Thomson.

Figure 6
Historical Pricing Trends in Europe, 386 Processor



Source: Dataquest (August 1994 Estimates)

Looking closely at the major changes in price (see Figure 6), there are two large falls on the chart for the 386DX: April 1992 and April 1993. The 1992 fall was mainly due to a big price decline from Intel to defend its market position in the 486 arena. The company was ready for AMD's announcement of a 486 processor, and reduced most of its processor devices accordingly. AMD had announced the introduction of a 486 product for the summer of 1992, but this actually appeared in April 1993, following delays caused by court rulings. The price decline in April 1993 was not a result of this introduction, but because the processor we tracked was changed from the ceramic-packaged to the plastic-packaged device. The drop in price shows the premium commanded by ceramic parts.

Since April 1993 the fall in prices has been as a result of improvements in efficiency in the manufacturing, together with the entry of other suppliers of 386 products. Computer users have rapidly switched preferences to 486 processors, and it appears that the move to Pentium-based computers will be at a similar pace.

Semiconductor Pricing and Analysis

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

Standard Logic

The standard logic market is recovering well from the shortages that have plagued it for many years now. Lead times are gradually reducing as capacity is added, and prices are slowly falling as a result. Surface-mount devices are in great demand still, with CMOS in greater demand than bipolar. CMOS prices have, therefore, remained firm but bipolar prices have weakened a little.

As always, the applications that have the greatest need are telecoms and data processing: consequently, regional usage is concentrated in the United Kingdom, Germany and Italy. Industrial use is also showing good recovery, with distributors reporting strong sales.

The outlook for this market is good, although there are signs of a seasonal slowdown for the first time in two years. Most order books are nearly full for the fourth quarter of 1994, although there are exceptions with some companies.

Analog

There are no price or lead time changes for analog components this month.

Table 1
European Semiconductor Pricing July 1994
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (percent)	1K Adder (percent)	Lead Time (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.46	10%	15%	8-10
74F244	PDIP	100K	0.28	10%	15%	4-6
Analog						
78L05	TO92	100K	0.16	10%	10%	16-24
IMSG176D 35-MHz Video DAC		100K	1.30	15%	25%	8-12
Microcomponents						
80386SX-25	PQFP	5K	18.00	0%	5%	4
80386DX-40	PQFP	5K	25.00	0%	10%	2-6
80486DX-33	CPGA	5K	220.00	-5%	5%	4-8
68040-25	CPGA	5K	180.00	-5%	10%	8-10
R3000-25	CPGA	5K	75.00	-5%	15%	4-10
DRAM						
1M×1-80 (1M)	SOJ	100K	4.90	5%	15%	18
4M×1-80 (4M)	SOJ	100K	13.00	5%	15%	12-14
512K×9-80 (4M)	SOJ	100K	15.10	5%	15%	12-16
256K×16-80 (4M)	SOJ	100K	15.00	5%	15%	18
4M×4-70 (16M)	SOJ	10K	57.50	0%	15%	10-12
(4M×1)×2+1M-80	SIMM	50K	34.70	5%	15%	16
128×8-80 VRAM	SOJ	100K	6.80	5%	15%	12
Flash						
1M-17 (128K×8)	PDIP	10K	5.05	0%	30%	14-16
2M-17 (256K×8)	PDIP	10K	11.40	0%	30%	14-16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	5.00	10%	20%	14-16
SRAM						
256K-70 (32K×8)	PDIP	50K	3.20	5%	10%	14
256K-25 (64K×4)	PDIP	20K	4.10	5%	15%	14
1M-70 (128K×8)	PDIP	50K	8.90	5%	10%	14

Source: Dataquest (August 1994 Estimates)

Microcomponents

The processor market is still buoyant, with strong demand for PCs across Europe. As with standard logic, there are hints of a seasonal slowdown, but this is not particularly severe. The market is ahead of what would normally be expected, even if there is a slight hint of slowing. Demand for both 68040 and x86 products is strong, with the focus on the demand side being towards higher-performance computing. Potential shortages in some key components are having some effect on PC production though, and this may be reducing the overall demand as manufacturers could ship more products if they could get the parts. These components are usually discrete products, but some memory is also difficult to obtain.

Prices are showing their usual quarterly decline, with changes in 68040 and 486 figures. Lead times show little change, reflecting the good balance between supply and demand.

Memory

The general market has changed little since last month's survey. There is some isolated evidence of a limited number of customers slowing their production rates during the third quarter, but this hiccup will be more than compensated during the final quarter of the year. Many PC producers are showing very aggressive build plans for the final quarter.

DRAM

There is little change in the surveyed prices for DRAM this month. The overall climate of demand exceeding supply is still the case, and there are still more severe problems on the wider word-width DRAMs.

Pricing levels for the 1M DRAM are unchanged this month, with certain customers continuing to demand the device in reasonable quantities.

The 4M DRAM remains in short supply, with prices remaining relatively flat on last month. Most suppliers have reached their peak shipment volumes and are managing their production mix very closely. A strong link between the factories and the suppliers and customers is essential during the allocation period, so that the demand mix matches the supply mix as closely as possible.

The 16M DRAM has shown a slight reduction in price in this month's survey. Key DRAM suppliers are faced with the difficult problem of setting realistic production quantities for 16M, while producing as many 4M DRAMs as possible.

SRAM

The SRAM market is still experiencing key device shortages, especially at the high-speed end of the market. Increased levels of demand, especially for cache applications, coupled with reduction in production quantities has caused delivery times to exceed 16 weeks on some devices.

Flash

Flash prices have fallen again this month as supply levels from the major producers, Intel and AMD, are increased. Other smaller competitors are also entering the market and, although their quantities are relatively small at the moment, the market is bound to become more competitive.

EPROM

There is little change in the pricing levels seen for EPROM this month, with SGS-Thomson, TI and National Semiconductor leading the market.

Current Exchange Rates

1 US dollar =
- 0.650 pounds
- 1.580 deutsche marks
- 5.400 French francs
- 0.825 ECU

Industry Highlights

Researchers and analysts in Dataquest's European Semiconductor Group routinely gather intelligence on the European semiconductor market. Some of this information is published electronically on a weekly basis via Dataquest's Semiconductor On-line Service DQ-Monday. The following key European industry events review the past four weeks, and are selected on the basis of their perceived industry impact.

Philips to Invest $280 Million in Dutch Fab

Philips Semiconductors of the Netherlands has announced it is to invest about Fl 500 million (approximately $280 million) in its fab in Nijmegen, the Netherlands, which will create about 300 new jobs at the facility.

This is the largest investment by Philips since the company ran into financial difficulties in the 1990s. While a $280 million investment is not small, it is only a short-term solution to years of under investment.

The Nijmegen plant, which is Philips' largest semiconductor facility, currently has an output of 15,000 6-inch wafers per month. The expansion will add a further 2,700 m^2 of high-class clean rooms. This is expected to add additional production capacity of more than 10,000 8-inch submicron wafers per month, with first products expected by the end of 1996.

The clean room will be based on the concept of "mini-environments" with SMIF boxes. The mini-environment systems means that employees are separated from the production process: that is, an environment is built around the production equipment. The clean room will be built to standards allowing class 0.1 to be achieved.

The 8-inch wafers will initially be 0.5-micron CMOS, which has been developed in cooperation with SGS-Thomson with the support of JESSI, although the investment will provide the capability to produce ICs in 0.35-micron CMOS technology. The products will mainly concentrate on the areas of advanced consumer products, multimedia and personal communications.

This investment is part of Philips' worldwide investment schedule, aimed at strengthening its position as a semiconductor manufacturer. In this regard, Philips is also continuing to expand its other wafer production facilities and assembly capacity worldwide. Recently, the company invested $50 million in Caen for the production of SACMOS and high-frequency BiCMOS ICs while, in Bangkok, about $100 million has been invested to extend the existing assembly factory. Philips has also opened a joint-venture assembly facility with Motorola in Malaysia for the assembly of SMD transistors and diodes.

Despite all this we still believe that Philips will have to invest in a new fab, which could cost up to $1 billion. The most likely location still remains Philips' home country of the Netherlands.

Widescreen Appeal Across Europe

Six weeks after unveiling Europe's first commercially available PALplus television in Germany, Nokia Consumer Electronics of Finland is to launch 28-inch wide-screen TVs in the United Kingdom later this year. This is timed to coincide with the UK's independent broadcaster, Channel 4, launching regular PALplus broadcasts. The Nokia PALplus TV set is an entry-level PALplus set and will cost about $2,200 when it is introduced in the United Kingdom.

For more information contact Andrew Norwood. Clients of European Semiconductor Application Market Service will shortly be receiving a *Dataquest Perspective* on the future of Widescreen and Digital broadcasting in Europe.

Seventh Son for ARM

As part of the Advanced RISC Machines (ARM) drive to set a consumer RISC standard, the company has announced a license agreement with Asahi Kasei Microsystems Co. (AKM) of Tokyo.

AKM, a wholly owned semiconductor unit of Asahi Chemical Industry, entered the semiconductor business in June 1983. AKM's product line includes full custom LSIs and application-specific standard products (ASSPs) for mobile communications, digital transmission and digital audio applications, and is based on AKM's CMOS mixed analog/digital technology.

This is the seventh licensing agreement that ARM has signed for its RISC chip; the other agreements are VLSI Technology, GEC Plessey Semiconductors, Sharp, Texas Instruments, Cirrus Logic and Samsung. ARM has been looking to strengthen its presence in the Japanese market, and AKM's commitment to the ARM architecture helps it to penetrate further this important market, where AKM supplies almost all the major electronics companies. This complements the existing license held by Sharp.

AKM has developed CMOS mixed-signal LSI technology and is engaged in the manufacture and sale of many full custom products and ASSPs in the field of mobile telecommunications, audio and mass storage. AKM focuses on system solutions, specializing in combining analog and digital circuitry. The company will combine the ARM7 microprocessor with its advanced mixed-signal technology to provide ARM-powered communications solutions. It plans to build chip sets for telephones adhering to the pan-European GSM standard, as well as the American IS54 and Japanese digital standards.

With most handsets using 8- or 16-bit microcontrollers, the 32-bit ARM may be something of an overkill, but ARM does offer a combination of performance, low-power consumption and small die-size vital requirements for systems embedded in consumer products.

The demise of one of ARM's competitors, the Hobbit, has been confirmed by AT&T which says it is closing the doors on its personal communicator venture, EO. AT&T acquired its 52 percent stake in the Santa Clara, CA, company in 1991. EO has sold fewer than 10,000 units of its personal communicator with the Hobbit core since its introduction a little over a year ago. AT&T says that it will re-evaluate its strategy in the wireless communicator arena.

A European Summer Slowdown?

Stories have been springing up in the European press that Europe is entering a summer slowdown in its PC market—or is this the first sign of a long-term slowdown? With the PC market accounting for more than 20 percent of European semiconductor consumption, any long-term slowdown could have dramatic effects.

From the semiconductor industry's viewpoint, there is not much evidence of a slowdown. DRAM prices in Europe remain unchanged and lead-times show no sign of shortening. If European PC manufacturers were scaling down their build plans, we would expect to see an effect on price and/or lead time.

However, we have heard of some PC companies reducing their DRAM requirements for the third quarter, although the major US companies show no sign of reducing their memory requirements and are, in fact, requesting more. The small no-name PC companies are coming under continued pressure from the big players, as well as having problems with securing memory.

It is worth remembering that the last two years have been unusual because the market has not experienced the traditional summer slowdown (across Europe companies take a much longer holiday period than in the United States and Japan).

With the time lag between production and sales now negligible, it is important to look at European shipments. Here, sales for the first quarter of 1994 were typical, while the second and third quarters are traditionally weaker; it looks like this year is no exception. A boost to the traditionally strong fourth quarter is expected from cheaper Pentium machines.

Currently, Pentium machines are expensive, and it may be that many people are delaying buying a new PC until the Pentium machines fall below the $2,000 mark. In the United States, Dell has already announced a sub-$2,000 machine while, in Europe, Pentium-class machines have not yet reached this level and are still hovering at about $2,500.

However, we expect Pentium machines to fall below $2,000 in Europe before the end of the year. The downward trend is being pushed by Intel in an effort to stem the success of the PowerPC, and the company is continuing to lower prices: at the beginning of July it cut the price of a 60-MHz Pentium by 13.0 percent to $581; for quantities of 1,000 plus machines the price will drop a further 28 percent to $418 in August.

At the moment, we do not believe that there is a long-term slowdown, but rather a seasonal slowing in demand, with people waiting for better deals on Pentium machines. Therefore, if the fourth quarter does boom as expected, with Pentium machines leading the way, we will see a worsening in the supply and demand balance for memory, especially 16M DRAMs, which is standard for Pentium-class machines.

Mitsubishi Electric to Assemble 16M DRAMs in Germany

Mitsubishi Electric Corp. will start assembling 16M DRAMs in Germany, commencing next January. The move is in response to growing demand for use in workstations and high-performance personal computers.

According to a report in the Japanese press, the company will turn out 300,000 chips a month at its plant in Alsdorf, Germany for sale throughout Europe. This unit is currently assembling 900,000 4M DRAMs per month for use in personal computers.

We are seeing continued globalization of the manufacture of electronics components by more politically astute international manufacturers, in response to the threats of dumping duties from Europe and the United States. Furthermore, Japanese companies are seeing investment abroad as a way to offset the losses caused by repatriating revenues during the period of a strong Yen.

Mitsubishi already has a fab shell at its site in Alsdorf, Germany, but this has not yet been equipped to carry out fabrication; when asked, Mitsubishi said that there may be some decision early next year concerning the site. However, since we have been waiting nearly three years for the investment decision, do not hold your breath!

Calluna PCMCIA Drives

Scottish disc drive designer and manufacturer, Calluna Technology, has announced that it has started shipping samples of its 170MB PCMCIA Type III discs drives; full production is due to start in September of this year.

Founded in 1991 by ex-Rodime employees, Calluna specialized in small form factor disk drives. The 170MB disk drive is the fourth PCMCIA mass storage device from Calluna, and follows the 85MB, 105MB and 130MB drives. It will be followed, in turn, by a 210MB product later this year.

Calluna points out that by December 1993, 361 PC models were announced with PCMCIA slots, 126 of which were Type III slots. Also, that in 1994 almost all new notebooks as well as many desktop machines will feature PCMCIA slots.

Siemens Profits Down

Siemens has reported it third-quarter results, with profits down for the nine months to June 30 at the equivalent of $784 million. Turnover for the nine months rose 3 percent to $36,269 million. The company said that it expects full-year net profits to be down 10 to 15 percent on the $1,240 million it reported for the year to September last.

Philips Profits Up

Philips, the diverse Dutch electrical group, reported that its net profits more than trebled in the second quarter. Profits reached Fl 402 million ($226 million) from Fl 117 million in the previous year. Sales rose 6.8 percent to Fl 14.3 billion from Fl 13.4 billion.

However, beneath the excellent improvement in profits, sales rose only 6.8 percent. "We're starting to see the benefits from cost-cutting," said Dudley Eustace, Philips' finance director, "but we can't cut costs forever. At some point you have to resolve the competitive situation by growing the company."

Philips will receive additional financial help from the partial public offering on the Taiwan stock exchange of Taiwanese Semiconductor Manufacturing Co. (TSMC), which is scheduled for September 5 this year. Philips currently holds 40 percent stake in the company.

Philips says the high growth in the semiconductor market and demand for picture tubes led to the components and semiconductor sector showing a growth in sales of 19 percent to Fl 4,334 million ($2,431 million), with income reaching Fl 750 million.

Fujitsu's Durham Plant "Best in World"

Fujitsu's semiconductor plant in Durham, United Kingdom has won the Best Factor award in the Fujitsu Group. The plant's impressive performance since its start-up in October 1991 resulted in it winning the internal Fujitsu award: the site had been able to move into profitability only two years after start-up

The Durham plant currently employs just under 500 people, and has been operating at a rate equating to £100 million ($153 million) per annum since the spring of 1994. Operational profitability was reached in October 1993 and, in December 1993, the plant reached 1.5 million devices per month. Production is planned to reach about 2.5 million devices per month by the spring of 1995.

During 1995, Fujitsu will increase production of the shrunk version of 4M DRAM and will introduce 16M DRAM production, with maximization of plant capacity in 1996. In 1998, there is the possibility of a second fab at that site coming online.

Siemens Upgrades the Unbuilt Dresden

Just months after breaking ground on its new facility in Dresden, Germany, Siemens has announced that it will upgrade plans for the site and will include back-end facility. The latter will add about $65 million to the cost of the site, increasing the number of jobs created by 250.

Siemens plans to institute a completely new back-end concept to outweigh the disadvantages, in terms of salaries, of using Germany as a test and assembly location. This will include a fully computerized production control system and increased automation, resulting in a significant reduction in production throughput times. This reverses a decision made at the end of 1993 (see *IC Europe*, December 1993) to move production to the Far East to help stem losses in the semiconductor division.

Suard Charged With Embezzlement: Keeping Up with the Americans

Pierre Suard, Chairman of Alcatel Alsthom, has been charged with embezzlement, fraud and corruption for failing to explain why he spent $720,000 of company money on security systems for his two residences. This is the latest in a series of scandals surrounding Alcatel-Alsthom. In the past, other managers were accused of overcharging France Telecom to the tune of FF 80 million.

Fortunately, Europe still has some way to go to match the Americans. In the 1980s, the US defense industry—the most pampered commercial kids of the Reagan era—set a criminal standard to which many other corporations still apparently aspire. Boeing, Rockwell International, General Dynamics, Lockheed, General Electric and Northrop all have criminal records; several are repeat offenders. Even the Pentagon referred to such corporate behavior as "systemic," "insidious" and "company-approved."

News Round-up

WSTS has announced that unit shipments for the 4M DRAM have outstripped a record standing since 1984. Since the peak of the 64K DRAM, all subsequent generations have peaked at successively lower quarterly unit shipments, leading analysts to believe that a predictable trend was in place. The 4M DRAM appears to have undone this, breaking the record held by the 64K after nearly a decade.

SGS-Thomson has won approval from the European Commission to approach the French and Italian governments for more funds to support research and development activities.

Grundig Satellite Communications, the satellite TV joint venture between Grundig of Germany and Gooding Consumer Electronics of the United Kingdom, has picked up the low noise block (LNB) business of GEC-Marconi for an unnamed amount.

Oxford Instruments of the United Kingdom is "delighted" to hear that IBM, AT&T, Motorola and Loral have announced a joint venture to develop x-ray lithography for future generations of semiconductor chip manufacturing. The alliance involves an investment in excess of $100 million, along with governmental funds. The joint venture will conduct development at IBM's Advanced Semiconductor Technology Center (ASTC) located at East Fishkill, NY. This is where IBM has been operating a synchrotron built by Oxford Instruments since the mid-1980s.

IBM's overhaul of its PC operations in the United States—closing down the Boca Raton research and development center and moving it to the Raleigh manufacturing site as well as other changes—has meant good news for John McLelland, who becomes Vice President of Worldwide Manufacturing. The promotion of the Scot to this post is a vindication of the success of IBM's Greenock facility, and will be of help to Greenock employees who have to justify why IBM has this massive site on the edge of Europe.

Tulip Computers, the Dutch PC manufacturer, has announced that it will start construction of a new factory and offices at Rosmalen, Netherlands this autumn. The new site will have an eventual production capacity of 300,000 units, research and development will also be relocated there.

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I. C. EUROPE

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I.C. EUROPE

A Monthly Report on European High Technology Industries

July 1994

In This Issue

I.C. Europe is a monthly report on European high-technology industries. The information is compiled and published by Dataquest's UK-based European Semiconductor Group research team with contributions from Paris, San Jose, and Tokyo. This month's contributors are: Mike Glennon, Sarah Jacob, David Moorhouse, Andrew Norwood, Adrian Walker, and Mike Williams.

State of the Industry

The WSTS flash three-month average bookings for the month of June were $1,656 million, a 2.1 percent decline over May's restated $1,691 million. May was restated upwards by 1.1 percent over last month's preliminary figure.

The flash actual billing figure for June was $1,755 million, dropping the three-month average book-to-bill ratio to 1.06. Figure 1 shows the European three-month average bookings and billings; and the book-to-bill ratios for the past 13 months.

Booking and billing figures are gradually approaching normal behavior, following two years of high growth. This is apparent in the return of seasonal conditions. Three-month average bookings are showing a small decline, which is normal for this time of year. Actual billings are showing their typical end-of-quarter peak—again normal for this time.

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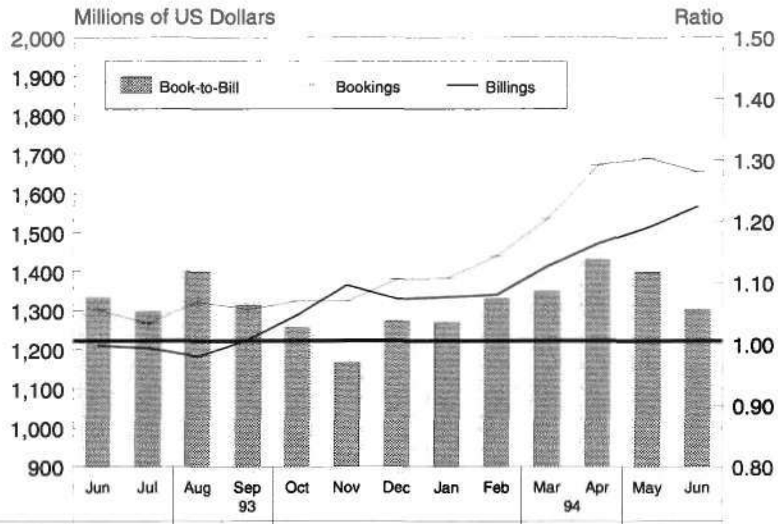
European Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	Jun	Jul	Aug	Sep 93	Oct	Nov	Dec	Jan	Feb	Mar	Apr 94	May	Jun
Book-to-Bill	1.08	1.05	1.12	1.06	1.03	0.97	1.04	1.04	1.07	1.09	1.14	1.12	1.06
Bookings	1,302	1,267	1,322	1,303	1,324	1,324	1,380	1,383	1,440	1,535	1,674	1,691	1,656
Billings	1,210	1,204	1,182	1,225	1,289	1,366	1,330	1,335	1,341	1,413	1,471	1,513	1,567

Source: WSTS, SIA

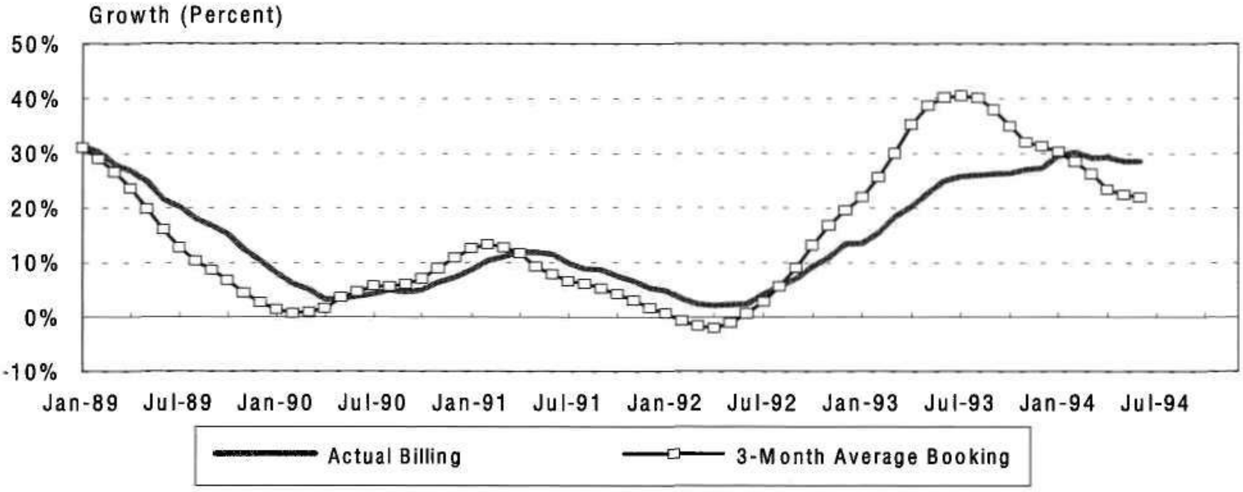
The net Figure 1result is the fall in the book-to-bill ratio. We would normally expect the ratio to fall below 1 in August, and stay there until January, but the above-average level of the ratio may delay this fall below unity until September or October.

Looking at the longer-term averages shows the stabilization of the market, and the return to normal behavior. Figure 2 shows the 12-month average for bookings and 3-month average billings, and it is clear from this that billings growth has stabilized. Bookings growth has been falling for nearly a year now, but this too may be levelling off at about 20 percent. With billing growth levelling at between 25 and 30 percent, the scene is set for the book-to-bill ratio to fall below 1.

Three-month average growth is less clear, but Figure 3 does suggest that the longer-term growth may be stabilizing. Bookings 3-month rolling-average growth is showing signs of an upturn following a reasonably stable period, compared to the slow decline of the 12-month average booking growth. Billings data are less clear, but the cyclical nature of 3-month average compared with the relatively stable 12-month average does imply some stability at least.

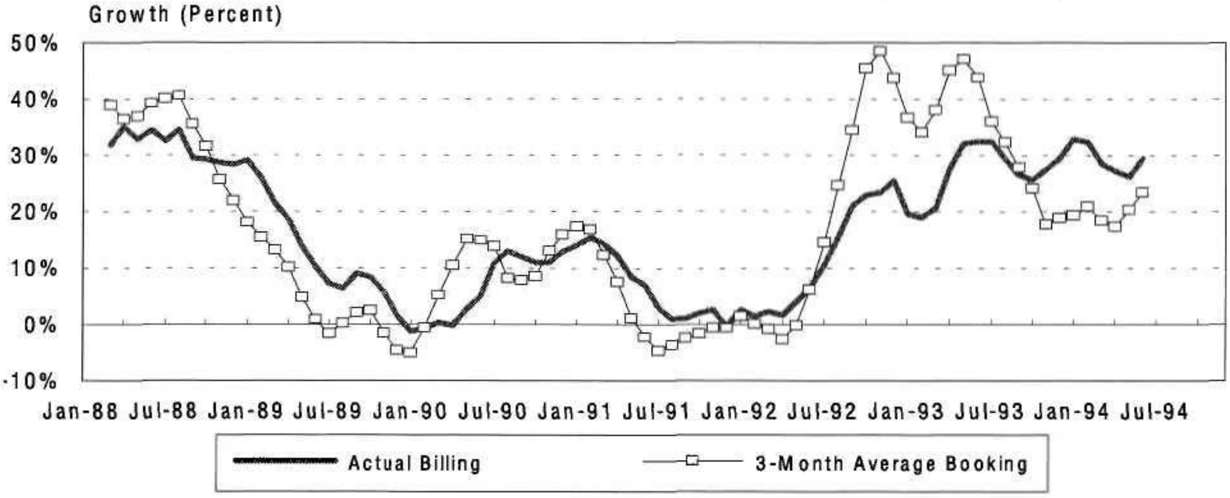
The market this year is stabilizing, and we are seeing a return to more normal behavior. The seasonality we have seen in previous years has returned. This is clear from the booking and billing data, but also

Figure 2
European 12-Month Moving Average Semiconductor Booking and Billing Growth



Source: WSTS, SIA

Figure 3
European 3-Month Moving Average Semiconductor Booking and Billing Growth



Source: WSTS, SIA

anecdotal evidence supports a summer slowdown in equipment production. PC sales in particular are slowing—and the general feeling is that this is due to a seasonal slowdown rather than a fundamental fall-off of demand.

In the longer term there is still a shortfall in capacity, and this is keeping average prices high. We expect these prices to remain high while capacity is short. Shortfalls in DRAM production, for example, are unlikely to be resolved before mid-1995. The longer-term outlook is still for high growth—about 25 percent for 1994—with 1995 also returning reasonable revenue for most companies.

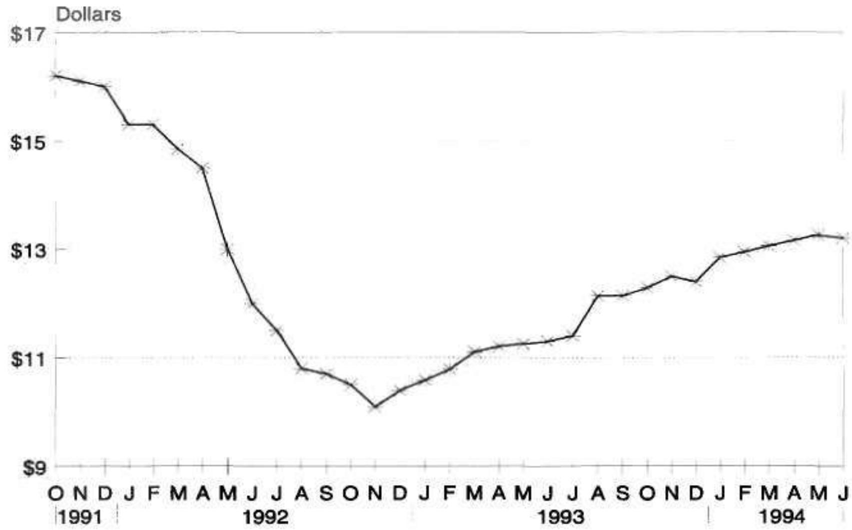
Historical Pricing Trends

This section of I.C. Europe looks at historical pricing trends for a key semiconductor component. This month the focus is on 4M×1 DRAM.

Figure 4 illustrates the historical pricing curve for the 4M×1 DRAM in Europe since the end of 1991. The normal erosion for the DRAM families is evident in the first part of the graph, but there was a dramatic reversal at the end of 1992 that has kept the average sales price (ASP) rising continuously since then.

The years 1991 and 1992 were extremely slow for the sector that demands much of the DRAM devices sold in Europe—electronic data processing (EDP). Much of the production in Europe in this segment is centered around the PC, and the market during 1991 and 1992 was relatively weak. This weakness had been passed on to the semiconductor suppliers, and they had seen a significant reduction in profits, resulting in a ramp-down in capital investment. DRAM production lines were run down, new lines were not commissioned, and new factories were not built. Demand was slow for 4M DRAM, and the pricing fell throughout the years 1991 and 1992. However, with PC prices falling, consumers switched back to PC purchases at the end of 1992. The increase of demand for PCs resulted in a large production increase, and hence a very large jump in the

Figure 4
Historical Pricing Trends in Europe, 4M×1 DRAM 80ns 100,000 Units Minimum Price



Source: Dataquest (July 1994 Estimates)

requirements for memory, especially the 4M DRAM, which was the latest DRAM generation.

Since the end of 1992, the 4M DRAM price has risen to over $13, jumping in July 1993 due to the Sumitomo explosion. Even though new production lines have been running up to full capacity, there is still a demand/supply imbalance. DRAM suppliers have invested in 4M DRAM production, but as the device is due to reach peak volumes this year, they are also conscious of the next generation, the 16M. 4M devices have been produced on 16M lines, and also some microprocessor, ASIC and SRAM lines have been converted to produce 4M DRAM in a struggle to keep up with the huge demand from the PC segment.

There are some signs that supply is nearing demand for some 4M devices at the moment. However, there are a multitude of devices in the 4M DRAM family and Dataquest expects that some may stay in allocation for the foreseeable future as demand patterns change. There is a definite trend towards wider devices (especially ×16) which are still in the minority of the total production numbers.

Dataquest expects that the cost per bit crossover of 4M and 16M should occur during the late part of the third quarter of this year. Users are beginning to migrate to the 16M device, but the supply/demand gap could be worse than that for the 4M DRAM. Dataquest estimates that the gap could reach as much as 25 percent before the year-end.

At this stage, the end market demand for PCs is still strong, and although there could be a small slowdown during the summer months, Dataquest expects the fourth quarter to be particularly strong. If this happens, the pressure on 4M DRAM will increase again, keeping prices high and the lead times out beyond 16 weeks.

Semiconductor Pricing and Analysis

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

Standard Logic

This month's survey has shown little change in pricing levels for standard logic devices. Overall business levels have remained strong, with no signs of any softening.

Analog

There was no change to the price or delivery from this month's survey.

Microcomponents

There was no change recorded for microcomponents this month. Business has remained strong for all Intel processors, and initial signs are that sales of PowerPC processors has started well.

Memory

The overall scenario for memory is largely unchanged from last month's survey. Prices are firm, lead times are steady, and supply is still lagging behind demand. PC producers are bracing themselves for a very busy final quarter to this year, as the traditional Christmas market is expected to be particularly buoyant.

DRAM

DRAM prices and lead times are largely unchanged this month. Most suppliers are booked through the rest of this year, with certain multinational customers showing exceptional demand levels.

Demand for 1M devices is remaining strong, but there are some mix changes occurring in the short term. The continued exodus of suppliers from the discrete 1M market is causing many customers to begin their upgrade to either 4M or 16M.

Pricing of 4M DRAM is still steady, with demand for certain organizations pushing lead times out. Notable in this is the ×16 devices, where the continued increase in demand for video applications is the main reason for the demand spike.

Demand for 16M DRAMs is rising quickly, with key customers beginning to increase their volumes. Although prices are falling, 16M DRAM based modules are still relatively expensive, but despite this, their popularity is increasing.

Table 1
European Semiconductor Pricing June 1994
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (percent)	1K Adder (percent)	Lead Time (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.46	10%	15%	10-16
74F244	PDIP	100K	0.32	10%	15%	10-16
Analog						
78L05	TO92	100K	0.16	10%	10%	16-24
IMSG176D 35-MHz Video DAC		100K	1.30	15%	25%	8-12
Microcomponents						
80386SX-25	PQFP	5K	18.00	0%	5%	4
80386DX-40	PQFP	5K	25.00	0%	10%	2-6
80486DX-33	CPGA	5K	220.00	-5%	5%	10-14
68040-25	CPGA	5K	195.00	-5%	10%	10-14
R3000-25	CPGA	5K	75.00	-5%	15%	4-10
DRAM						
1M×1-80 (1M)	SOJ	100K	4.90	5%	15%	18
4M×1-80 (4M)	SOJ	100K	12.95	5%	15%	12-14
512K×9-80 (4M)	SOJ	100K	15.00	5%	15%	12-16
256K×16-80 (4M)	SOJ	100K	14.95	5%	15%	18
4M×4-70 (16M)	SOJ	10K	58.50	0%	15%	10-12
(4M×1)×2+1M-80	SIMM	50K	34.50	5%	15%	16
128×8-80 VRAM	SOJ	100K	6.80	5%	15%	12
Flash						
1M-17 (128K×8)	PDIP	10K	5.30	0%	30%	14-16
2M-17 (256K×8)	PDIP	10K	11.85	0%	30%	14-16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	5.05	10%	20%	16
SRAM						
256K-70 (32K×8)	PDIP	50K	3.25	5%	10%	12-14
256K-25 (64K×4)	PDIP	20K	4.15	5%	15%	12-14
1M-70 (128K×8)	PDIP	50K	8.80	5%	10%	12-14

Source: Dataquest (July 1994 Estimates)

SRAM

There are signs of a tightening in supply for some key SRAM devices. This seems to be due to a combination of causes. Demand has strengthened on a worldwide basis with some signs of the consumer market, a key area for SRAM consumption, recovering slightly. Coupled with this is the ramp-back in production for the 1M SRAM. Also, the slow upgrade to the 4M device has kept demand for the 1M and 256K densities remaining for longer than would normally be expected.Flash

Prices are continuing to fall for flash devices, as supply becomes close to demand. The main areas of demand are for the 1M and 2M densities, and although Intel still holds a majority of the market, other suppliers have announced recent joint ventures, including NEC with Sundisk and SGS-Thomson with AMD, which should stand them in good stead for the future.

EPROM

EPROM prices have shown little change in this month's survey.

Current Exchange Rates

1 US dollar =
0.646 pounds
1.569 deutsche marks
5.386 French francs
0.822 ECU

Special Review

This month's special review presents the highlights from a recent Dataquest Perspective from Dataquest's Asia/Pacific service, looking into Asia/Pacific's soaring semiconductor chip deficits.

Asia/Pacific's Semiconductor Chip Deficits Soars

The Asia/Pacific semiconductor market continues to thrive, and semiconductor manufacturers are scurrying to expand local facilities to capture opportunities in the world's fastest-growing markets. However, as Dataquest forecasts Asia/Pacific semiconductor consumption to surpass Japan by 1996, we see the semiconductor industries are uninvested and ill-prepared for this level of growth:

- Asia/Pacific's semiconductor demand is forecast to expand by 32 percent to approximately $21 billion in 1994.
- Semiconductor production will exceed $10 billion, with a growth rate of 26 percent.
- The difference between Asia/Pacific's semiconductor consumption and its production will increase by 37 percent, which is faster growth than either consumption or production.
- Capital spending in 1993 and 1994 is growing by a feverish 62 and 58 percent, respectively.
- We believe the growth in Asia/Pacific's huge gap between consumption and production will not begin to slow until after 1996.

When examining Asia/Pacific's semiconductor production and consumption from 1991 to 1994, a number of points stand out. Asia/Pacific semiconductor consumption will have more than doubled during a three-year period, unprecedented by any market of this size in history. Semiconductor production will have nearly tripled in the same period.

Nevertheless, opportunities for semiconductor manufacturing have proliferated as locally produced semiconductors account for less and less as a percentage of the total available market. This is even more surprising when one considers the proven success of semiconductor suppliers which have invested in manufacturing to improve market share.

But the picture is much worse than predicted above. In actuality, South Korea's massive expenditures in DRAM manufacturing are for world exports, while only Taiwan, China and Singapore, to a lesser extent, are shipping most of their products to Asia/Pacific. Therefore, if one was to exclude both the Korean market and industry from this picture, the imbalance is more extreme. The lagging investment in Southeast Asia front-end semiconductor manufacturing is becoming a major political issue in China, Hong Kong, Taiwan and Singapore.

European investment is almost nonexistent in this region, only SGS-Thomson having a front-end operation. SGS-Thomson's Fab One in Singapore remains focused on consumer but there has been no official announcement of its expansion. SGS-Thomson manufactures bipolar and MOS consumer ICs and power transistors using 4- and 5-inch wafers. It has decided to expand its design center facilities, and this could be followed by further fab expansion. As this company looks to build more wafer fabs around the world, Asia/Pacific is likely to be one of its first.

Dataquest Perspective

Capital spending rebounded in 1993 but did not generate enough new capacity in 1994 to slow the growth in Asia/Pacific's "chip deficit." We expect a repeat of this scenario in 1995 as the markets continue to significantly outpace the region's ability to feed itself. This will spell large, long-term opportunities to those that capitalize on these local markets.

Although the region has led the world in semiconductor capital spending in recent years, its semiconductor markets continue to outpace the region's production, thereby increasing "chip deficits" and political concerns of "foreign dependence." We believe semiconductor manufacturers will increasingly turn to this region as a semiconductor manufacturing base, whether it be for foundry services or investments in their own semiconductor wafer fabrication facilities.

By Daniel Heyler

Daniel Heyler, based in Korea, is just one of the Dataquest analysts based in the Asia/Pacific region carrying out local research for the Semiconductors Asia/Pacific service. Other recent reports from the Asia/Pacific service this year include:

Semiconductor Market Opportunities in China
Asia/Pacific-Rest of World Semiconductor Consumption by Application
Final 1993 Asia/Pacific-Rest of World Semiconductor Market Share
Mainland China Semiconductor Consumption by Application Market Forecast
Taiwanese Electronic Equipment and Semiconductor Consumption Outlook

Still to come:-

Singapore Semiconductor Consumption by Application
Hong Kong Semiconductor Consumption by Application
Asia/Pacific Wafer Fabrication Facilities
Asia/Pacific Round-Up 1994 and Outlook 1995
Hong Kong Electronic Equipment and Semiconductor Consumption Outlook
Singapore Electronic Equipment and Semiconductor Consumption Outlook
Taiwan Semiconductor Manufacturing Company—Profile

For more information on any of the above reports or our other Asia/Pacific research please contact Andrew Norwood on +(44) 494 422726

Industry Highlights

Researchers and analysts in Dataquest's European Semiconductor Group routinely gather intelligence on the European semiconductor market. Some of this information is published electronically on a weekly basis via Dataquest's Semiconductor Online Service DQ Monday. The following key European industry events review the past four weeks, and are selected on the basis of their perceived industry impact.

NEC Looking for a Home for $1 Billion

NEC is looking at establishing a new semiconductor fabrication plant; at the moment the United Kingdom and the United States seem the likely options. A decision on where the plant will be sited will be made this autumn.

If NEC does invest $1 billion in a new plant, it will be the single biggest investment by NEC, and the most surprising thing about this announcement is that Japan is not even in the running. The main reason that Japan is out of the running is, of course, the high value of the yen, which also makes overseas investment much more attractive.

At the moment NEC has six plants inside Japan: these are Kumamoto, Hiroshima, Kanagawa, Shiga, Yamagata and Yamaguchi. Although production at most of these plants has been increased, this year the limit of expansion has been reached. Outside of Japan NEC has one plant in the United States at Roseville, California, and the other in Livingston, Scotland.

Expanding existing locations is the obvious choice; the Californian plant—which is the biggest—is not seen as such an attractive option because NEC would not necessarily want to concentrate such a large portion of its foreign production in one location. There is also continuing anxiety about the probability of a major earthquake in California before the end of the century.

It is understood that NEC plans to use its latest plant in Kyushu, number 8 line, as the blueprint for any new development; the Kyushu plant is set to manufacture 16M DRAMs along with SRAMs and RISC processors. The new plant will be used for the manufacture of 16M, leading onto 64M DRAMs, as well as ASIC products, which NEC sees as a strategic market. NEC has not announced the size of any investment, but the Kyushu plant's investment now stands at about $950 million.

According to the *Financial Times* newspaper, the new plant will also be manufacturing 60M DRAMs. At the moment Dataquest does not expect this market to take off, although it could become a niche market!

A European Summer Slowdown?

Stories have been springing up in the European press that Europe is entering a summer slowdown in its PC market. Or is this the first sign of a long-term slowdown? With the PC market accounting for more than 20 percent of European semiconductor consumption, any long-term slowdown could have dramatic effects.

From a semiconductor point of view there is not much evidence of a slowdown. DRAM prices in Europe remain unchanged, and lead times show no sign of shortening. If European PC manufacturers were scaling down their build plans, we would expect to see an effect on price and/or lead time.

However, we have heard of some PC companies reducing their DRAM requirements for the third quarter, although the major US companies show no sign of reducing their memory requirements and are requesting more. The small no-name PC companies are coming under continued pressure from the big players, as well as having problems with securing memory.

It is worth remembering that the last two years have been an unusual period because the market has not experienced the traditional summer slowdown; across Europe, companies take a much longer holiday period than in the United States and Japan.

With the time lag between production and sales now negligible, it is important to look at European shipments. Here, first-quarter 1994 sales were typical; second- and third-quarter sales are traditionally weaker, and it looks like this year is no exception. But we expect a boost to the traditionally strong fourth quarter from cheaper Pentium machines.

At the moment the Pentium machines are expensive. It may be that many people are putting off buying a new PC and are waiting for Pentium machines below the $2,000 mark—Dell has already announced a sub-$2,000 machine in the United States. In Europe, Pentium-class machines have not reached this level and are hovering around $2,500.

However, we expect Pentium machines to fall below $2,000 in Europe before the end of the year. The downward trend is being pushed by Intel in an effort to stem the success of the PowerPC. Intel continues to lower prices: at the beginning of July it cut the price of a 60-MHz Pentium by 13.0 percent to $581; the price will drop a further 28 percent to $418 in August—this is for quantities of 1,000-plus.

We do not believe there is a long-term slowdown at present, but rather a seasonal slowing in demand and people waiting for better deals on Pentium machines. Therefore, if the fourth quarter does boom as expected, with Pentium machines leading the way, we will see a worsening in the supply and demand balance for memory—especially 16M, which is standard for Pentium-class machines.

ARM RISC Processors for TVs

A UK company, Online Media, formed by Acorn Computer (the Olivetti company) has developed a consumer set-top box for interactive TV, video-on-demand (VOD), video CDs and computer games.

The set-top box design is based on the ARM-610 RISC processor with I/O and video controller ICs also designed by ARM, an MPEG-1 image decoder from C-Cube, 2MB ROM and a minimum 2MB RAM. Online plans to integrate as many of these functions on one chip as possible. The boxes will sell for between $300 and $450, as anything more expensive will deter customers.

Online, a spin-off launched last week by Acorn Computers in Cambridge, England, will subcontract the manufacture of the boxes. It has teamed up with international equipment and information suppliers such as Olivetti, Bell Northern Research (part of Northern Telecom), News International, and Alcatel NV.

Technology partners with Online include ARM and Advanced Telecommunications Modules Limited (ATM Ltd.) of Cambridge. ATM Ltd. has developed a low-cost, high-speed standard networking interface for the box. System software is supplied by Oracle, and this is also in VOD trials by BT and Bell Atlantic.

$40 Million Korean Investment in United Kingdom

Goldstar Electronics is to invest $40 million in a new venture creating more than 400 new jobs at its new plant in Washington, Tyne and Wear, England, for the manufacture of color televisions and microwave ovens. In attracting Goldstar to the United Kingdom, Industry Minister Tim Sainsbury said: "This is another major success for the United Kingdom and the northeast of England. It reflects the government's continuing commitment to attracting quality inward investment projects and to maintaining a user-friendly business environment."

As an incentive to investing in the United Kingdom, the UK Department of Trade and Industry will provide $6 million Regional Selective Assistance (RSA) grant to the Korean company. RSA grants are available to UK and overseas companies to support investment in the Assisted Areas of England, Scotland and Wales designated as Development or Intermediate areas. Available to both manufacturing and service industries, RSA gives financial help to those projects which are shown to be viable, that create or safeguards jobs, benefit the regional and national economy, and which without the assistance of the RSA would not go ahead.

Philips Reduces LCD Stake

Philips has sold a 10 percent stake in the Flat Panel Display company (FPD) to Germany chemicals company Merck; this reduces Philips' holding to 70 percent. FPD was formed at the end of 1992, with Philips as the largest investor with 80 percent. Two other companies, Thomson and Sagem, each held a 10 percent stake, and this will remain unchanged. The Eindhoven, Netherlands factory already sells active LCDs, but full commercial production is not due to start until autumn.

Merck, which has particular expertise in liquid crystal materials, says it does not want to produce active matrix LCDs, and compete with its customers, but rather to understand the issues of production. Thus, it looks at this as a kind of research and development.

GPS Improves Its Image with MPEG-2

UK-based GEC Plessey Semiconductors (GPS) is about to sign a deal to develop MPEG-2 devices for the potentially massive market of digital set-top boxes. GPS is building on its strengths in compression from development of a chipset for videoconferencing and its long-established presence in the TV and cable TV industries with radio frequency (RF) devices. It is already a significant supplier to cable TV set-top box manufacturers, including the biggest of them all, General Instrument of the United States.

General Instrument's dominance of the cable TV industry in the United States has put it under pressure via an antitrust investigation. In an attempt to head off this investigation, General Instrument has adopted a strategy of promoting an open standard architecture for digital set-top boxes and providing its proprietary compression technology to the merchant market.

General Instrument's compression technology "Digicipher" will be integrated with MPEG-2 in a chipset to provide a common semiconductor solution for both standards. General Instrument has recently signed deals with other semiconductor vendors in an attempt to generate cost-effective industry standards. The benefits to any semiconductor company licensed with this technology could be enormous. In the fourth quarter of this year Dataquest will produce an in-depth report on digital video compression concentrating on its use in digital video consumer products.

Bosch Announces Loss of $63.3 Million

Robert Bosch, the privately owned German electronic and vehicle parts manufacturer, has announced operating losses of more than DM 100 million ($63.3 million) for last year.This loss can be attributed to a number of causes which includes:

- Recession
- Pressure on prices from car manufacturers
- Low capacity utilization
- Strength of the deutsche mark

In addition to the above are the costs that Bosch has incurred as a result of its rationalization measures undertaken in the last 12 months to cut costs and improve productivity. This has included the reduction of 13,200 jobs. A further 4,100 jobs are to go, leaving a work force of 152,500 by the end of 1994.

Hermann Scholl, the group's chairman, stated that the turnover in the first five months of 1994 are up 6 percent. He indicated that this was due to demand outside of Germany, and his overall opinion was that sales by the end of the year would be up 4 percent and that we should see a modest turnover growth in 1995.

In addition to this, Bosch indicated that it is restructuring its communication technology activities: public communications technology, private communications technology and radio technology have been brought together into one division from July 1. Mr. Scholl said: "The objective of the above restructuring is designed to strengthen Bosch's position in a growing but intensely competitive market."

SGS-Thomson and AMD Agree on Flash Standard

SGS-Thomson and AMD have announced an agreement to cooperate on the definition of future flash memory products. The collaboration, based on AMD's single-voltage architecture, will hasten growth in the worldwide flash memory market. Both companies will independently develop compatible products around the standard. This brings to three the number of major memory suppliers supporting a standard flash memory architecture. AMD's joint venture with Fujitsu was announced in 1992, and the two companies are completing construction of a fab in Japan this year.

Last year SGS-Thomson garnered the number-one position in worldwide EPROM shipments partly by seizing the opportunities left behind by Intel and AMD, both of which reduced their shipments into the growing EPROM market and increased their flash memory shipments. It is not unusual for participants in the flash market to convert some of their other businesses to flash, and this is what got Catalyst into trouble last year. We believe that SGS-Thomson will want to maintain its newly achieved number-one position in the EPROM market, and will enter the flash market through expansion, rather than conversion.

AMD, meanwhile, is following a track of standardization and strong competitive sourcing to try to wrestle the market away from Intel, the current first-ranked supplier. The success of this approach cannot be predicted, but should be fuelled mainly by the strength of the competitors sourcing AMD-compatible products. SGS-Thomson is a good choice, since it has a proven basis in its EPROM technology.

IBM Selling French Fab

Rumors are that IBM looks is looking to sell its bipolar fabrication plant in Corbeil-Essonnes, France. The company is seeking either a buyer for the line or a company to take over the running of it. The plant has a capacity of 30,000 5-inch wafers, but is upgradable to 6-inch process. IBM has apparently received interest from several US and Far Eastern companies including International Rectifier, QPL, Exar and National Semiconductor.

Olivetti and Hughes to Invest in New Company

Hughes Network System of the United States and Olivetti of Italy have formed a new company to provide digital satellite communications across Europe. The new Hughes Olivetti Telecom company will take over the existing very small-aperture terminal operations of Hughes in the United Kingdom. Hughes and Olivetti each own 50 percent of the new company. The two companies will jointly invest $25 million in the project over the next five years, after an initial capital investment of $2 million. The new organization will provide a network that can carry voice, data and video communications from London to Central and Eastern Europe. The services network is known as Hotstar.

News Round-Up

Philips Display Components of the Netherlands has announced that it plans to invest Fl 75 million ($35.5 million) in its picture tube factory in Brazil. **Mitsubishi** is to start the assembly of microcontrollers at its plant in Alsdorf in Germany; although no date was given, a company spokeswoman said it would be "in the near future." **Longshine Electronics** of Taiwan is planning to invest in a plant in Europe to manufacture CD-ROM drives and, later, wireless LANs. Initial CD-ROM production would be in the region of 30,000 a month. Rumor has it that **Simtek** of the United States is phasing out GPS as a source of nonvolatile memory chips and has signed a licensing and development deal with German company Zentrum Mikroelektronik Dresden.

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I.C. EUROPE

A Monthly Report on European High Technology Industries

June 1994

In This Issue

I.C. Europe is a monthly report on European high-technology industries. The information is compiled and published by Dataquest's UK-based European Semiconductor Group research team with contributions from Paris, San Jose, and Tokyo. This month's contributors are: Mike Glennon, Sarah Jacob, David Moorhouse, Andrew Norwood, Adrian Walker, and Mike Williams.

State of the Industry

The WSTS flash three-month average bookings for the month of May were $1,673 million, continuing the consecutive billion-dollar booking months. May was the 21st consecutive month of billion-dollar-plus bookings, and the actual three-month level was the highest recorded level ever for three-month average bookings. The preliminary figure was practically flat on the final level for April.

The 3-month average billings figure for May was $1,416 million, resulting in a book-to-bill ratio of 1.12. The billings level has reduced by 3 percent from April's level, which was a record billings level of $1,465 million. Figure 1 illustrates the 3-month average bookings and billings in Europe, and the book-to-bill ratio for the last 13 months.

The 3-month and 12-month average growths for bookings and billings are shown in Figures 2 and 3 respectively. The actual 12M growth in bookings has been slowing since the second quarter of 1993, but the

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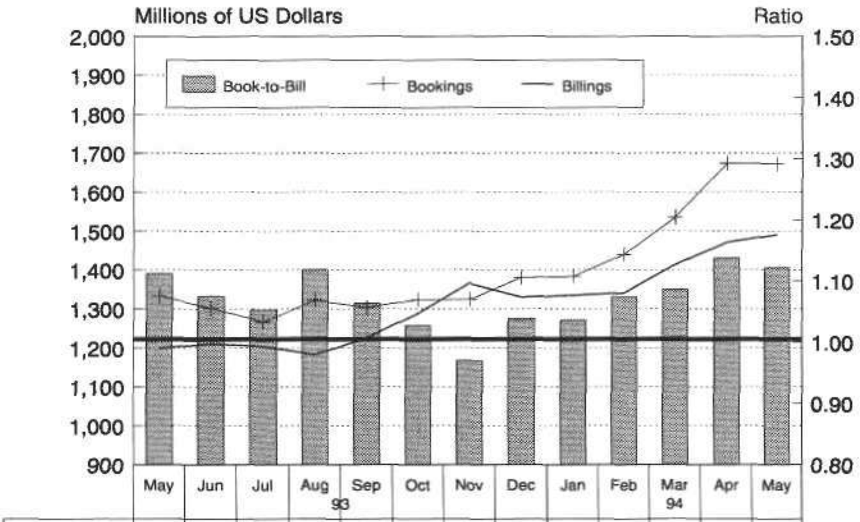
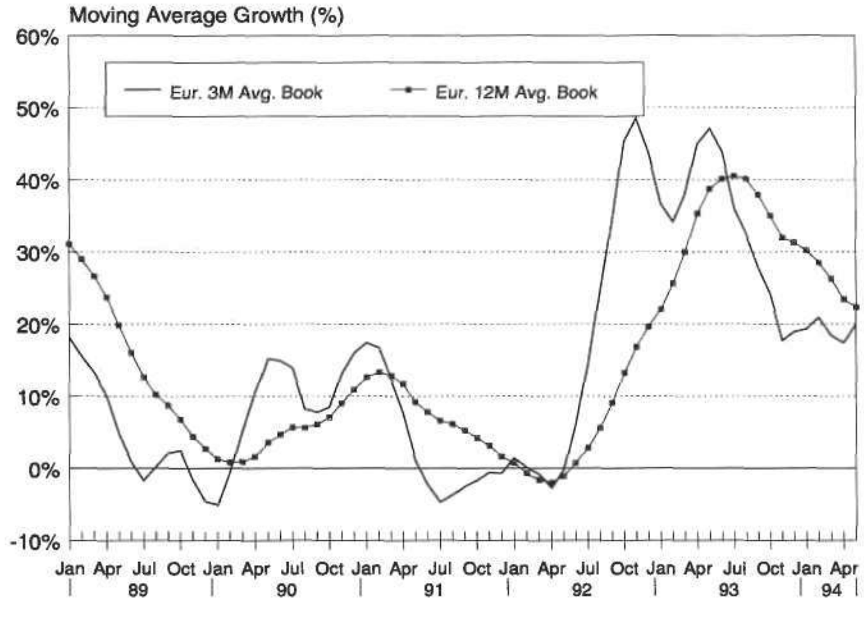
Figure 1
European Semiconductor Orders Booked and Sales Billed (Three-Month Average)



	May	Jun	Jul	Aug	Sep 93	Oct	Nov	Dec	Jan	Feb	Mar 94	Apr	May
Book-to-Bill	1.11	1.08	1.05	1.12	1.06	1.03	0.97	1.04	1.04	1.07	1.09	1.14	1.12
Bookings	1,334	1,302	1,267	1,322	1,303	1,324	1,324	1,380	1,383	1,440	1,535	1,674	1,673
Billings	1,199	1,210	1,204	1,182	1,225	1,289	1,366	1,330	1,335	1,341	1,413	1,471	1,491

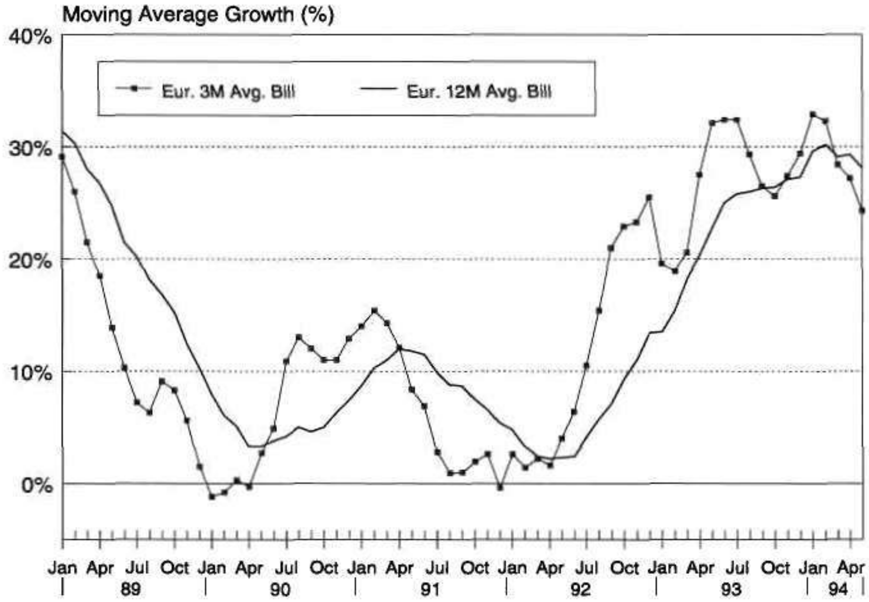
Source: WSTS, SIA

Figure 2
European Total 3-Month and 12-Month Semiconductor Bookings Growth



Source: WSTS, SIA

Figure 3
European Total 3-Month and 12-Month Semiconductor Billings Growth



Source: WSTS, SIA

growth is still hovering at 20 percent of one year ago. Considering that the level in 1993 was more than 40 percent ahead of 1992 illustrates both the strength and length of the current boom.

Many suppliers are now fully booked well into the final quarter of this year, and there are no signs of any reduction in end-market activity at this stage.

Billings levels have tailed off recently, with the short-term 3-month average dipping below the longer-term 12-month line. Billings growth is still close to 30 percent over last year, and there are signs that the billings could pick up again provided all orders booked can be billed later in the year.

Dataquest Perspective

The PC production boom shows no sign of slowing in Europe. All major PC producers are trying to achieve the aggressive build plans that they set themselves at the beginning of the year. PCs based on the 486 processor are now responsible for close to 80 percent of PC shipments, and this is increasing demand for other semiconductor devices, especially memory, PC chip sets and specialist logic devices.

Dataquest has estimated that the PC semiconductor total available market (TAM) in Europe was worth more than 20 percent of the total TAM in Europe in 1993. This level is sure to rise during 1994, provided there is no sustained slowdown in PC manufacturing in the second half of this year. Dataquest has heard of some build-up in inventory levels among some subcontractors in the United States, along with some signs of supply channels for PCs filling up. However, these seem to be seasonal factors rather than any definite indications of slowdown in the end markets for PCs.

In Europe there are signs that other industry segments are stabilizing. The automotive market has grown in the United Kingdom during this year, though other regions have had little or no growth during 1993, year to date. Consumer markets are relatively sluggish, with some activity increase in satellite receivers. The World Cup during June could prompt some extra demand for color TV and VCR, but this effect should be short-lived. In the telecommunications market, demand for GSM mobile telephones is still very strong and will continue throughout the rest of this year.

The semiconductor market has matured over its lifetime, and seems to be modulating the peaks and troughs in the market that have been seen in the past. At this time, the market demand for semiconductors is strong, and Dataquest can see no reason for this situation to drop away rapidly. The historic boom-bust cycle for the semiconductor industry could be a thing of the past, as the increased pervasion of semiconductors continues.

Historical Pricing Trends

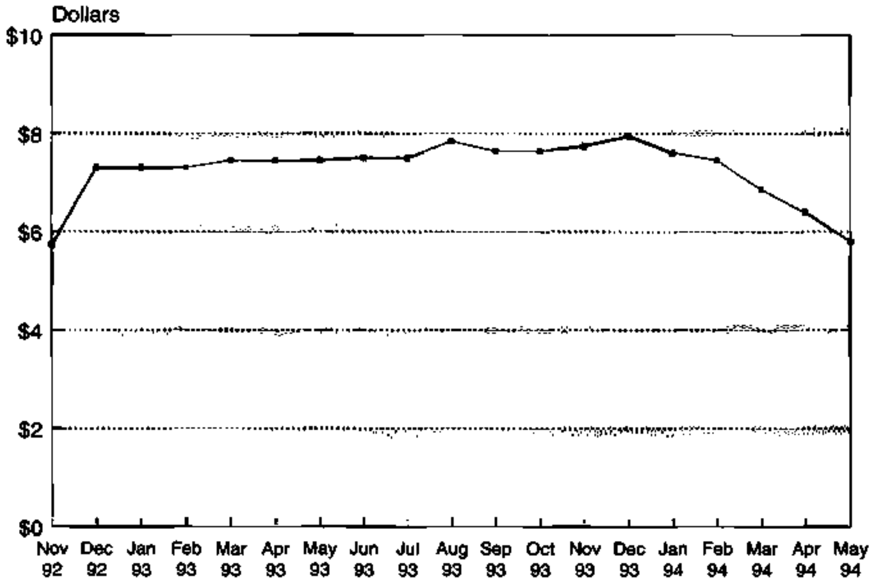
This section of I.C. Europe *looks at historical pricing trends for a key semiconductor component; this month the focus is on 1M flash memory.*

Figure 4 shows the historical pricing trends for flash memory since November 1992. During this time period, the relatively young flash memory market has developed strongly by replacing design slots traditionally held by other forms of nonvolatile memory and also being used in brand-new applications.

Flash memory was first announced by Toshiba in 1985, but the first company to bring the device to commercial applications was Intel. Since then, Intel has retained its number-one supplier position, though in recent times its share of the market has been eroded by its closest competitor, AMD. Currently, in excess of 20 suppliers are operating in, or planning to join, the flash memory arena. Many of these are large DRAM producers that are viewing the flash memory device as a threat to the future of DRAM devices. Once the cost per bit for flash falls below that of DRAM (during the 1994 to 1995 period), flash is a very attractive form of memory for main storage.

Intel and AMD held almost 95 percent share of the flash market in Europe in 1992, with both companies expanding production levels. The young market of digital mobile phones was developing quickly, and demand levels were increasingly strong for flash. At this time, Intel was transferring its production processes to its foundry partner, NPNX in

Figure 4
Historical Pricing Trends in Europe, 1M Flash Memory



Source: WSTS, SIA

Japan. However, the transfer process that began during the third quarter of 1992 ran into many technical difficulties that were not corrected for almost a year. During this period, the effect of the loss of production ramp-up pushed prices strongly upwards and moved lead times beyond 26 weeks.

The loss of deliveries affected many flash users in Europe. Where possible, companies turned back to EPROM for their nonvolatile storage, providing a knock-on effect to the EPROM family as well. Other companies tried to weather the storm, and turned to AMD and smaller companies to fulfil their demands for flash. As a result, AMD's market share for flash in Europe rose from 15 percent in 1992 to 35 percent in 1993.

Intel's production problems were fixed at midyear 1993. Since then, prices have been reluctant to fall. This is because many companies that moved back to EPROM from flash returned to take up the increase in flash availability. Also, other companies that had not turned to flash have done so now.

During 1994, demand and supply are now much more in line, and flash pricing seems to have returned to a normal price erosion curve. Demand will remain strong for the foreseeable future, and even though there are many new entrants due to begin production of flash, there is still ample room for them. However, as the competition increases, there are bound to be companies that will find the going tough, and they may become casualties of the fastest-growing memory segment for at least the next five years.

Semiconductor Pricing and Analysis

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

Standard Logic

This month has seen no change to the pricing levels for standard logic.

Analog

There has been a small increase in the 78L05 device in this month's survey, as the part has been showing signs of increased demand.

Microcomponents

There are no changes in the pricing levels for microcomponents in this month's survey results. The continued marketing efforts by Intel to promote the Pentium seem to be having little effect on actual take-up rates, as all 486 derivatives still account for greater than 80 percent of all PC shipments.

PowerPC-based machines are starting to be sold in quantities in the European market, and Apple is continuing to sell 68xxx-based machines across different model types.

Memory

There has been little price fluctuation across memory devices in this month's survey. Suppliers are now booked well into the final quarter and are seeing little evidence of any signs of slowdown in the end markets for PCs. DRAM continues to see strong demand, and on the whole, production is still lagging.

DRAM

DRAM prices have remained static over last month's pricing levels, and order quantities have stayed strong throughout all families and densities.

The 1M part is still providing some good profits and turnover for the handful of suppliers that are still offering discrete devices. The demand for 4M DRAMs still leads production, keeping prices well above the normal pricing levels at the stage of a DRAM's life cycle. This demand is set to continue throughout the summer, with no evidence of any seasonal slowdown. The rate of take-up of 16M DRAM is still increasing. Although pricing levels are falling, there seems to be no clear price leader at this stage.

SRAM

The 256K SRAM arena is still seeing very tough competition for business. Many broad-line SRAM suppliers have moved into more lucrative areas in the SRAM market, or are concentrating on 1M devices.

Table 1
European Semiconductor Pricing May 1994
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (percent)	1K Adder (percent)	Lead Time (weeks)
Standard Logic						
74AC244	PDIP	100K	0.46	10%	15%	8-16
74F244	PDIP	100K	0.29	10%	15%	8-16
Analog						
78L05	TO92	100K	0.16	10%	10%	16-24
IMSG176D 35-MHz Video DAC		100K	1.30	15%	25%	8-12
Microcomponents						
80386SX-25	PQFP	5K	18.00	0%	5%	4
80386DX-40	PQFP	5K	25.00	0%	10%	2-6
80486DX-33	CPGA	5K	220.00	-5%	5%	10-14
68040-25	CPGA	5K	195.00	-5%	10%	10-14
R3000-25	CPGA	5K	75.00	-5%	15%	4-10
DRAM						
1M×1-80 (1M)	SOJ	100K	4.90	5%	15%	18
4M×1-80 (4M)	SOJ	100K	12.95	5%	15%	12-14
512K×9-80 (4M)	SOJ	100K	14.90	5%	15%	12-16
256K×16-80 (4M)	SOJ	100K	14.55	5%	15%	18
4M×4-70 (16M)	SOJ	10K	58.90	0%	15%	10-12
(4M×1)×2+1M-80	SIMM	50K	33.70	5%	15%	16
128×8-80 VRAM	SOJ	100K	6.64	5%	15%	12
Flash						
1M-17 (128K×8)	PDIP	10K	5.80	0%	30%	14-16
2M-17 (256K×8)	PDIP	10K	12.30	0%	30%	14-16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	5.00	10%	20%	16
SRAM						
256K-70 (32K×8)	PDIP	50K	3.10	5%	10%	10
256K-25 (64K×4)	PDIP	20K	4.05	5%	15%	10-12
1M-70 (128K×8)	PDIP	50K	8.65	5%	10%	12-14

Source: Dataquest (June 1994 Estimates)

There are some signs that delivery is becoming tighter for the 1M density as demand levels increase. Production space has been taken by 4M DRAM, and any increase in demand may cause delivery problems. The 1M SRAM has been slow to ramp up demand from usual SRAM customers, but this will change as the year continues.

Flash

Continuing improvement in delivery for flash memory devices is producing pricing reductions across most densities. Intel and AMD are still servicing the majority of the flash market, though other smaller US producers are picking up small levels of business.

EPROM

Prices for EPROM devices have held steady from last month's survey. The market is being led by SGS-Thomson in Europe followed by AMD, National Semiconductor and Texas Instruments.

Current Exchange Rates

1 US dollar =
- 0.663 pounds
- 1.672 deutsche marks
- 5.692 French francs
- 0.866 ECU

Special Review

This month's special review looks at the Dataquest European Vendor of the Year awards, announced at Dataquest's 13th Annual Semiconductor Conference, held in London during May.

The third Dataquest European Semiconductor Vendor of the Year awards were presented at the European Semiconductor Conference held in London in May.

In assessing the results, Dataquest defined five categories and awards: an overall Vendor of the Year award; a top vendor in one or more subcategories: a medium-size vendor with sales between $50 million and $500 million; and a niche vendor with European sales of less than $50 million. A new category and award was added this year, and this was due to a significant increase of respondents recognizing and voting for distributors that provided them with the service they needed. Dataquest regards this as an indication of a change in strategic direction among the user community, as pan-European distribution groups form.

The five awards that were presented this year are as follows:

- The European vendor of the year was presented to Motorola for the third consecutive year (Figure 5).
- Philips Semiconductors received an award for quality and technical support (Figure 8).

- European medium-size vendor of the year was awarded to AMD (Figure 7).
- IDT was voted European niche vendor of the year (Figure 6).
- Avnet EMG won the European distributor of the year award (Figure 9).

Methodology

The selection of the European Vendor of the Year awards was based on a customer opinion poll conducted from February to April 1994 as part of Dataquest Europe's annual procurement survey. Each year Dataquest surveys senior buyers in order to understand purchasing trends, issues and customer satisfaction. The survey was expanded in 1994 to more than 70 equipment manufacturers across Europe.

Respondents to the survey were asked to nominate and rank their top three semiconductor vendors, in first, second and third positions, based on the criteria of delivery, quality, price, responsiveness, technical support and overall performance. Dataquest estimates that the total spending power of those companies that felt able to respond, which was approximately 57 percent of surveys sent out, represented 40 percent of the total European semiconductor market.

Vendor Assessment Category Definitions

Delivery refers to a vendor's ability to simply meet the schedules it committed to its customers. 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 their suppliers make.

Quality refers to the quality of semiconductor products shipped to a customer. The customer requires products that consistently conform to data sheet specifications. If a vendor fails to deliver reliable products then, as with delivery, the customer will feel unable to trust its business to its supplier.

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 that have zero defect, and always meets its schedules, but if it takes weeks to get a price and lead time commitment on a simple 74LS00, then doing business with that vendor becomes very frustrating.

The **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 get only a limited amount of understanding 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.

Price is the actual price paid for product.

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 it needs to succeed in its markets.

Dataquest Perspective

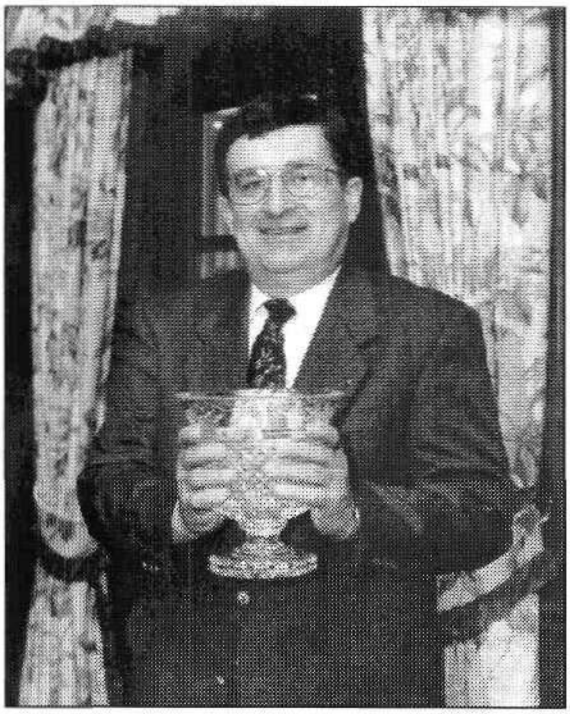
This is the third year that Motorola has won the overall vendor of the year award presented by Dataquest. Two years ago, we reported that US-based vendors were ahead of the pack; again, this was reflected in three of the awards presented this year. However, European vendors are catching up quickly in Europe. Philips, for the second year running, received an award, and SGS-Thomson was not too far behind in a couple of the categories.

Japanese vendors on the whole fared poorly, particularly in the categories of delivery and responsiveness, and this is quite clear from the results.

The overall results show that semiconductor vendors are not meeting customer expectations as well as last year, particularly in terms of delivering goods on time, quality and pricing. This is a contributory factor behind equipment manufacturers increasing the number of vendors they chose to do business with and procuring more products via distribution channels.

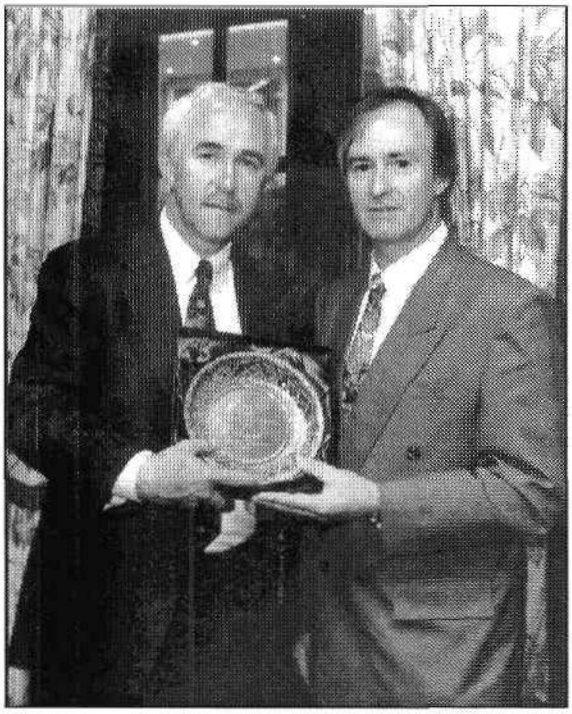
By Sarah Jacob

Figure 5



Fred Schlapak, Senior Vice President and General Manager of Motorola's European Semiconductor Group, was pleased to receive our European Vendor of the Year 1994 award, Motorola winning for the third successive year.

Figure 6



Len Perham, Chief Executive Office of IDT, and Bill Cowing, received the European Niche Vendor of the Year award.

Figure 7

David Brand, Director of European Operations for AMD, was presented with the European Medium-Size Vendor of the Year 1994 award by John Rogers, Senior Vice President and Managing Director of Dataquest Europe.

Figure 8

Gunther Dengel (right), Director of International Marketing and Sales for Philips, received an award for European Quality and Technical Support Vendor of the Year, from Jim Eastlake, Director of Dataquest's European Semiconductor Group.

Figure 9

Keith Williams (left), President of Avnet EMG International, was awarded the European Distributor of the Year award, seen here with Fred Schlapak.

Industry Highlights

Researchers and analysts in Dataquest's European Semiconductor Group routinely gather intelligence on the European semiconductor market. Some of this information is published electronically on a weekly basis via Dataquest's Semiconductor Online Service, DQ Monday. The following key European industry events review the past four weeks, and are selected on the basis of their perceived industry impact.

Philips Car Systems Wins BMW Car Navigation Contract

Philips has won a contract to supply BMW with a modernized version of its CARIN navigation computer known as the CC-93, which incorporates global positioning systems (GPS) technology. The CC-93 was developed in conjunction with systems supplier Philips Car Systems. The contract initially for the high-end BMW cars was first announced by BMW as part of an option package for the new 7-series cars. For the first time an interactive, intelligent system is used that integrates state-of-the-art navigation technology into the vehicle's control concept, from satellite-supported position-fixing, via dynamic electronic maps in a variety of scales, to itineraries described by means of voice output.

Incorporating an address book with a storage capacity of 2KB, the CC-93 allows the driver to store up to 25 frequently used addresses and select them directly as destinations. In addition to these permanently stored addresses, the system also remembers the last starting position, making it a simple task to begin the return journey. Current GPS engine modules are being sold in volume at an average selling price of $200.

Philips is now extending this to include high-end car radio systems for BMW. Sources close to BMW believe that this could eventually lead to the end of Bosch Blaupunkt's sales to BMW, which cuts across all BMW car series. The significance of this contract may in future extend to BMW's Rover cars group (although BMW maintains that Rover is a separate business group), and could translate to nearly 1 million car radio sets annually.

The average semiconductor content of European car radios is estimated to be nearly $14, although for very high-end systems this could reach $20 to $25, incorporating radio data systems (RDS), and digital character transmission with traffic message channel (TMC). Dataquest believes that in the near future, European car radio manufacturers/vendors will need to have in-house expertise or alliances involving technology such as communication, car identification and remote tolling technology in order to sustain supplier relationships with the automotive industry.

Other European companies with car navigation systems include Bosch with its Travelpilot, Renault with its Atlas system, Siemens' Ali-Scout, Gilardini's (Fiat subsidiary) GPS navigation system, Daimler-Benz's Routen-rechner and General Logistics' Trafficmaster. Several Japanese manufacturers have launched many products on the Japanese aftermarket in the last three years, and this could position them well for the global GPS car navigation and entertainment systems market.

Philips Looking for a New Fab

After years of losses and lack of investment, Philips is now thinking of expanding its fab capacity; the company is looking to build a new chip plant, which could cost anything up to $1 billion. A desision on the plant's location is expected later this year but it is almost certainly expected to be within Europe, and most likely in Philips' home country of the Netherlands. Another option for Philips would be to expand capacity at its plant in Nijmegen, where there is room for expansion, although this would only be a short-term solution. Even without this investment, Philips is expected to double its investment in fixed assets this year.

Amstrad Buys Viglen

Amstad, the UK consumer electronics company, has announced that it is to acquire Viglen, the UK personal computer maker. Amstrad will make a £30 million down payment for Viglen and up to £30 million more depending on its profits over the next three years. Viglen sells direct to customers, cutting out the retailers with whom Amstrad chairman Alan Sugar has clashed in the past over their business terms. Dataquest estimates that Viglen manufactured 43,000 desktop machines at its assembly site in Alperton, London during 1993.

NEC Invests in County Meath Facility

NEC has announced plans to invest more than £50 million in its County Meath, Ireland integrated circuit assembly plant. Currently, the plant employs 350 people, and the expansion will result in an extra 110 jobs being created. There will be a 1,800 m^2 expansion, which will double the plant's capacity for final assembly and testing of memory chips. The plant has been the designated assembly and test center for Europe for NEC's 16M DRAMs.

This current investment brings the total sum spent on the factory to more than £92 million over the last two years. It reconfirms NEC's policy to both fabricate and assemble state of-the-art components in Europe for distribution to other world regions.

TEMIC Gets Silicon Germanium

TEMIC has announced that by 1995, it will be able to bring into production devices developed for its new semiconductor technology, silicon germanium (SiGe). This follows the recent announcement of developments and utilization of SiGe by IBM and Analog Devices.

Both TEMIC and IBM/Analog Devices envisage that this technology will provide major benefits for attacking the fast-growing radio frequency (RF) device market. The RF market is already experiencing exceptional growth due to the proliferation of cellular telephones worldwide. This market is set to explode over the next 10 years as cellular technology switches to digital transmission, a whole range of digital cordless telephones are introduced, and wireless LANs take off.

Compaq Doubles Up in Europe

Compaq has announced that it is to invest $15 million in its PC plant in Erskine, Scotland in addition to the investment of $10.5 million announced at the end of January. Compaq will add three more surface-mount lines to the two lines announced in January. PCBs are scheduled to begin rolling off the first lines by the end of July, with all five lines scheduled to be in operation by the end of this year.

Compaq has invested some $130 million (at current exchange rates) to date in Scotland and currently employs more than 800 people there. The 50,000 m^2 plant is the main supplier of the complete line of Compaq PC products to European, African and Middle Eastern markets. Dataquest estimates that in 1993 Compaq manufactured 950,000 machines in Scotland. European shipments increased by 71 percent in 1993, and for the first quarter of 1994 Compaq's market share was 11.8 percent of the European market compared with IBM's 11.0 percent. Compaq could well be on course to beat IBM in Europe in 1994.

Tadpole and Digital Develop Alpha AXP Workstation Notebook

Tadpole Technology, the Cambridge, England–based designer and manufacturer of workstation-class portable computer systems, and Digital Equipment Corp. have announced an agreement in which the two companies will jointly design and develop a workstation-class notebook computer based on Digital's Alpha AXP DECchip 21066 RISC microprocessor. Previously, Tadpole has developed RISC notebooks based around the SPARC processor, and more recently a PowerPC 601–based ES/6000 notebook for IBM.

Tadpole Technology also reported a pretax loss of £1.3 million for the six months to March 31, and announced a fund-raising issue of stock to the tune of £6.8 million—London-quoted shares jumped in value on the news. The money will fund the group's anticipated working capital and capital expenditure needs for, according to chief executive, George Grey, "the significant increase in business levels" caused by the new SPARC-book 3 and the RS/6000 notebook for IBM. Grey expects the Digital notebooks to contribute to Tadpole's 1995 fiscal year.

Analog Devices Expands in Ireland

Analog Devices is undertaking a $245 million expansion at its integrated circuits facility in Limerick, Ireland, established in 1977. The expansion, backed by the Industrial Development Agency (IDA) of Ireland, is expected to create 310 new jobs. The investment mainly involves the introduction of 6-inch wafer fabrication production. This technology, which up to now has been subcontracted by the company, significantly increases the efficiency and cost-competitiveness of producing linear integrated circuits, and is required for many of the company's latest products.

The investment will include the construction of a total of 1,800 m^2 of new clean rooms and the installation of new equipment for 6-inch wafer fabrication technology. Of the total planned investment, about $75 million will be on the development of existing activities. In addition to its Limerick operation, the company has manufacturing facilities in Massachusetts, North Carolina and California in the United States, and elsewhere in Japan, the Philippines and Taiwan.

ARM Continues with More Success

Advanced RISC Machines Limited (ARM) has recently been announcing a string of good news, the most important being that ARM has signed up another licensee for its RISC chip, this time the Korean company Samsung Electronics. Under the terms of the agreement, Samsung will embed ARM6, ARM7 and ARM610 RISC technology in products to be jointly developed by Samsung and ARM for emerging markets where computing, communications and consumer electronics converge. Initially, Samsung will apply the ARM 32-bit RISC technology to a number of the company's own peripheral products, including hard disk drives, laser printers and multimedia processors. Robin Saxby, Managing Director of ARM, welcomed Samsung to the ARM partnership, stating: "As Samsung is one of the world's leading consumer electronics and semiconductor companies, it will greatly help establish ARM as the leading consumer RISC standard."

The strength of this partnership for ARM is that Samsung will be using the RISC chip in high-volume consumer products, complementing the other licensees.

Another announcement was that ARM has joined forces with a group of European companies under the European Community's EITC (previously ESPRIT) initiative to develop smart card security systems incorporating analysis techniques such as voice recognition. Called CASCADE (*C*hip *A*rchitecture for *S*mart *CA*rds and portable intelligent *DE*vices), the project was initiated by the French smart card manufacturer GEMPLUS and is part of the OMI (Open Microprocessor Systems Initiative). Despite continual advances in microprocessor technology, smart cards have not evolved beyond the traditional 8-bit-based CISC processors, such as the 8051 or 6805. By developing a new ASIC based on ARM's 32-bit RISC technology, GEMPLUS expects to make dramatic gains in the performance of smart cards, resulting in up to a hundred times the processing power of existing smart card chips. The CASCADE project started in December 1993 and is running for two-and-a-half years. The objective of the project is to have a new smart card architecture designed and integrated into a working demonstrator.

IBM and VLSI Technology have announced a memorandum of understanding for the development of Serial Storage Architecture (SSA) interface based on the ARM processor. VLSI will develop and manufacture ICs for SSA applications that will be available for purchase and use by IBM in future storage products. SSA, which is being promoted vigorously as an industry standard by IBM, offers much higher operating speeds than existing serial protocols, such as RS-232. Consequently, SSA can be used with high-speed peripherals such as hard disk arrays, for which the only currently viable option is a parallel interface.

ARM is now gaining widespread acceptance, but little is now heard of Europe's other chip marvel, the transputer. UK start-up Inmos developed the transputer back in the 1970s with government backing, but soon requiring vast amounts of cash, it was sold to Thorn-EMI only to be passed on again to SGS-Thomson. The T9000 transputer has been subject to continued delays and Inmos is yet to announce the final product.

Hitachi Separates Chip Design

Hitachi has announced that it is to create a new company to carry out its semiconductor design and engineering operations in Europe. The engineering division was formerly known as EuroDESC and was part of Hitachi Europe, but has now been split out into a company known as Hitachi Micro Systems. Based at Hitachi Europe's European headquarters in the United Kingdom, it will provide a broad range of services to customers in Europe. Hitachi expects to make significant investment over the next three years, expanding the organization to about 60 people.

Micronas Acquisition

Small specialist semiconductor company Micronas of Finland has acquired Ascom's microelectronics business. The plan is to merge the ASIC capabilities of Micronas with the sensor technology of Ascom microelectronics to develop "Smart Sensors." Ascom's capability includes pressure sensors and accelerometers; developing these into smart sensors makes them ideally suited to the demands of the automotive market. This will put the company in a specialist supplier category, with the likes of Analog Devices Inc., which has perfected this semiconductor technology. Potential applications will include integrated airbags, which Dataquest forecasts will have growth of 45 percent per year between 1994 and 1998.

News Round-Up

Alcatel has built a new optoelectronics production facility recently in Nozay, France. In addition to this, Alcatel has formed a new subsidiary, Alcatel Optronics. The plant will make devices for outside consumption as well as for use in Alcatel equipment, including lasers and photodiodes. Approximately 230 people will be employed at the new 6,000 m^2 site.

SGS-Thomson Microelectronics is to invest $3.4 million in its two back-end facilities in Casablanca, Morocco. The two plants, which mainly deal with RF and subsystem assemblies, had a turnover $129 million in 1993; the plants were part of Thomson Semiconductors before it merged with SGS in 1987.

Matra Defence is selling its US subsidiary Fairchild Space and Defense to Orbital, based in Fairfax, Virginia, for $105 million. **Motorola** is expanding production of pagers and battery packs at its Swords, Ireland plant. **Newport Wafer Fab**, the Gwent-based supplier of 4-inch silicon wafers, is seeking to expand production at its Welsh plant, increasing capacity in 4-inch wafers and at the same time pulling together plans for 6- or 8-inch wafer production. **Seagate Technologies** has announced the opening of its magnetic head wafer fabrication facility in Springtown, Northern Ireland; the plant provides enough wafers from which to make in excess of 100 million thin-film recording heads a year.

Delco Electronics Corp., a unit of General Motors Corp., has opened a new production plant at Rennes, France. Delco said the new facility, to be operated by its wholly owned Texton Electronique unit, will produce car-alarm systems and ancillary equipment for the French car market and for export to automobile manufacturers in other European countries. **Siemens Semiconductor** has started construction of its DRAM facility in Dresden, eastern Germany, with Chancellor Kohl laying the foundation stone.

TEMIC has officially opened its 6-inch bipolar line at Heilbronn, Germany, which is the first to use the flexible automated wafer (FAW) production technique developed within the JESSI program. Part of the capital of SGS-Thomson could be floated on the stock market in the near future, according to one of SGS-Thomson's largest shareholders, CEA Industrie.

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I.C. EUROPE

A Monthly Report on European High Technology Industries

March 1994

In This Issue

I.C. Europe is a monthly report on European high-technology industries. The information is compiled and published by Dataquest's UK-based European Semiconductor Group research team with contributions from Paris, San Jose and Tokyo. This month's contributors are: Mike Glennon, David Moorhouse, Andrew Norwood and Adrian Walker.

State of the Industry

The WSTS flash three-month-average bookings for the month of February were $1,463 million, so continuing the trend of billion dollar bookings months, a trend which has now reached 18 consecutive months. The January bookings level was revised downwards by 1 percent over its preliminary level. The growth for February's bookings was 6.0 percent over January's level. Three-month average billings for February reached $1,340 million, almost no change on the restated January level of $1,335 million.

February's three-month average book-to-bill ratio has risen again to 1.09, a noticeable rise from the 1.04 revised figure for January. The rise in overall bookings and the relatively flat billings level has pushed the ratio higher for February. Figure 1 shows the three-month average bookings and billings; and the book-to-bill ratio for the last 13 months in Europe.

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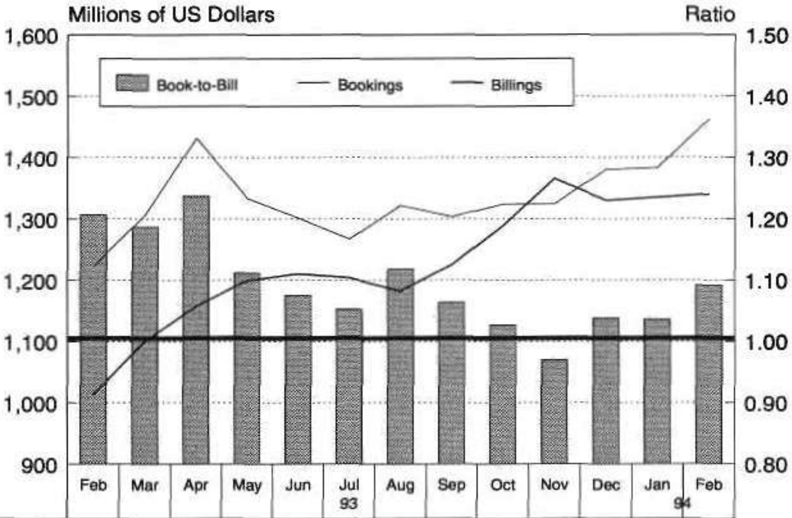
Publication Date: March 1994

Figure 1
European Semiconductor Market Historical 12-Month Bookings and Billings Activity



	Feb	Mar	Apr	May	Jun	Jul 93	Aug	Sep	Oct	Nov	Dec	Jan 94	Feb
Book-to-Bill	1.21	1.19	1.24	1.11	1.08	1.05	1.12	1.06	1.03	0.97	1.04	1.04	1.09
Bookings	1,223	1,306	1,431	1,334	1,302	1,267	1,322	1,303	1,324	1,324	1,380	1,383	1,463
Billings	1,014	1,101	1,157	1,199	1,210	1,204	1,182	1,225	1,289	1,366	1,330	1,335	1,340

Source: WSTS, SIA

Overall business levels remain strong as the first quarter of 1994 carries on the trend of the previous three quarters. The PC production "boom" in Europe has continued past the traditional strength of the Christmas market and on into 1994. Many major PC producers are looking to ramp up their production levels above their 1993 amounts, as end-customer demand for PCs continues. Corporate purchases are expected to grow strongly this year as major European economies begin to recover. The small office, home office (SOHO) market is also expected to demand more PCs as the end sales price for PCs remains attractive to the single user.

The strong base for PC production in the electronic data processing (EDP) sector in Europe is mirrored by the mobile telecommunications manufacturers in the communications area. This "new" market gained in strength throughout 1993 and, with the continued drive towards digital communication in Europe, will continue its buoyancy in 1994. Microcontrollers and some memory devices are being consumed in large quantities in this application. Flash memory and EPROM were the key memory devices being seen in handsets, along with some SRAM parts. The demand for discretes for RF modules and other areas in the handset are also seeing good demand growth.

The long-suffering consumer market could begin to recover in Europe in 1994 after a number of years of depression. Digital TV and CD-I are expected to gain momentum during this year, as consumer spending re-emerges.

Dataquest expects another year of good growth for the semiconductor market in Europe. Following on from the 27 percent increase from 1992 to 1993, our outlook forecasts a rise of between 15 and 20 percent for 1994 over 1993.

Historical Pricing Trends

This section of I.C. Europe *looks at historical pricing trends for a key semiconductor component. This month the focus is on the 680X0 processor.*

The introduction of the PowerPC processor is likely to have a major effect on processor pricing in PC applications. The PowerPC processor can be seen as a replacement for the 68040, and certainly this will be the case in the short term in Apple computers, one of the main users of the 68040. However, there is a 68060 planned, and its place in the computer market is so far uncertain considering the hopes for the PowerPC from many suppliers in the PC market.

Long-term pricing for the 680X0 shows the processor behaving in a stable manner. In general, the pricing follows the behavior expected; this suggests that the balance between supply and demand goes in favor of the demand side, that is, there is more supply than demand.

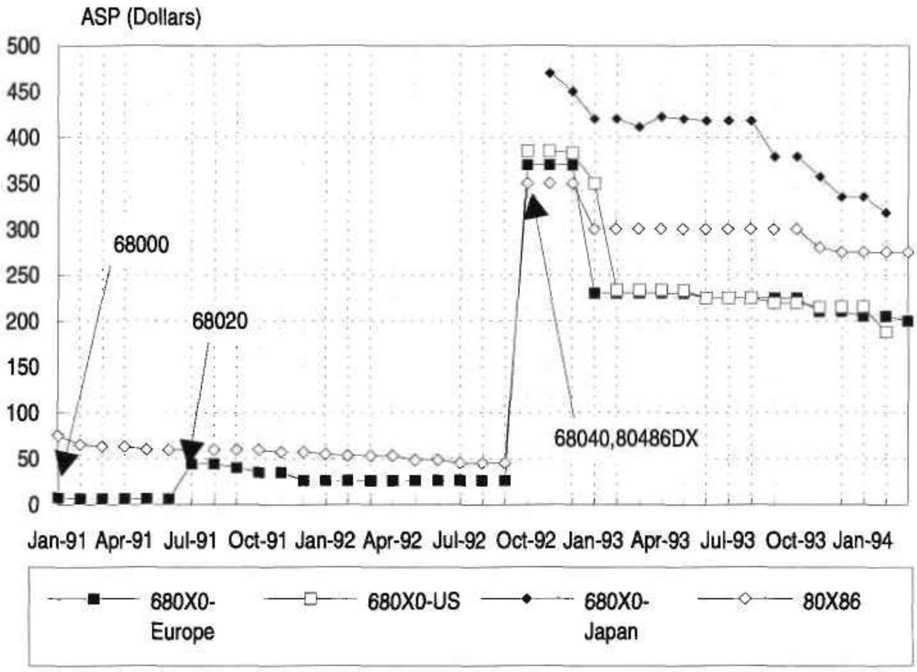
Price tracking for the 68040 began in October 1992; prior to this the device tracked was the 68020, and previously the 68000. Figure 2 shows the price tracking, and it is clear from the graph that the 68020 had stabilized in price, and demand was declining. There have been gentle price reductions for the 68040, generally following the quarterly pattern dictated by the supplier.

Included in the figure is the price for the 68040 for other regions of the world, and it is here that the apparent stability of the 68040 pricing can be called into question. Europe has generally led the price decline of the component around the world, with North America following closely behind. It is only in 1994 that the US price decline has overtaken that of Europe. The price in Japan for the device is well ahead of the other two regions. This would suggest that demand is well ahead of supply for the 68040 in Japan.

The PowerPC was targeted at Intel's Pentium with an aggressive introductory price—well below Intel's price for the Pentium. However, with Intel's equivalent processor price plotted on the same graph as the 680X0, it is apparent that Motorola has been pricing its products below Intel for many years.

Future pricing for the 680X0 and the PowerPC will clearly be dictated by the performance of Pentium, PowerPC and 68060 market share results. Intel has already stated it will be able to ship between 5 million and 7 million Pentium processors in 1994, and Motorola and IBM are both pushing the PowerPC hard as an alternative to X86 as an architecture. The next two years should be interesting times in the processor world.

Figure 2
Historical Pricing Trends in Europe and Worldwide, 680X0 Processors



Source: Dataquest (March 1994)

Semiconductor Pricing and Analysis

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

Standard Logic

Demand in the standard logic market is growing, and this can only have one of two effects: either lead times must extend, or prices must rise. In this case it is prices that must rise, as much of the standard logic product range is on allocation. Lead times for AC parts are already about 16 weeks, but realistically this is allocation. Therefore we have seen price rises in the product. Fast logic parts are under less demand, though, and prices and lead times are stable here.

This increase in demand is across the board for AC parts, covering data processing, and communications generally. Added to this is the continuing shortfall in small-outline (SO) package capacity, also contributing to extended lead times. However, we believe SO manufacturing capacity is increasing, but slowly. In the longer term supply will increase to meet demand, but in the meantime the standard logic market is showing increasing signs of becoming a profitable business.

Table 1
European Semiconductor Pricing February 1994
All Prices in US Dollars (including import duty where relevant)

Product	Package	No. Units	Volume Price	10K Adder (Percent)	1K Adder (Percent)	Lead Time (Weeks)
Standard Logic						
74AC244	PDIP	100K	0.46	10%	15%	16-20
74F244	PDIP	100K	0.29	10%	15%	8-16
Analog						
78L05	TO92	100K	0.15	10%	10%	16-24
IMSG176D 35-MHz Video DAC		100K	1.30	15%	25%	8-12
Microcomponents						
80386SX-25	PQFP	5K	20.00	0%	5%	4
80386DX-40	PQFP	5K	30.00	0%	10%	2-6
80486DX-33	CPGA	5K	220.00	-5%	5%	10-14
68040-25	CPGA	5K	195.00	-5%	10%	10-14
R3000-25	CPGA	5K	75.00	-5%	15%	4-10
DRAM						
1M×1-80 (1M)	SOJ	100K	4.40	5%	15%	18
4M×1-80 (4M)	SOJ	100K	12.80	5%	15%	12-14
512K×9-80 (4M)	SOJ	100K	14.90	5%	15%	12-16
256K×16-80 (4M)	SOJ	100K	14.30	5%	15%	18
4M×4-70 (16M)	SOJ	10K	63.00	0%	15%	10-12
(4M×1)×2+1M-80	SIMM	50K	32.00	5%	15%	14
128×8-80 VRAM	SOJ	100K	6.60	5%	15%	10-12
Flash						
1M-17 (128K×8)	PDIP	10K	7.00	0%	30%	16
2M-17 (256K×8)	PDIP	10K	15.00	0%	30%	16
UV EPROM						
2M-17 (256K×8)	CDIP	50K	4.90	10%	20%	16
SRAM						
256K-70 (32K×8)	PDIP	50K	3.30	5%	10%	10-12
256K-25 (64K×4)	PDIP	20K	4.40	5%	15%	10-12
1M-70 (128K×8)	PDIP	50K	8.30	5%	10%	10

Source: Dataquest (March 1994 Estimates)

Analog

There are no price or lead time changes identified for analog components this month. Demand for the video DAC is declining further as PC manufacturers focus more on the higher-specification devices, with wider word-widths.

Microcomponents

Processor demand continues to be strong, but there are no price or lead time changes identified—with the exception of the gentle decline in 68040 pricing to below $200. Apple is ready to introduce PowerPC-based Macintosh machines, and this will have some impact on demand for 68040 processors. In the longer term we expect much of the emphasis to switch to the PowerPC for mainstream computing. However, there are other applications for the 68040: Apple is not Motorola's only customer, and demand for the processor is still strong in other applications.

The outlook for Intel pricing is about to change a little, as AMD is reported to have won the microcode case it has been fighting against Intel for some considerable time. As this news is still breaking it has, of course, no impact on this month's pricing, which shows no change. Nevertheless, we expect Intel to appeal against the decision made in the federal court.

Memory

Conditions are still strong in the memory market with no signs of end demand slipping from EDP equipment producers in Europe. Many are looking to increase build plans stated at the beginning of the year as their end-customer demand seems to be growing.

DRAM suppliers are cautiously adding production space especially for 16M DRAMs. Although the majority of DRAMs shipped in 1994 will be the 4M density, some suppliers are looking to convert users to the larger density as 1994 continues.

DRAM

Prices are still increasing for the 1M density as some users continue to demand the device against suppliers which are eager to pull out of production. Most suppliers are not offering this density to customers, but continue to produce for their own usage on DRAM modules.

The 4M continues to experience demand that is higher than supply, keeping prices and lead times stable. Major suppliers have now reached their peak shipping volumes for 4M and are unlikely to put further investment into new 4M lines. Production mix changes may be necessary as demand from users fluctuates during 1994, though. Dataquest expects some increase in demand for the wider-word-width devices as new applications begin production in Europe.

The 16M density is beginning to ramp up into volume production at many suppliers. Some suppliers are keen to see pricing fall, so that bit-for-bit pricing between 4M and 16M is reached. Dependent on the device, Dataquest expects pricing crossover between the third quarter of 1994 and the first quarter of 1995.

SRAM

Competition is still fierce in many sectors of the SRAM market as suppliers attempt to increase or hold on to their market share. This has produced some price falls in the market, especially for slow 256K SRAM. The 1M SRAM continues to fight for production space with the 4M DRAM, and demand quantities are now increasing from many end market sectors and customers.

Flash

There has been a marked fall in prices for flash memory in this month's survey. This is a reflection of the increased availability for the device now that Intel's Japanese foundry partners are shipping more products. End demand is still strong from both mobile handset producers and the computer industry, and this is set to continue throughout 1994.

EPROM

There are some price reductions in the EPROM market, as suppliers adjust to the changes in the flash arena. Dataquest expects flash to encroach further into traditional EPROM design slots during 1994, reducing the overall EPROM market.

Current Exchange Rates

1 US dollar =

- 0.67 pounds
- 1.706 deutsche marks
- 5.806 French francs
- 0.883 ECU

Special Review

This month, this section of I.C. Europe *shows European semiconductor final market share rankings for the top 20 companies (Table 2).*

Table 2
Top 20 European Semiconductor Final Market Share Rankings by Vendor
(Millions of Dollars)

1992 Rank	1993 Rank	Change in Rank	Ranked Companies	1992 Sales ($M)	1993 Sales ($M)	1992-93 Annual Growth (%)	1993 Market Share (%)
2	1	1	Intel	1,136	2,056	81.0	13.3
3	2	1	Motorola	975	1,260	29.2	8.1
1	3	-2	Philips Semiconductors	1,138	1,104	-3.0	7.1
4	4	0	Siemens	912	1,039	13.9	6.7
5	5	0	SGS-Thomson Microelectronics	895	1,005	12.3	6.5
6	6	0	Texas Instruments	737	871	18.2	5.6
7	7	0	NEC	489	605	23.7	3.9
8	8	0	Toshiba	465	578	24.3	3.7
12	9	3	Samsung	333	510	53.2	3.3
9	10	-1	National	423	454	7.3	2.9
10	11	-1	AMD	349	452	29.5	2.9
11	12	-1	Hitachi	333	425	27.6	2.7
-	13	NA	IBM	0	409	NA	2.6
-	14	NA	TEMIC	0	340	NA	2.2
16	15	1	Mitsubishi	176	270	53.4	1.7
14	16	-2	Fujitsu	190	267	40.5	1.7
22	17	5	AT&T	112	205	83.0	1.3
17	18	-1	Analog Devices	143	182	27.3	1.2
13	19	-6	GEC Plessey Semiconductors	194	158	-18.6	1.0
20	20	0	LSI Logic	115	146	27.0	0.9
			Total All Companies	12,218	15,486	26.7	100.0
			Total European Companies	4,157	4,365	5.0	28.2
			Total North American Companies	5,530	7,706	39.3	49.8
			Total Japanese Companies	2,008	2,608	29.9	16.8
			Total ROW Companies	523	807	54.3	5.2

NA = not applicable
Source: Dataquest (March 1994 Estimates)

Industry Highlights

Researchers and analysts in Dataquest's European Semiconductor Group routinely gather intelligence on the worldwide semiconductor market. Some of this information is published electronically on a weekly basis via Dataquest's Semiconductor On-line Service. The following key European industry events review the past four weeks, and are selected on the basis of their perceived industry impact.

Xilinx Establishes Plant in Ireland

Xilinx, a San Jose, California–based manufacturer of programmable gate arrays, has announced it is to locate a European facility in Dublin, Ireland. However, the actual site has yet to be chosen. This facility will be used for the final phases of manufacture for the company's field-programmable gate arrays (FPGA). This will involve primarily the testing of the devices. Silicon fabication of the devices will continue to be through the use of the foundry agreements Xilinx already has with Japanese and Far Eastern semiconductor manufacturers. The existing sales, marketing and applications locations will be maintained at their present locations throughout Europe.

Xilinx is establishing this plant to provide more support for its European customers, and the plant will focus primarily on Europe. In the longer term, though, the plant may be used to provide international support. There will also be some design and development at the plant, and again this will be focused on European products and support. The existing research and development organization recently acquired will remain in Scotland. This was formerly Algotronics, headed by John Gray. Mr. Gray has a long history of innovation behind him through companies such as Lattice Logic and European Silicon Structures, so he should be able to make a significant contribution to Xilinx's research effort.

The plant will involve investment of about $18 million, and is expected to generated about 200 jobs initially. The company expects to create an additional 100 jobs at the plant by the end of the decade.

Dataquest Perspective

Xilinx has been very successful in the FPGA market, and this commitment to a European facility reflects the increasing confidence the company has in its ability to support a fast-growing European business. The company expects its European revenue to grow its share of the worldwide revenue over the next four years, and is making appropriate investments to ensure the support organization is in place.

FPGA is one of the fastest-growing segments of the ASIC market, although competition is growing. Xilinx, with a strong position in Europe, will set the pace for other suppliers with this investment. Most of the other major players in the market are also North American and have yet to make the same level of investment. This should confer an advantage to Xilinx for at least the short term.

NEC Boosts European Wafer Production

NEC plans to boost its wafer production at Livingston, Scotland, with an aim to manufacture 23,000 six-inch wafers per month for 4M DRAMs. Assembly of 16M DRAMs will also begin, with a target output of 300,000 units per month.

NEC's assembly facility outside Dublin in Ireland is also to be expanded; output of various semiconductor products will rise from the present level of 3 million to approximately 4.5 million per month. It is expected that there will be further announcements later this year.

Toshiba to Assemble 16M DRAMs in Europe and United States

Toshiba plans to assemble 16M DRAMs in Europe and the United States starting this spring. US assembly will be performed at the company's San Jose, California facility; while assembly in Europe will be performed in Germany by Toshiba GmbH. The move was said to be both in support of the burgeoning demand in the two regions, and to counter the negative impact of the strong yen; Toshiba's earnings have been hurt due to the recent rapid appreciation of the yen, and assembly overseas can sometimes be more profitable than exports. Production is expected to start at "several tens of thousands of units per month," and increase, to meet demand, up to the level of 200,000 to 300,000 units.

Intel Opens New Irish Facility

Intel has officially opened its new facility in Leixlip, Ireland. The facility, known as Fab 10, is Intel's largest, most advanced and first European Union–based wafer fabrication facility. Intel has invested $750 million on Fab 10 which uses 0.6 µm, 4-layer metal BiCMOS technology on 8-inch diameter (200 mm) wafers. Fab 10 is a 56,000 m^2 facility with 6,000 m^2 of Class 1 clean room space. The facility utilizes an overhead monorail material handling system to move wafers between the areas of the fab, and floor-based robots for intra-area wafer transportation. In training its work force, Intel sent 450 Fab 10 employees to Intel factories around the world for two years to learn how the company builds its chips. Intel estimates the cost of training at approximately $100 million.

GPS Puts Production Out to Foundry

GEC Plessey Semiconductors (GPS) is looking at two foundries in the Far East to make as much as 40 percent of its products. GPS' managing director, Tom Urwin, says one of the companies is Taiwan Semiconductor Manufacturing Company (TSMC), while the other is believed to be Chartered Semiconductor Manufacturing (CSM) of Singapore, which announced a new fab for its foundry business at the end of 1993. GPS will use the two companies to cope with demand until its plant expansion at Roborough, United Kingdom is complete, when the proportion of GPS products made at foundries will fall to under 20 percent.

Philips in the Black

Philips, the Dutch electronics group, moved into profit in the year-ended December 1993; net profit excluding extraordinary items totalled Fl 856 million ($460 million) compared with the previous year's net loss of Fl 900 million ($513.9 million). Net profit was boosted with the sale of Philips' stake in the Matsushita Electric joint venture during the year. Philips said sales grew in North America and Asia but fell back in Europe; overall turnover rose by 1 percent to Fl 58.8 billion ($31.6 billion). The consumer electronics division's sales fell to Fl 21,335 million ($11,488 million), down 2 percent on a comparable basis. Revenue from the components and semiconductors group increased by 13 percent to Fl 6,892 million ($3,711 million).

Nokia Pulls the Plug on TV Tubes

Nokia the Finnish electronics group has reported sales of Fmk 23.7 billion ($4.14 billion), a 21 percent growth on 1992; operating profit rose to Fmk 1,465 million ($255.8 million). Nokia Telecommunications and Nokia Mobile Phones reported the best results, with sales up 43 percent and 73 percent respectively. Nokia Consumer Electronics also managed to increase sales to Fmk 6.9 billion ($1.2 billion), although the group still incurred a loss of Fmk 747 million ($130 million).

At the same time, Nokia announced it is to stop production of TV tubes after failing to find a buyer for the loss-generating operation. The factory based in Esslingen, Germany will close with the loss of up to 1,970 jobs. Nokia will increase the purchase of tubes from other sources, notably Hitachi.

A Bull Market?

The French government has confirmed that Bull Computers will be next to be privatized along with the AGF insurance group after the current privatizations. Bull will probably come to market in several phased stages, including a small public offer and the sale of minority stakes to industrial partners.

GSM Chip Sets Arrive

AT&T Microelectronics has launched a five-chip-set solution to support the European cellular standard GSM. The "Sceptre" chip set is one of the most highly integrated solutions available today. All devices are packaged in low-profile surface-mount packages, operating from a 2.7V supply, consuming 725mW in talk mode and 30mW in standby. This allows handsets to function from a three-cell battery, thus reducing handset weight and size. The chip set includes a unique 2W, gallium arsenide, monolithic integrated microwave IC (GaAs MIMIC), RF power amplifier.

The proposed volume pricing is $100 per chip set in volume lines, with forecasts for a total GSM handset semiconductor content of $120 in 1994, and the price expected to fall to $75 by 1998. This is the start of third-generation GSM chip sets; other semiconductor vendors such as Analog Devices and VLSI Technology Inc. have developed chip sets with similar levels of integration.

Digital Reaffirms Commitment to Scotland

Digital Equipment has announced an investment package of more than $135 million for its manufacturing sites in Ayr and South Queensferry in Scotland. The investment involves $97 million for the South Queensferry fab to increase production and to move the fab over to a 0.5 µm CMOS 5 process which will be needed for the production of the Alpha AXP 300-MHz processor at the fab. A sum of $30 million will be spent at the Ayr plant to increase production of PCs.

Time for the Minicar?

Mercedes-Benz, the German car maker, is joining up with Swiss watch maker SMH to develop a city minicar—the Swatchmobile. The idea has been promoted by Nicholas Hayek, chairman of SMH, for several years and prototypes have appeared hitherto as two-seater minicars with a variety of engines from electric to petrol and hybrid systems.

ASM and IMEC Establish Joint Research Efforts in Belgium

At the IEEE International Solid-State Circuits Conference, ASM International NV (Bilthoven, Netherlands and Phoenix, Arizona), a semiconductor equipment manufacturer, and IMEC (Leuven, Belgium), an independent R&D organization that develops and licenses microelectronics technology worldwide, announced that they have signed an agreement to collaborate on clean-room research activities for semiconductor processing. Joint research efforts are being conducted at IMEC's facilities in Belgium using ASM's semiconductor processing equipment and IMEC's semiconductor processing facilities.

VLSI and Sorep Establish Joint Venture

VLSI Technology Inc. and Sorep SA, of Chateaubourg, France, have established a joint-venture company, ComAtlas SA, a subsidiary of Sorep, in which they will each hold a 50 percent stake. Terms of the agreement were not disclosed. ComAtlas will develop a range of products for the digital television market including set-top boxes. ComAtlas expects to introduce its first products in 0.6 µm CMOS in the first half of this year. ComAtlas will remain at its current location of Chateaubourg, near Rennes, France, and will work closely with VLSI's Consumer and Industrial Products Division, based in San Jose, California.

SCI Buys Third European Plant

Contract manufacturer SCI has finalized its purchase of Hewlett-Packard's 5,000 m^2 surface-mount facility at Grenoble in France. SCI will continue to supply Hewlett-Packard with a substantial proportion of the plant's output. SCI already has two plants in Europe at Irvine, Scotland and Cork, Ireland.

Mark Your Calendars
13th Annual European Semiconductor Conference—May 26, 1994—London, England

Emerging Applications: The PC and Beyond

Dataquest's 13th Annual European Semiconductor Industry Conference will be held in London, England on May 26 this year. This one-day conference is *the* ideal opportunity for you to update yourself on the latest European and worldwide trends and issues in semiconductors. This year the conference will adopt a *new* one-day format to focus on a broad range of emerging applications that Dataquest believes will nourish and sustain the semiconductor market into the next century.

Senior Dataquest analysts will begin the day by presenting their latest forecasts and analysis of the following:

- Vendor performance
- Trends in memories, microcomponents, ASICs and discretes
- Key application drivers
- Government and trade issues affecting the industry

The conference will then hear senior executives from the vendor and end-user communities present their assessments and expectations of the semiconductor applications most likely to succeed.

Applications that the conference plans to cover include the following:

- **Personal computing**: A review of the future of the PC, its impact on 3V/low-power semiconductors, and on storage technologies
- **Communications**: ATM, mobile data communications, and the evolution of the local loop
- **Consumer**: The future of the television set, developments in consumer appliances, and set-top boxes (video-on-demand)
- **Automotive**: Multiplexed wiring and toll/in-car navigation
- **Industrial**: Utilities metering, lighting, motor control

Target Audience

Senior management, strategic planners, marketing managers, and managers involved in either the manufacturing, distribution or purchase of semiconductors would benefit significantly from this conference. End users will find this meeting especially helpful in planning future product strategies and in anticipating product changes, and will value the opportunity to meet senior executives from key semiconductor vendors. By exploring such a wide range of topics, this conference is sure to attract professionals from many industries. It will present a valuable opportunity to exchange views and discuss industry trends and directions.

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May 26, The Edwardian International, London Heathrow, United Kingdom

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Dataquest Index

I.C. Europe Semiannual Index

January - June 1994 July 29, 1994

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This is the half-year 1994 index of key industry terms, companies and products for *I.C. Europe.* Entries are followed by the month of publication and the page number(s). Product names are listed under the company that manufactures or publishes the product. General information about a company itself is found under the full company name. Each citation indicates only the beginning page of a discussion or topic (the range of page numbers is not cited).

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I.C. Europe 1993 Index

January - December 1993 February 28, 1994

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This is the 1993 index of key industry terms, companies, and products for I.C. Europe. Entries are followed by the month of publication and the page number(s). Product names are listed under the company that manufactures or publishes the product. General information about a company itself is found under the full company name. Each citation indicates only the beginning page of a discussion or topic (the range of page numbers is not cited).

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Semiconductors Europe—Market Statistics

January - December 1993 February 28, 1994

How to Use This Index

Dataquest has decided to print the index for Market Statistics (MS) separately. Therefore, the index for each service is in two parts. This should make it easier and quicker to identify the items of interest to you. For Market Statistics documents, only table titles are indexed. A key at the bottom of this page indicates the product abbreviations. Entries are followed by the date of publication and the page number(s). A Table of Contents for 1993 Dataquest Market Statistics publications is included at the end of the index.

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Note: The following abbreviations identify products associated with the Semiconductors Europe group.

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How to Use This Index

This is a cumulative index of key industry terms, companies, and products for 1993 core and segment issues of *Dataquest Perspectives* (DP), *MarketTrends* (MT), *IndustryTrends* (IT), *Inquiry Summaries* (IS), *User Wants and Needs* (UW), *Focus Reports* (FR), and *Vendor Profiles* (VP) documents. The *Market Statistics* (MS) index is printed separately and accompanies this index. A key at the bottom of this page indicates the product abbreviations. Entries are followed by the date of publication and the page number(s). Product names are listed under the company that manufactures or publishes the product. General information about a company itself is found under the full company name. Each citation indicates only the beginning page of a discussion of a topic (the range of page numbers is not cited). Most Dataquest documents issued during 1993 appear in this index. A Table of Contents for 1993 Dataquest publications listing each issue number, title, and date is included at the end of the index. Article titles are listed for the *Dataquest Perspectives.* Some cover dates have been duplicated on the same type of document. To help locate an index entry, we have added an indicator after the date and before the page number that identifies the issue number. An example of this would be SEMI- EU-DP-9304 and SEMI-EU-DP-9305 both dated June 18, 1993. The index entry would be like this:

Europe
    electronic equipment production, SEMI-EU-DP (Jun 18):[04]1
    market forecast, SEMI-EU-DP (Jun 18):[05]7

The [04] indicates SEMI-EU-DP-9304 and the [05] indicates SEMI-EU-DP-9305.

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Semiconductors

Major European Manufacturers' Semiconductor Spend Analysis

Market Statistics

1994

Program: Semiconductor Applications Markets Europe
Product Code: SAMM-EU-MS-9404
Publication Date: December 29, 1994

Major European Manufacturers' Semiconductor Spend Analysis

Market Statistics

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Major European Manufacturers' Semiconductor Spend Analysis

This report contains detailed information on the estimated 1994 semiconductor spend of major electronic equipment manufacturers in Europe. Also provided is the semiconductor spend of European companies worldwide. It should be noted that there has been a change in this year's methodology, and comparison with last year's revenue figures are not necessarily valid.

Methodology

Detailed research has been conducted to estimate European equipment production and semiconductor consumption by company and top-level application. The research is based on primary research and analyses of annual reports published by these companies, and is supported by a combination of other Dataquest and industry sources as highlighted.

Besides published company data, the following other sources have been used to further develop the accuracy of these tables:

- Results of Dataquest's European semiconductor procurement surveys
- Results of equipment production surveys
- Consultation with Dataquest analysts from the European personal computer group, European computer group, European document management group and European telecommunications group
- Press clippings
- Manufacturing database

In addition, draft estimates of these tables have been checked by a number of major semiconductor vendors, whose input and support for this project has been invaluable.

For each company, annual reports were chosen whose fiscal years most closely matched the 1993 calendar year. Where more recent reports were available, these were used.

Reported revenues were listed by category of sales and converted to US dollars using the exchange rates shown in Table 1 (see the section on exchange rates). Each company's revenue was then interpreted to isolate those electronic hardware components that originated from its own manufacturing operations. Consequently, revenues derived from nonelectronic manufacturing activities, such as badging (sales of OEM equipment), software, maintenance and other services were excluded.

Each manufacturing revenue is further divided into the six major application segments tracked as part of the **Semiconductor Applications Markets Europe** service. From this, Dataquest derived "ex-factory" revenues. It should be noted that this is the first time that Dataquest has used ex-factory revenues in our semiconductor spend analysis; previously we have reported end-user revenues. This makes year-on-year comparisons of equipment revenue invalid.

The ex-factory revenues for each application segment were next multiplied by Dataquest semiconductor I/O ratios that best reflect the products that each company manufactures.

Further estimation was used to determine what proportion of each company's operations is located in Europe. This is based on all available data provided in the annual report (such as plant locations, employee breakdown by geography, and sales by local subsidiaries). These estimates were further supplemented by data from the **Semiconductor Applications Markets Europe** service group's own records of manufacturing and procurement locations in Europe.

At this point, the electronics production and semiconductor consumption revenues reflect the situation that pertained in 1993. These figures are next adjusted to give current estimates for 1994 by applying the growth rates determined from the equipment production and semiconductor consumption tables forecasts.

Where possible, major restructuring that has occurred since an annual report was published (for example, the sale or acquisition of an electronics manufacturing division) has been taken into account in our estimates.

Can You Help?

Dataquest has published these consumption rankings for a number of years now, and we are continuously trying to improve our estimates. Consequently, we would appreciate any feedback, amendments or additions that you can offer.

Segmentation

This section outlines the market segments specific to this report. Dataquest's objective is to provide data along lines of segmentation that are logical, appropriate to the industry in question.

For a detailed explanation and a complete listing of all market segments tracked by Dataquest, please refer to the Dataquest publication, *Semiconductor Market Definitions*, SEMI-EU-MS-9401.

Dataquest defines the electronic equipment industry as the group of competing companies primarily engaged in manufacturing electronic goods. For the purposes of this report, important products of the electronics industry include data processing equipment, communications equipment, selected types of industrial equipment, consumer electronics, selected types of military and civil aerospace and defense-oriented electronics, and automotive electronics.

For forecasting purposes, Dataquest segments the electronics industry into six broad semiconductor application markets; sublevels are segmented as follows:

- **Electronic Data Processing (EDP)**
  - Computers
  - Data storage
  - Terminals
  - Input/output devices
  - Smart cards
  - Dedicated systems
- **Communications**
  - Premise telecoms
  - Public telecoms
  - Mobile communications
  - Broadcast and studio equipment
  - Other communications
- **Industrial**
  - Security and energy management systems
  - Manufacturing and instrumentation systems
  - Medical equipment
  - Other industrial equipment
- **Consumer**
  - Audio
  - Video
  - Personal electronics
  - Appliances
- **Military and Civil Aerospace**
- **Transportation**

Exchange Rates

Dataquest uses an average annual exchange rate for each European country for converting revenue to US dollar values. The 1993 exchange rate estimate uses actual average monthly exchange rates from January through December (these data are gathered and supplied by the Dun & Bradstreet Corporation). The annual rate is estimated as the arithmetic mean of the 12 monthly rates. Exchange rates are provided in Table 1 for your reference. Exchange rates for historical years are available on request.

Table 1
Average 1992 and 1993 Rates per US Dollar

Country	1992 Rate	1993 Rate	Change 1992/1993
Austria (Schilling)	10.9500	11.6500	-6.0%
Belgium (Franc)	32.0200	34.6700	-7.6%
Denmark (Krone)	6.0200	6.4901	-7.2%
ECU	0.7700	0.8580	-10.3%
Finland (Markka)	4.4500	5.7317	-22.4%
France (Franc)	5.2700	5.6717	-7.1%
Germany (Mark)	1.5600	1.6556	-5.8%
Greece (Drachma)	189.7400	229.3300	-17.3%
Hong Kong (Dollar)	7.7400	7.7235	0.2%
Ireland (Punt)	0.5900	0.6829	-13.6%
Italy (Lira)	1227.7500	1577.8500	-22.2%
Netherlands (Gulden)	1.7500	1.8583	-5.8%
Norway (Krone)	6.1800	7.1054	-13.0%
Portugal (Escudo)	134.3400	161.0800	-16.6%
Spain (Peseta)	101.9000	127.8700	-20.3%
Sweden (Krona)	5.8100	7.8217	-25.7%
Switzerland (Franc)	1.4000	1.4803	-5.4%
United Kingdom (Pound)	0.5700	0.6668	-14.5%

Source: Dun & Bradstreet

Worldwide Production and Consumption

The following tables show Dataquest's estimates for 1994 equipment production and semiconductor consumption for European companies worldwide. The tables are presented as follows:

- Table 2 shows 1994 worldwide electronic equipment production for the major equipment companies based in Europe. These revenues are ex-factory costs. The revenues are further broken down by application segments.
- Table 3 shows 1994 worldwide estimates of semiconductor consumption for the companies listed in Table 2.

Table 2
1994 European Companies' Worldwide Equipment Production
(Millions of Dollars)

Company	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Actebis	333.1	-	-	-	-	-	333.1
AEG	-	-	192.3	1,325.1	-	-	1,517.4
Alcatel	-	7,659.0	174.0	-	384.0	-	8,217.0
Amstrad	68.8	92.3	-	204.4	-	-	365.4
Ascom	132.4	1,184.2	132.5	-	80.5	-	1,529.7
Asea Brown Boveri	-	261.3	850.3	-	-	-	1,111.6
ASI	218.8	-	-	-	-	-	218.8
Bang & Olufsen	-	39.0	-	196.6	-	-	235.6
Bosch	-	2,992.0	128.9	-	-	3,203.7	6,324.6
Bosch-Siemens	-	-	-	2,116.5	-	-	2,116.5
Bull	1,175.6	-	64.7	-	-	-	1,240.2
Deutsche Aerospace	-	181.2	40.6	-	980.9	-	1,202.7
Electrolux	-	-	-	2,565.1	-	73.1	2,638.2
Elonex	171.3	-	-	-	-	-	171.3
Ericsson	-	4,584.4	61.8	-	301.5	-	4,947.8
Escom	499.8	-	-	-	-	-	499.8
GEC	132.6	-	1,996.2	121.0	2,575.6	-	4,825.4
GPT	-	1,080.3	-	-	-	-	1,080.3
Grundig	38.0	93.4	-	1,148.6	-	163.3	1,443.3
ICL	862.8	-	-	-	-	-	862.8
Italtel	-	827.2	-	-	72.4	-	899.6
Lucas	-	-	153.8	-	331.1	715.6	1,200.6
Magneti Marelli	-	-	-	-	-	563.2	563.2
Mannesmann	-	-	160.3	20.9	-	720.2	901.5
Matra	-	874.8	-	-	687.4	40.2	1,602.3
Nokia	132.7	2,004.7	47.3	643.3	-	33.8	2,861.9
Olivetti	2,430.8	171.6	88.4	-	-	-	2,690.8
Peacock	274.2	-	-	-	-	-	274.2
Philips	109.2	1,052.4	1,097.2	4,882.2	-	244.5	7,385.4
Rank Xerox	764.6	-	-	-	-	-	764.6
Sagem	46.7	407.6	38.4	-	367.9	70.9	931.5
Schlumberger	381.1	200.9	754.5	-	118.6	-	1,455.1
Siemens	3,129.9	6,729.2	3,099.5	130.0	164.3	864.9	14,117.8
TEMIC	-	-	-	-	-	573.5	573.5
Thomson Consumer Electronics	-	215.9	-	3,754.2	-	-	3,970.1
Thomson-CSF	114.5	212.9	-	-	2,814.8	-	3,142.2
Tulip Computer	197.4	-	-	-	-	-	197.4
Valeo	-	-	-	-	-	870.5	870.5
Vobis	585.5	-	-	-	-	-	585.5
Total	$11,800	$30,864	$9,081	$17,108	$8,879	$8,138	$85,869

Source: Dataquest (December 1994 Estimates)

Table 3
1994 European Companies' Worldwide Semiconductor Consumption
(Millions of Dollars)

Company	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Actebis	84.8	-	-	-	-	-	84.8
AEG	-	-	13.9	23.4	-	-	37.3
Alcatel	-	677.3	12.5	-	10.1	-	699.8
Amstrad	6.8	8.4	-	49.2	-	-	64.3
Ascom	12.9	106.1	9.6	-	2.1	-	130.6
Asea Brown Boveri	-	22.8	60.4	-	-	-	83.2
ASI	55.7	-	-	-	-	-	55.7
Bang & Olufsen	-	3.5	-	47.3	-	-	50.8
Bosch	-	264.8	9.2	-	-	337.1	611.2
Bosch-Siemens	-	-	-	42.8	-	-	42.8
Bull	118.3	-	4.6	-	-	-	122.9
Deutsche Aerospace	-	16.4	3.0	-	25.9	-	45.3
Electrolux	-	-	-	40.0	-	8.0	48.0
Elonex	43.6	-	-	-	-	-	43.6
Ericsson	-	400.8	4.4	-	7.8	-	413.0
Escom	127.2	-	-	-	-	-	127.2
GEC	12.7	-	143.0	8.8	67.7	-	232.1
GPT	-	95.5	-	-	-	-	95.5
Grundig	3.7	8.5	-	211.7	-	17.6	241.5
ICL	85.1	-	-	-	-	-	85.1
Italtel	-	66.0	-	-	1.9	-	67.9
Lucas	-	-	10.9	-	8.7	75.6	95.1
Magneti Marelli	-	-	-	-	-	60.9	60.9
Mannesmann	-	-	11.4	1.5	-	76.5	89.3
Matra	-	79.4	-	-	18.1	4.4	101.8
Nokia	13.5	336.4	3.4	100.1	-	3.7	457.1
Olivetti	231.1	15.2	6.3	-	-	-	252.7
Peacock	70.0	-	-	-	-	-	70.0
Philips	12.6	118.9	75.3	743.0	-	27.5	977.2
Rank Xerox	50.6	-	-	-	-	-	50.6
Sagem	4.6	37.0	2.8	-	9.7	7.7	61.8
Schlumberger	33.7	16.7	51.8	-	3.1	-	105.3
Siemens	307.0	584.7	219.4	9.8	4.3	93.1	1,218.3
TEMIC	-	-	-	-	-	62.6	62.6
Thomson Consumer Electronics	-	17.9	-	783.5	-	-	801.4
Thomson-CSF	11.3	13.5	-	-	74.2	-	99.0
Tulip Computer	25.2	-	-	-	-	-	25.2
Valeo	-	-	-	-	-	94.9	94.9
Vobis	138.4	-	-	-	-	-	138.4
Total	$1,449	$2,890	$642	$2,061	$234	$870	$8,145

Source: Dataquest (December 1994 Estimates)

European Production and Consumption

The following tables show Dataquest's estimates for 1994 equipment production and semiconductor consumption for companies worldwide. The tables are presented as follows:

- Table 4 shows 1994 European electronic equipment production in millions of dollars for the major equipment manufacturers in Europe. These revenues are broken down by application segment. The total line at the bottom of the table shows the total production of the listed companies: the "effective European equipment production" line shows Dataquest's latest estimates for European effective (where semiconductor components are procured in Europe) electronic equipment production in ex-factory revenue. The "percentage" line shows the above companies' percentage of that European effective equipment production.
- Table 5 shows 1994 European estimates of semiconductor consumption for the companies listed in Table 5; again, a percentage of the listed companies is shown against the total European market.

Table 4
1994 Worldwide Companies' European Equipment Production
(Millions of Dollars)

Company	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Acer	170.0	-	-	-	-	-	170.0
Actebis	333.1	-	-	-	-	-	333.1
AEG	-	-	174.8	1,325.1	-	-	1,499.8
Alcatel	-	6,116.2	140.7	-	312.5	-	6,569.4
Amstrad	68.8	92.3	-	204.4	-	-	365.4
Apple	880.0	-	-	-	-	-	880.0
Ascom	119.6	1,064.8	119.9	-	73.1	-	1,377.4
Asea Brown Boveri	-	182.4	604.9	-	-	-	787.4
ASI	218.8	-	-	-	-	-	218.8
AT&T	432.1	152.1	-	-	-	-	584.2
Bang & Olufsen	-	39.0	-	196.6	-	-	235.6
Bosch	-	2,539.8	110.4	-	-	2,123.6	4,773.8
Bosch-Siemens	-	-	-	2,116.5	-	-	2,116.5
Bull	831.5	-	46.0	-	-	-	877.5
Compaq	1,396.0	-	-	-	-	-	1,396.0
Dell	621.0	-	-	-	-	-	621.0
Deutsche Aerospace	-	181.2	40.6	-	980.9	-	1,202.7
Digital Equipment	1,248.0	-	-	-	-	-	1,248.0
Electrolux	-	-	-	1,883.1	-	73.1	1,956.2
Elonex	171.3	-	-	-	-	-	171.3
Ericsson	-	3,430.6	47.0	-	231.1	-	3,708.6
Escom	499.8	-	-	-	-	-	499.8

(Continued)

Table 4 (Continued)
1994 Worldwide Companies' European Equipment Production

Company	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Ford	-	-	-	-	-	703.8	703.8
GEC	106.8	-	1,614.2	97.2	2,096.2	-	3,914.4
GPT	-	862.7	-	-	-	-	862.7
Grundig	38.0	93.4	-	979.4	-	140.5	1,251.2
Hewlett-Packard	939.9	-	279.5	-	-	-	1,219.4
Hitachi	16.5	-	25.5	453.2	-	-	495.3
IBM	8,375.0	-	-	-	-	-	8,375.0
ICL	862.8	-	-	-	-	-	862.8
Intel	202.0	-	-	-	-	-	202.0
Italtel	-	827.2	-	-	72.4	-	899.6
Lucas	-	-	101.9	-	221.8	474.3	798.1
Magneti Marelli	-	-	-	-	-	509.7	509.7
Mannesmann	-	-	114.1	14.8	-	512.7	641.5
Matra	-	874.8	-	-	605.0	40.2	1,519.9
Matsushita	523.8	770.6	175.1	1,035.4	-	11.7	2,516.6
Mitsubishi	-	47.4	-	148.8	-	-	196.2
Motorola	42.4	3,116.6	96.9	-	-	196.8	3,452.6
Nokia	132.7	1,701.7	47.3	643.3	-	33.8	2,558.9
Northern Telecom	-	478.3	-	-	-	-	478.3
Olivetti	1,897.5	137.1	71.5	-	-	-	2,106.1
Peacock	274.2	-	-	-	-	-	274.2
Philips	109.2	681.9	726.8	3,431.2	-	184.7	5,133.7
Rank Xerox	764.6	-	-	-	-	-	764.6
Sagem	46.7	407.6	38.4	-	367.9	70.9	931.5
Sanyo	-	-	-	220.0	-	-	220.0
Schlumberger	136.4	69.9	273.6	-	43.9	-	523.9
Siemens	2,521.3	4,697.7	2,205.0	91.6	118.0	782.8	10,416.4
Sony	197.3	-	-	1,529.4	-	22.2	1,748.9
Sun Microsystems	1,210.0	-	-	-	-	-	1,210.0
TEMIC	-	-	-	-	-	573.5	573.5
Thomson Consumer Electronics	-	64.4	-	1,142.9	-	-	1,207.3
Thomson-CSF	114.5	212.9	-	-	2,814.8	-	3,142.2
Toshiba	583.9	-	1.4	759.4	-	-	1,344.8
Tulip Computer	197.4	-	-	-	-	-	197.4
Valeo	-	-	-	-	-	849.1	849.1
Vobis	585.5	-	-	-	-	-	585.5
Total	$26,869	$28,842	$7,056	$16,272	$7,938	$7,303	$94,280
Total European Equipment Production	$42,415	$39,246	$25,681	$18,506	$23,091	$9,560	$158,499
Companies' Percentage of European Production	63.3%	73.5%	27.5%	87.9%	34.4%	76.4%	59.5%

Source: Dataquest (December 1994 Estimates)

Table 5
1994 Worldwide Companies' European Semiconductor Consumption
(Millions of Dollars)

Company	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Acer	43.0	-	-	-	-	-	43.0
Actebis	84.8	-	-	-	-	-	84.8
AEG	-	-	12.7	23.4	-	-	36.1
Alcatel	-	554.8	10.3	-	8.2	-	573.3
Amstrad	6.8	8.4	-	49.2	-	-	64.3
Apple	280.0	-	-	-	-	-	280.0
Ascom	11.8	96.6	8.7	-	1.9	-	119.1
Asea Brown Boveri	-	16.5	44.1	-	-	-	60.7
ASI	55.7	-	-	-	-	-	55.7
AT&T	51.1	13.8	-	-	-	-	64.9
Bang & Olufsen	-	3.5	-	47.3	-	-	50.8
Bosch	-	218.1	7.8	-	-	223.0	448.9
Bosch-Siemens	-	-	-	42.8	-	-	42.8
Bull	87.8	-	3.4	-	-	-	91.2
Compaq	378.0	-	-	-	-	-	378.0
Dell	186.0	-	-	-	-	-	186.0
Deutsche Aerospace	-	16.4	3.0	-	25.9	-	45.3
Digital Equipment	123.0	-	-	-	-	-	123.0
Electrolux	-	-	-	30.2	-	8.0	38.2
Elonex	43.6	-	-	-	-	-	43.6
Ericsson	-	294.6	3.3	-	5.1	-	303.0
Escom	127.2	-	-	-	-	-	127.2
Ford	-	-	-	-	-	76.9	76.9
GEC	10.5	-	117.7	7.2	55.3	-	190.7
GPT	-	78.3	-	-	-	-	78.3
Grundig	3.7	8.5	-	183.3	-	15.3	210.8
Hewlett-Packard	132.4	-	20.4	-	-	-	152.8
Hitachi	1.6	-	1.9	65.4	-	-	68.9
IBM	870.5	-	-	-	-	-	870.5
ICL	85.1	-	-	-	-	-	85.1
Intel	51.6	-	-	-	-	-	51.6
Italtel	-	66.0	-	-	1.9	-	67.9
Lucas	-	-	7.4	-	5.9	51.8	65.1
Magneti Marelli	-	-	-	-	-	55.7	55.7
Mannesmann	-	-	8.3	1.1	-	56.0	65.4
Matra	-	79.4	-	-	16.0	4.4	99.7
Matsushita	51.6	69.9	12.8	76.4	-	1.3	212.0
Mitsubishi	-	5.7	-	35.8	-	-	41.5
Motorola	4.2	418.8	7.1	-	-	21.5	451.6
Nokia	15.3	194.8	3.3	77.4	-	3.6	294.5

(Continued)

Table 5 (Continued)
1994 Worldwide Companies' European Semiconductor Consumption
(Millions of Dollars)

Company	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Northern Telecom	-	43.4	-	-	-	-	43.4
Olivetti	187.1	12.4	5.2	-	-	-	204.7
Peacock	70.0	-	-	-	-	-	70.0
Philips	12.6	58.6	51.4	412.8	-	19.4	554.8
Rank Xerox	50.6	-	-	-	-	-	50.6
Sagem	4.6	37.0	2.8	-	9.7	7.7	61.8
Sanyo	-	-	-	52.9	-	-	52.9
Schlumberger	13.5	6.3	19.9	-	1.2	-	40.9
Siemens	291.2	403.4	156.1	11.0	2.6	82.2	946.5
Sony	19.5	-	-	196.3	-	2.4	218.1
Sun Microsystems	160.0	-	-	-	-	-	160.0
TEMIC	-	-	-	-	-	62.6	62.6
Thomson Consumer Electronics	-	5.8	-	256.7	-	-	262.5
Thomson-CSF	11.3	13.5	-	-	74.2	-	99.0
Toshiba	57.6	-	0.1	56.0	-	-	113.7
Tulip Computer	49.4	-	-	-	-	-	49.4
Valeo	-	-	-	-	-	92.7	92.7
Vobis	138.4	-	-	-	-	-	138.4
Total	$3,771	$2,725	$508	$1,625	$208	$785	$9,621
Total European Semiconductor Consumption	$7,331	$4,090	$2,651	$2,147	$570	$1,477	$18,266
Companies' Percentage of Semiconductor Consumption	51.4%	66.6%	19.2%	75.7%	36.5%	53.1%	52.7%

Source: Dataquest (December 1994 Estimates)

Ranked European Production and Consumption

The following tables give Dataquest's top 10 European companies for the following categories:

- Table 6 shows 1994 European estimates of semiconductor consumption for the major manufacturers located in Europe, ranked in descending order.
- Table 7 shows the top 10 European electronic data processing equipment production and consumption by company 1994.
- Table 8 shows the top 10 European communications equipment production and consumption by company 1994.
- Table 9 shows the top 10 European industrial equipment production and consumption by company 1994.
- Table 10 shows the top 10 European consumer equipment production and consumption by company 1994.
- Table 11 shows the top 10 European military equipment production and consumption by company 1994
- Table 12 shows the top 10 European transportation equipment production and consumption by company 1994.

Table 6
Ranked 1994 Worldwide Companies' European Semiconductor Consumption (Millions of Dollars)

Company	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Siemens	291.2	403.4	156.1	11.0	2.6	82.2	946.5
IBM	870.5	-	-	-	-	-	870.5
Alcatel	-	554.8	10.3	-	8.2	-	573.3
Philips	12.6	58.6	51.4	412.8	-	19.4	554.8
Motorola	4.2	418.8	7.1	-	-	21.5	451.6
Bosch	-	218.1	7.8	-	-	223.0	448.9
Compaq	378.0	-	-	-	-	-	378.0
Ericsson	-	294.6	3.3	-	5.1	-	303.0
Nokia	15.3	194.8	3.3	77.4	-	3.6	294.5
Apple	280.0	-	-	-	-	-	280.0
Thomson Consumer Electronics	-	5.8	-	256.7	-	-	262.5
Sony	19.5	-	-	196.3	-	2.4	218.1
Matsushita	51.6	69.9	12.8	76.4	-	1.3	212.0
Grundig	3.7	8.5	-	183.3	-	15.3	210.8
Olivetti	187.1	12.4	5.2	-	-	-	204.7
GEC	10.5	-	117.7	7.2	55.3	-	190.7
Dell	186.0	-	-	-	-	-	186.0
Sun Microsystems	160.0	-	-	-	-	-	160.0
Hewlett-Packard	132.4	-	20.4	-	-	-	152.8

(Continued)

Table 6 (Continued)
Ranked 1994 Worldwide Companies' European Semiconductor Consumption
(Millions of Dollars)

Company	EDP	Comms	Industrial	Consumer	Military	Trans.	Total
Vobis	138.4	-	-	-	-	-	138.4
Escom	127.2	-	-	-	-	-	127.2
Digital Equipment	123.0	-	-	-	-	-	123.0
Ascom	11.8	96.6	8.7	-	1.9	-	119.1
Toshiba	57.6	-	0.1	56.0	-	-	113.7
Matra	-	79.4	-	-	16.0	4.4	99.7
Thomson-CSF	11.3	13.5	-	-	74.2	-	99.0
Valeo	-	-	-	-	-	92.7	92.7
Bull	87.8	-	3.4	-	-	-	91.2
ICL	85.1	-	-	-	-	-	85.1
Actebis	84.8	-	-	-	-	-	84.8
GPT	-	78.3	-	-	-	-	78.3
Ford	-	-	-	-	-	76.9	76.9
Peacock	70.0	-	-	-	-	-	70.0
Hitachi	1.6	-	1.9	65.4	-	-	68.9
Italtel	-	66.0	-	-	1.9	-	67.9
Mannesmann	-	-	8.3	1.1	-	56.0	65.4
Lucas	-	-	7.4	-	5.9	51.8	65.1
AT&T	51.1	13.8	-	-	-	-	64.9
Amstrad	6.8	8.4	-	49.2	-	-	64.3
TEMIC	-	-	-	-	-	62.6	62.6
Sagem	4.6	37.0	2.8	-	9.7	7.7	61.8
Asea Brown Boveri	-	16.5	44.1	-	-	-	60.7
ASI	55.7	-	-	-	-	-	55.7
Magneti Marelli	-	-	-	-	-	55.7	55.7
Sanyo	-	-	-	52.9	-	-	52.9
Intel	51.6	-	-	-	-	-	51.6
Bang & Olufsen	-	3.5	-	47.3	-	-	50.8
Rank Xerox	50.6	-	-	-	-	-	50.6
Tulip Computer	49.4	-	-	-	-	-	49.4
Deutsche Aerospace	-	16.4	3.0	-	25.9	-	45.3
Elonex	43.6	-	-	-	-	-	43.6
Northern Telecom	-	43.4	-	-	-	-	43.4
Acer	43.0	-	-	-	-	-	43.0
Bosch-Siemens	-	-	-	42.8	-	-	42.8
Mitsubishi	-	5.7	-	35.8	-	-	41.5
Schlumberger	13.5	6.3	19.9	-	1.2	-	40.9
Electrolux	-	-	-	30.2	-	8.0	38.2
AEG	-	-	12.7	23.4	-	-	36.1
Total	$3,771	$2,725	$508	$1,625	$208	$785	$9,621

Source: Dataquest (December 1994 Estimates)

Table 7
Ranked European Electronic Data Processing Semiconductor Consumption 1994
(Millions of Dollars)

Rank	Company	Equipment Production	Semiconductor Consumption
1	IBM	8,375.0	870.5
2	Compaq	1,396.0	378.0
3	Siemens	2,521.3	291.2
4	Apple	880.0	280.0
5	Olivetti	1,897.5	187.1
6	Dell	621.0	186.0
7	Sun Microsystems	1,210.0	160.0
8	Vobis	585.5	138.4
9	Hewlett-Packard	939.9	132.4
10	Escom	499.8	127.2

Source: Dataquest (December 1994 Estimates)

Table 8
Ranked European Communications Semiconductor Consumption 1994
(Millions of Dollars)

Rank	Company	Equipment Production	Semiconductor Consumption
1	Alcatel	6,116.2	554.8
2	Motorola	3,116.6	418.8
3	Siemens	4,697.7	403.4
4	Ericsson	3,430.6	294.6
5	Bosch	2,539.8	218.1
6	Nokia	1,701.7	194.8
7	Ascom	1,064.8	96.6
8	Matra	874.8	79.4
9	GPT	862.7	78.3
10	Matsushita	770.6	69.9

Source: Dataquest (December 1994 Estimates)

Table 9
Ranked European Industrial Semiconductor Consumption 1994
(Millions of Dollars)

Rank	Company	Equipment Production	Semiconductor Consumption
1	Siemens	2,205.0	156.1
2	GEC	1,614.2	117.7
3	Philips	726.8	51.4
4	Asea Brown Boveri	604.9	44.1
5	Landis & Gyr	289.8	21.1
6	Hewlett-Packard	279.5	20.4
7	Schlumberger	273.6	19.9
8	Matsushita	175.1	12.8
9	AEG	174.8	12.7
10	Smith Industries	140.6	11.0

Source: Dataquest (December 1994 Estimates)

Table 10
Ranked European Consumer Semiconductor Consumption 1994
(Millions of Dollars)

Rank	Company	Equipment Production	Semiconductor Consumption
1	Philips	3,431.2	412.8
2	Thomson Consumer Electronics	1,142.9	256.7
3	Sony	1,529.4	196.3
4	Grundig	979.4	183.3
5	Nokia	643.3	77.4
6	Matsushita	1,035.4	76.4
7	Hitachi	453.2	65.4
8	Toshiba	759.4	56.0
9	Sanyo	220.0	52.9
10	Amstrad	204.4	49.2

Source: Dataquest (December 1994 Estimates)

Table 11
Ranked European Military and Civil Aerospace Semiconductor Consumption 1994
(Millions of Dollars)

Rank	Company	Equipment Production	Semiconductor Consumption
1	Thomson-CSF	2,814.8	74.2
2	GEC	2,096.2	55.3
3	British Aerospace	1,133.2	29.9
4	Aerospatiale	1,048.8	27.7
5	Deutsche Aerospace	980.9	25.9
6	Matra	605.0	16.0
7	Racal	372.8	9.8
8	Sagem	367.9	9.7
9	Dassault	399.7	9.0
10	Smith Industries	333.4	8.6

Source: Dataquest (December 1994 Estimates)

Table 12
Ranked European Transportation Semiconductor Consumption 1994
(Millions of Dollars)

Rank	Company	Equipment Production	Semiconductor Consumption
1	Bosch	2,123.6	223.0
2	Valeo	849.1	92.7
3	Siemens	782.8	82.2
4	Ford	703.8	76.9
5	TEMIC	573.5	62.6
6	Mannesmann	512.7	56.0
7	Magneti Marelli	509.7	55.7
8	Lucas	474.3	51.8
9	Hella	237.4	25.9
10	Motorola	196.8	21.5

Source: Dataquest (December 1994 Estimates)

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Semiconductors

European Regional Semiconductor Consumption by Application

Market Statistics

1994

Program: Semiconductor Applications Market Europe
Product Code: SAMM-EU-MS-9403
Publication Date: September 29, 1994

European Regional Semiconductor Consumption by Application

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European Regional Semiconductor Consumption by Application

Introduction

This Market Statistics document presents our midyear forecast for European country semiconductor consumption by application market segment. The data are presented in two different ways for additional clarity of the market demographics for the reader. We have therefore divided the tables into two main sections. The first section shows country semiconductor consumption by end-application markets, and the second section gives end-application markets by country data. In the following paragraphs we explain our research forecast assumptions and how to use the tables.

Forecast Summary

Dataquest published, in April 1994, a Market Statistics document which shows electronic equipment production and semiconductor consumption forecast as at that time (reference, SAMM-EU-MS-9401). Our further research into application markets this year has resulted in this new forecast by country and application. The European semiconductor market in 1993 continued a rapid growth acceleration into 1994 from the fourth quarter of 1992. We have revised our forecasts to reflect this. The four major semiconductor markets are Germany, UK and Ireland, France, and Italy. Our forecast assumptions are mostly influenced by trends in these major markets highlighted here.

Germany

The electronic data processing (EDP) end-application market accounts for nearly a third (29.7 percent) of Germany's semiconductor market. The majority of the German EDP total available market (TAM) is in computers. Personal computers account for the largest proportion of this segment. The boom in home computer sales across Europe has helped the industry sustain growth. Although "no-names" will face price pressure due to tight component supplies, the unit component average selling prices (ASPs) will be higher, as the German market will be dominated by high-end personal computers—that is, xx486-based/Pentium machines—which will carry larger amounts of DRAM memory.

Strong growth in the communications end-application market will come mainly from the strong mobile communications industry in Germany during 1994. This will result in similar growth patterns for the local semiconductor market.

The military and civil aerospace portion of the German market will remain flat. However, this represents a growth because of the overall German semiconductor market growth.

Germany has the largest market for automotive semiconductor applications in Europe, accounting for more than 50 percent of the TAM. However, the German automotive market is one of the most depressed in Europe today, with car sales in Germany remaining flat and production also responding in the same way. Although automotive electronic content is rising, strong uptake of electronics will result in a 28 percent automotive semiconductor growth in 1994.

United Kingdom and Ireland

Electronic data processing accounts for more than 60 percent of the UK and Ireland semiconductor market. Industry estimates assert that nearly 90 percent of the Irish market is EDP. The strong EDP growth will overshadow growth in all the other markets. Each of the individual end-application markets will still have respectable growth, but EDP will grow by 35 percent because of the strong growth seen in 1993. Recent investment by Motorola in this region for cellular telephone production will help strengthen the communications market in the United Kingdom.

France

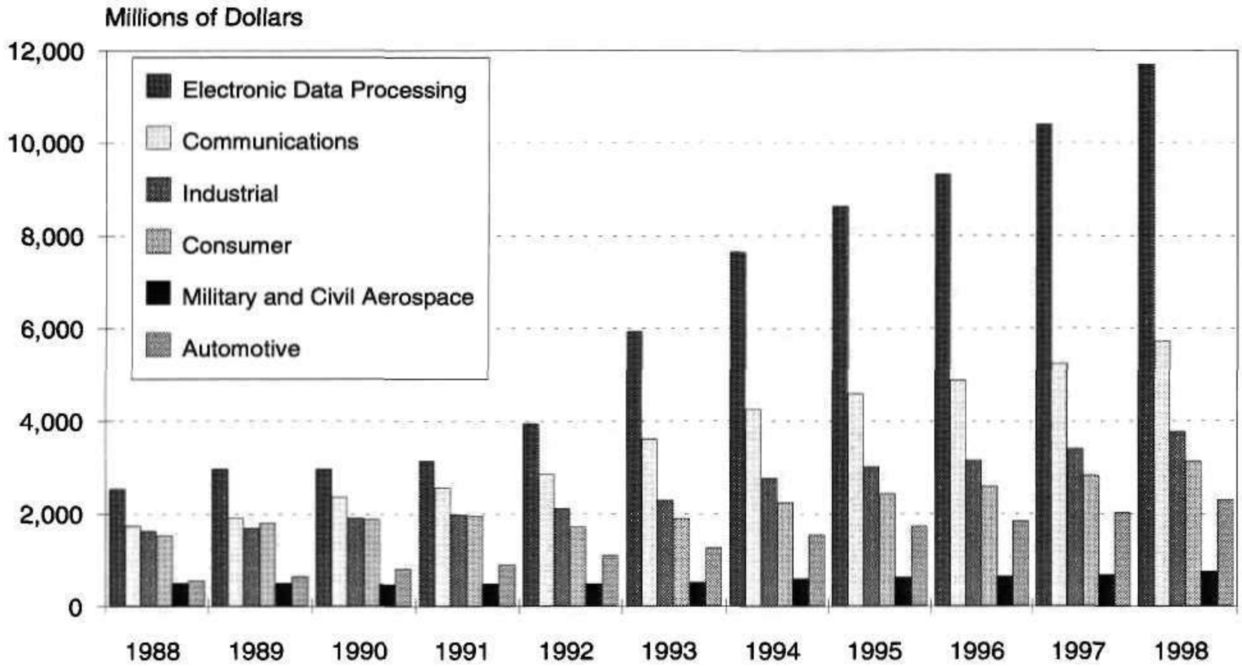
The French semiconductor market is experiencing a slower growth, due largely to the poor performance of the local major EDP producers, Group Bull and Zenith Data Systems (ZDS). Automotive growth in France and the relative strength of the computer industry is keeping the French semiconductor market afloat.

Italy

The Italian market behaves in a very erratic manner as exchange rate fluctuations continue to distort semiconductor industry performance. Most major vendors continue to trade in local currency (lire). Olivetti controls 25 percent of the total Italian semiconductor market. Other EDP players are Bull, Texas Instruments, Hewlett-Packard and IBM.

Section 1: Total Europe

Figure 1
European Semiconductor Consumption by End-Use Application
Market Forecast



Source: Dataquest (September 1994 Estimates)

Table 1-1
European Semiconductor Consumption by Application
(Millions of US Dollars)

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Electronic Data Processing	2,540	2,965	2,963	3,136	3,946	5,935	7,640	8,629	9,324	10,402	11,705	18.5%	14.5%	28.7%
Communications	1,736	1,915	2,362	2,567	2,854	3,611	4,262	4,593	4,881	5,240	5,721	15.8%	9.6%	18.0%
Industrial	1,625	1,685	1,917	1,979	2,112	2,282	2,763	3,015	3,149	3,397	3,776	7.0%	10.6%	21.1%
Consumer	1,526	1,795	1,883	1,951	1,718	1,889	2,238	2,434	2,595	2,818	3,136	4.4%	10.7%	18.5%
Military and Civil Aerospace	505	498	478	488	488	510	594	633	652	693	758	0.2%	8.2%	16.5%
Automotive	559	640	812	893	1,100	1,259	1,539	1,721	1,837	2,022	2,293	17.6%	12.7%	22.2%
Total	$8,491	$9,498	$10,415	$11,014	$12,218	$15,486	$19,036	$21,025	$22,438	$24,572	$27,389	12.8%	12.1%	22.9%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

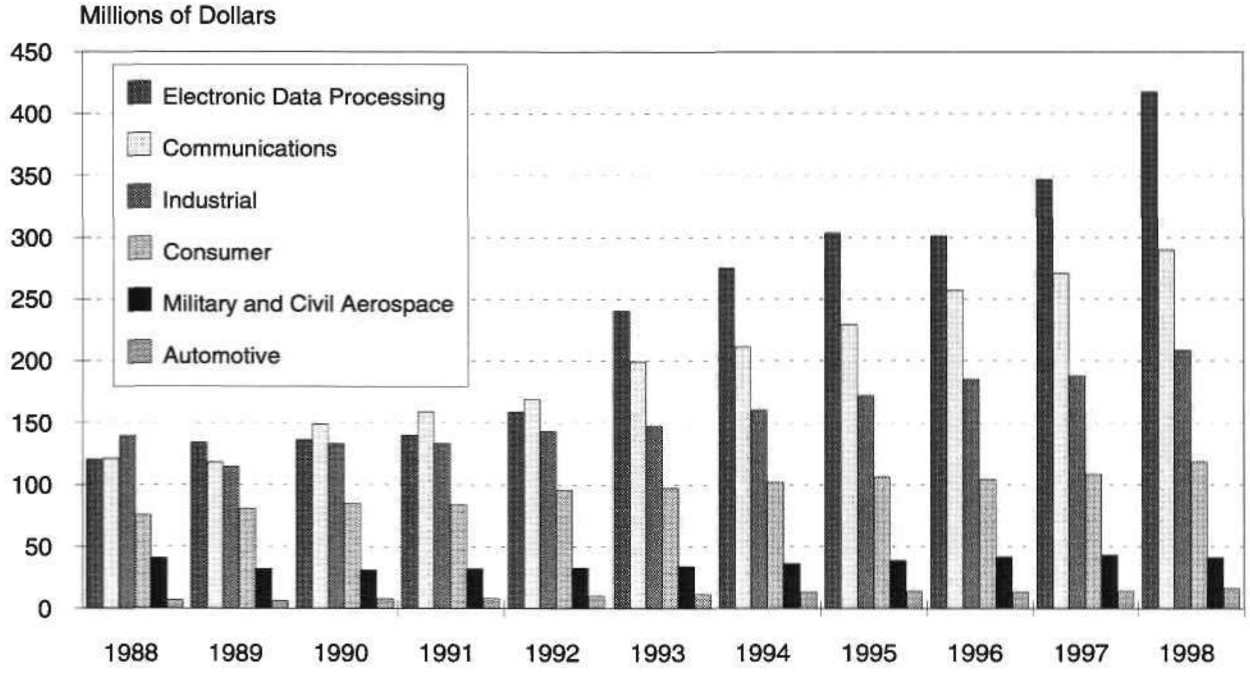
Table 1-2
European Semiconductor Consumption by Application
As a Percentage of Total Europe

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	29.9%	31.2%	28.4%	28.5%	32.3%	38.3%	40.1%	41.0%	41.6%	42.3%	42.7%
Communications	20.4%	20.2%	22.7%	23.3%	23.4%	23.3%	22.4%	21.8%	21.8%	21.3%	20.9%
Industrial	19.1%	17.7%	18.4%	18.0%	17.3%	14.7%	14.5%	14.3%	14.0%	13.8%	13.8%
Consumer	18.0%	18.9%	18.1%	17.7%	14.1%	12.2%	11.8%	11.6%	11.6%	11.5%	11.4%
Military and Civil Aerospace	5.9%	5.2%	4.6%	4.4%	4.0%	3.3%	3.1%	3.0%	2.9%	2.8%	2.8%
Automotive	6.6%	6.7%	7.8%	8.1%	9.0%	8.1%	8.1%	8.2%	8.2%	8.2%	8.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

Section 2: Benelux

Figure 2
Benelux Semiconductor Consumption by End-Use Application, Market Forecast



Source: Dataquest (September 1994 Estimates)

Table 2-1
Benelux Semiconductor Consumption by Application
(Millions of US Dollars)

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Electronic Data Processing	120	134	136	140	159	240	275	304	301	347	418	14.8%	11.7%	14.5%
Communications	121	118	149	159	169	199	211	229	257	271	290	10.5%	7.8%	6.0%
Industrial	140	115	133	133	143	147	161	172	186	188	209	1.1%	7.2%	9.0%
Consumer	76	80	85	84	96	97	102	106	104	109	119	5.2%	4.0%	4.5%
Military and Civil Aerospace	41	32	31	32	33	34	36	39	41	43	41	-3.4%	3.9%	6.1%
Automotive	7	6	8	8	10	12	13	14	13	14	16	12.0%	7.2%	12.9%
Total	$504	$485	$542	$556	$610	$730	$798	$864	$903	$972	$1,093	7.7%	8.4%	9.3%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 2-2
Benelux Semiconductor Consumption by Application
As a Percentage of Total Benelux Region

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	23.9%	27.6%	25.1%	25.2%	26.1%	32.9%	34.5%	35.2%	33.4%	35.7%	38.2%
Communications	24.0%	24.3%	27.5%	28.6%	27.7%	27.3%	26.5%	26.5%	28.5%	27.9%	26.5%
Industrial	27.7%	23.6%	24.5%	24.0%	23.4%	20.2%	20.1%	19.9%	20.6%	19.3%	19.1%
Consumer	15.0%	16.6%	15.7%	15.1%	15.7%	13.3%	12.7%	12.3%	11.5%	11.2%	10.9%
Military and Civil Aerospace	8.1%	6.6%	5.8%	5.8%	5.4%	4.7%	4.6%	4.5%	4.6%	4.5%	3.8%
Automotive	1.3%	1.2%	1.4%	1.4%	1.6%	1.6%	1.6%	1.6%	1.5%	1.5%	1.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

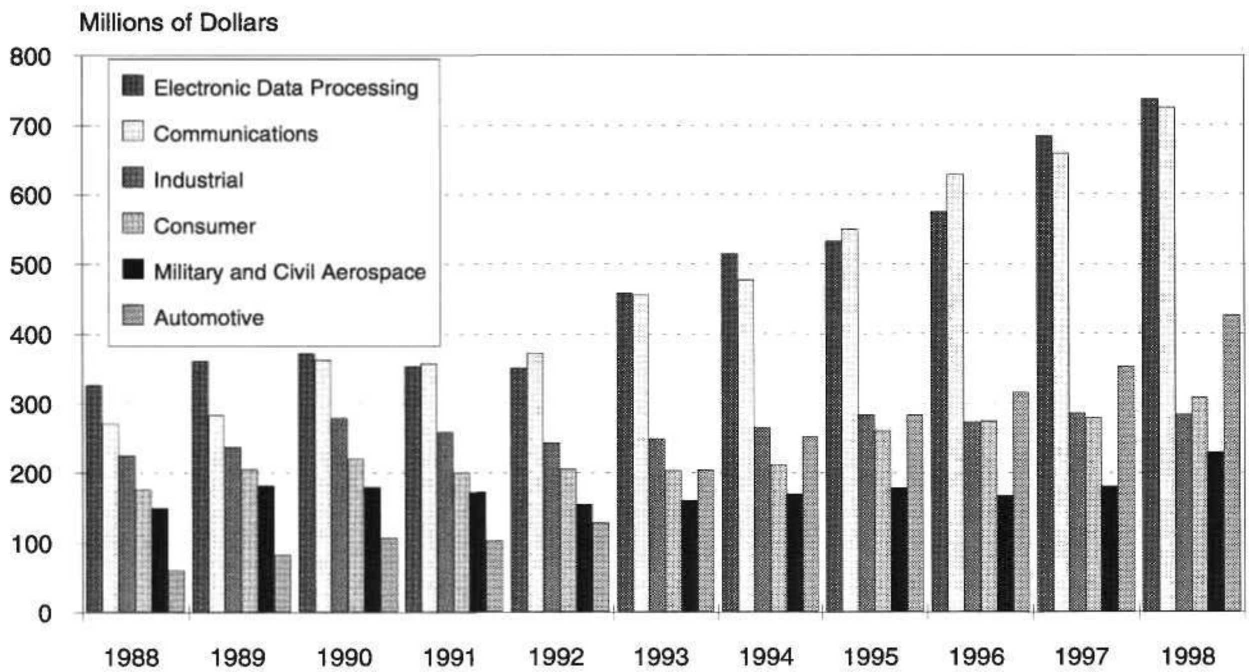
Table 2-3
Benelux Semiconductor Consumption by Application
As a Percentage of Total European Market

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	4.7%	4.5%	4.6%	4.5%	4.0%	4.0%	3.6%	3.5%	3.2%	3.3%	3.6%
Communications	7.0%	6.2%	6.3%	6.2%	5.9%	5.5%	5.0%	5.0%	5.3%	5.2%	5.1%
Industrial	8.6%	6.8%	6.9%	6.7%	6.8%	6.5%	5.8%	5.7%	5.9%	5.5%	5.5%
Consumer	5.0%	4.5%	4.5%	4.3%	5.6%	5.2%	4.5%	4.4%	4.0%	3.9%	3.8%
Military and Civil Aerospace	8.1%	6.4%	6.5%	6.6%	6.8%	6.7%	6.1%	6.1%	6.4%	6.2%	5.5%
Automotive	1.2%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%	0.7%	0.7%
Total	5.9%	5.1%	5.2%	5.0%	5.0%	4.7%	4.2%	4.1%	4.0%	4.0%	4.0%

Source: Dataquest (September 1994 Estimates)

Section 3: France

Figure 3
French Semiconductor Consumption by End-Use Application, Market Forecast



Source: Dataquest (September 1994 Estimates)

Table 3-1
French Semiconductor Consumption by Application
(Millions of US Dollars)

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Electronic Data Processing	327	361	372	353	350	458	515	533	575	684	736	7.0%	10.0%	12.3%
Communications	271	283	363	357	372	455	477	550	628	659	725	10.9%	9.8%	4.8%
Industrial	225	237	279	259	243	249	265	283	273	285	284	2.0%	2.6%	6.6%
Consumer	177	205	220	201	205	204	211	260	274	279	308	2.9%	8.6%	3.8%
Military and Civil Aerospace	150	182	180	172	155	160	170	179	167	181	229	1.3%	7.4%	5.8%
Automotive	61	83	107	103	128	204	252	283	315	352	426	27.5%	15.9%	23.3%
Total	$1,210	$1,351	$1,521	$1,444	$1,453	$1,730	$1,889	$2,087	$2,232	$2,440	$2,708	7.4%	9.4%	9.2%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 3-2
French Semiconductor Consumption by Application,
As a Percentage of Total French Region

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	27.0%	26.7%	24.5%	24.5%	24.1%	26.5%	27.2%	25.5%	25.7%	28.0%	27.2%
Communications	22.4%	20.9%	23.8%	24.7%	25.6%	26.3%	25.2%	26.3%	28.2%	27.0%	26.8%
Industrial	18.6%	17.6%	18.4%	17.9%	16.7%	14.4%	14.0%	13.6%	12.2%	11.7%	10.5%
Consumer	14.6%	15.2%	14.5%	13.9%	14.1%	11.8%	11.2%	12.4%	12.3%	11.5%	11.4%
Military and Civil Aerospace	12.4%	13.5%	11.8%	11.9%	10.7%	9.3%	9.0%	8.6%	7.5%	7.4%	8.5%
Automotive	5.0%	6.1%	7.0%	7.1%	8.8%	11.8%	13.3%	13.6%	14.1%	14.4%	15.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

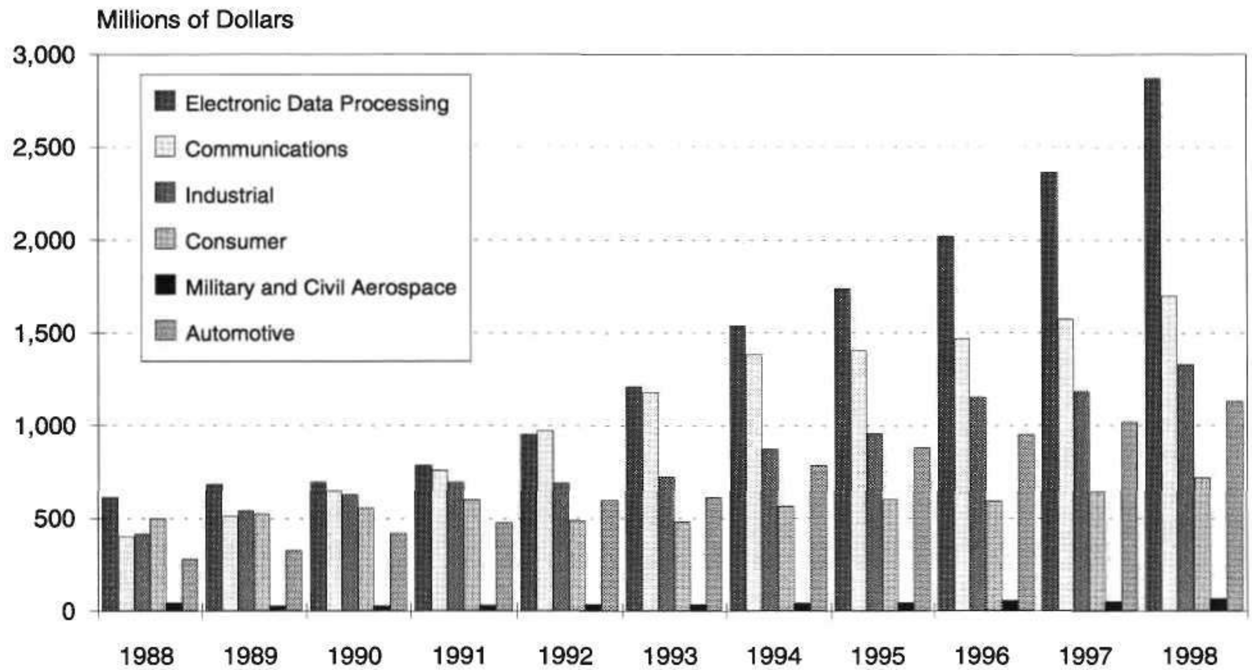
Table 3-3
French Semiconductor Consumption by Application
As a Percentage of Total European Market

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	12.9%	12.2%	12.6%	11.3%	8.9%	7.7%	6.7%	6.2%	6.2%	6.6%	6.3%
Communications	15.6%	14.8%	15.3%	13.9%	13.0%	12.6%	11.2%	12.0%	12.9%	12.6%	12.7%
Industrial	13.9%	14.1%	14.6%	13.1%	11.5%	10.9%	9.6%	9.4%	8.7%	8.4%	7.5%
Consumer	11.6%	11.4%	11.7%	10.3%	11.9%	10.8%	9.4%	10.7%	10.6%	9.9%	9.8%
Military and Civil Aerospace	29.7%	36.5%	37.6%	35.2%	31.8%	31.5%	28.6%	28.2%	25.6%	26.1%	30.2%
Automotive	10.8%	12.9%	13.2%	11.5%	11.6%	16.2%	16.3%	16.5%	17.2%	17.4%	18.6%
Total	14.3%	14.2%	14.6%	13.1%	11.9%	11.2%	9.9%	9.9%	9.9%	9.9%	9.9%

Source: Dataquest (September 1994 Estimates)

Section 4: Germany

Figure 4
German Semiconductor Consumption by End-Use Application, Market Forecast



Source: Dataquest (September 1994 Estimates)

Table 4-1
German Semiconductor Consumption by Application
(Millions of US Dollars)

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Electronic Data Processing	610	682	694	784	951	1,209	1,537	1,739	2,020	2,363	2,870	14.7%	18.9%	27.2%
Communications	403	512	646	758	973	1,177	1,380	1,404	1,467	1,573	1,696	23.9%	7.6%	17.2%
Industrial	414	541	627	691	689	724	872	957	1,152	1,185	1,328	11.8%	12.9%	20.5%
Consumer	499	523	554	600	485	480	565	602	593	644	718	-0.8%	8.4%	17.6%
Military and Civil Aerospace	45	28	27	31	34	35	40	44	56	50	68	-5.1%	14.5%	16.8%
Automotive	280	327	417	476	596	610	783	881	952	1,020	1,128	16.9%	13.1%	28.3%
Total	$2,250	$2,613	$2,965	$3,340	$3,728	$4,235	$5,178	$5,626	$6,240	$6,835	$7,808	13.5%	13.0%	22.3%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 4-2
German Semiconductor Consumption by Application
As a Percentage of Total German Region

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	27.1%	26.1%	23.4%	23.5%	25.5%	28.5%	29.7%	30.9%	32.4%	34.6%	36.8%
Communications	17.9%	19.6%	21.8%	22.7%	26.1%	27.8%	26.7%	25.0%	23.5%	23.0%	21.7%
Industrial	18.4%	20.7%	21.2%	20.7%	18.5%	17.1%	16.8%	17.0%	18.5%	17.3%	17.0%
Consumer	22.2%	20.0%	18.7%	18.0%	13.0%	11.3%	10.9%	10.7%	9.5%	9.4%	9.2%
Military and Civil Aerospace	2.0%	1.1%	0.9%	0.9%	0.9%	0.8%	0.8%	0.8%	0.9%	0.7%	0.9%
Automotive	12.4%	12.5%	14.1%	14.3%	16.0%	14.4%	15.1%	15.7%	15.2%	14.9%	14.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

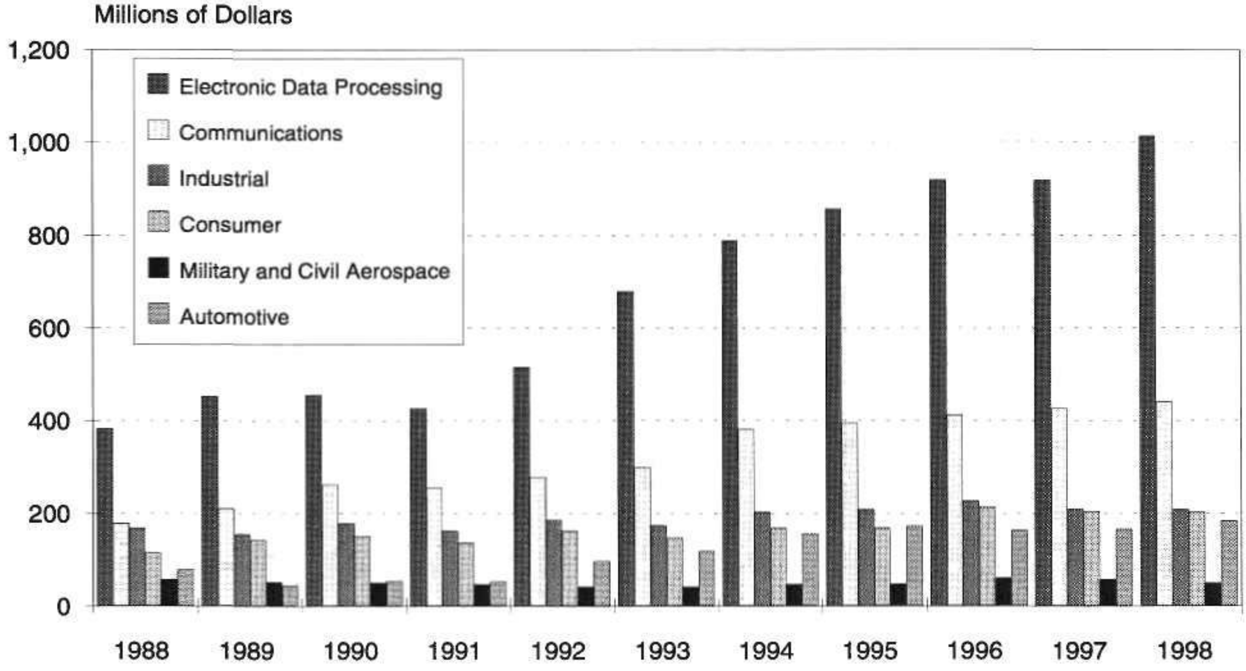
Table 4-3
German Semiconductor Consumption by Application
As a Percentage of Total European Market

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	24.0%	23.0%	23.4%	25.0%	24.1%	20.4%	20.1%	20.1%	21.7%	22.7%	24.5%
Communications	23.2%	26.7%	27.4%	29.5%	34.1%	32.6%	32.4%	30.6%	30.1%	30.0%	29.6%
Industrial	25.5%	32.1%	32.7%	34.9%	32.6%	31.7%	31.6%	31.7%	36.6%	34.9%	35.2%
Consumer	32.7%	29.1%	29.4%	30.8%	28.2%	25.4%	25.2%	24.7%	22.9%	22.9%	22.9%
Military and Civil Aerospace	8.9%	5.6%	5.7%	6.3%	7.0%	6.8%	6.8%	6.9%	8.6%	7.2%	9.0%
Automotive	50.0%	51.2%	51.4%	53.3%	54.2%	48.5%	50.9%	51.2%	51.8%	50.4%	49.2%
Total	26.5%	27.5%	28.5%	30.3%	30.5%	27.3%	27.2%	26.8%	27.8%	27.8%	28.5%

Source: Dataquest (September 1994 Estimates)

Section 5: Italy

Figure 5
Italian Semiconductor Consumption by End-Use Application, Market Forecast



Source: Dataquest (September 1994 Estimates)

Table 5-1
Italian Semiconductor Consumption by Application
(Millions of US Dollars)

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Electronic Data Processing	383	452	455	426	515	678	787	855	918	918	1,013	12.1%	8.3%	16.1%
Communications	178	209	262	255	278	298	381	394	412	426	441	10.9%	8.1%	27.7%
Industrial	168	155	178	163	186	174	202	208	226	209	207	0.7%	3.6%	16.4%
Consumer	116	144	151	136	162	147	168	168	213	204	203	4.8%	6.7%	14.4%
Military and Civil Aerospace	58	52	50	47	42	41	47	48	60	57	49	-6.5%	3.4%	12.7%
Automotive	80	44	55	52	97	119	156	173	163	166	183	8.3%	9.1%	31.5%
Total	$982	$1,056	$1,151	$1,079	$1,280	$1,457	$1,741	$1,845	$1,991	$1,981	$2,096	8.2%	7.5%	19.5%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 5-2
Italian Semiconductor Consumption by Application
As a Percentage of Total Italian Region

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	39.0%	42.8%	39.5%	39.5%	40.2%	46.5%	45.2%	46.4%	46.1%	46.3%	48.3%
Communications	18.1%	19.8%	22.8%	23.6%	21.7%	20.5%	21.9%	21.3%	20.7%	21.5%	21.0%
Industrial	17.1%	14.7%	15.5%	15.1%	14.5%	11.9%	11.6%	11.3%	11.4%	10.5%	9.9%
Consumer	11.8%	13.6%	13.1%	12.6%	12.7%	10.1%	9.6%	9.1%	10.7%	10.3%	9.7%
Military and Civil Aerospace	5.9%	4.9%	4.3%	4.4%	3.3%	2.8%	2.7%	2.6%	3.0%	2.9%	2.3%
Automotive	8.1%	4.2%	4.8%	4.9%	7.6%	8.1%	9.0%	9.4%	8.2%	8.4%	8.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

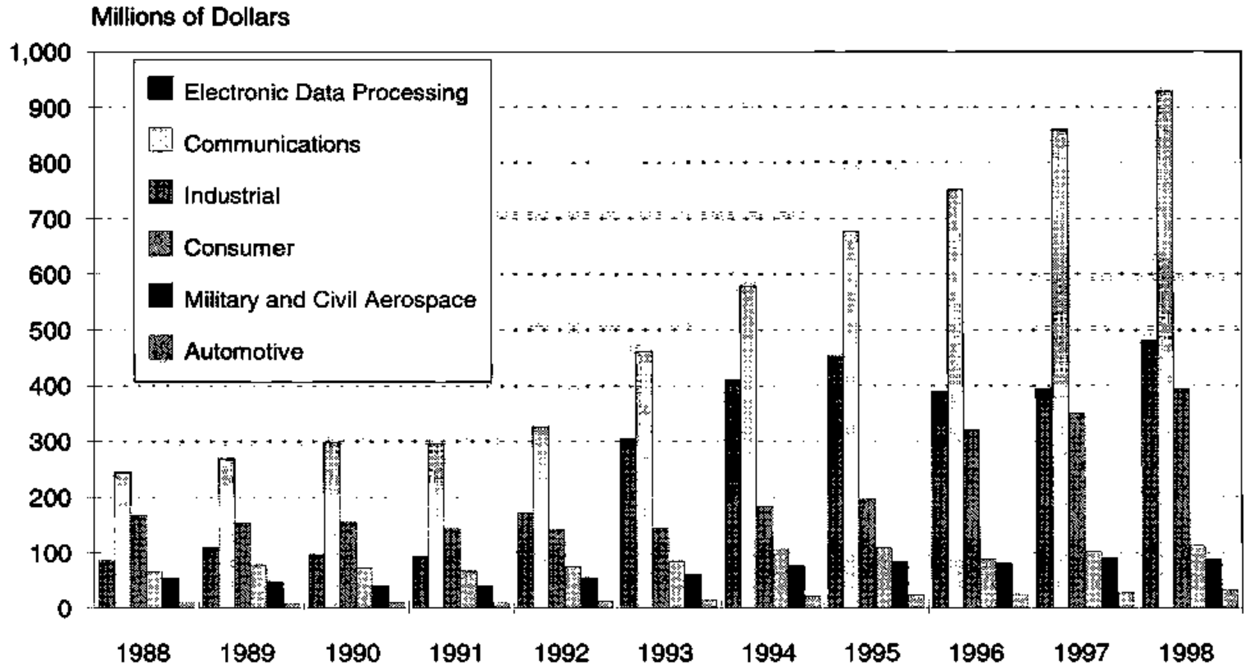
Table 5-3
Italian Semiconductor Consumption by Application
As a Percentage of Total European Market

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	15.1%	15.2%	15.4%	13.6%	13.1%	11.4%	10.3%	9.9%	9.8%	8.8%	8.7%
Communications	10.2%	10.9%	11.1%	9.9%	9.7%	8.3%	8.9%	8.6%	8.4%	8.1%	7.7%
Industrial	10.3%	9.2%	9.3%	8.2%	8.8%	7.6%	7.3%	6.9%	7.2%	6.1%	5.5%
Consumer	7.6%	8.0%	8.0%	7.0%	9.4%	7.8%	7.5%	6.9%	8.2%	7.2%	6.5%
Military and Civil Aerospace	11.5%	10.4%	10.4%	9.6%	8.6%	8.1%	7.9%	7.5%	9.2%	8.3%	6.5%
Automotive	14.2%	6.9%	6.8%	5.9%	8.8%	9.4%	10.1%	10.0%	8.9%	8.2%	8.0%
Total	11.6%	11.1%	11.1%	9.8%	10.5%	9.4%	9.1%	8.8%	8.9%	8.1%	7.7%

Source: Dataquest (September 1994 Estimates)

Section 6: Nordic

Figure 6
Nordic Semiconductor Consumption by End-Use Application, Market Forecast



Source: Dataquest (September 1994 Estimates)

Table 6-1
Nordic Semiconductor Consumption by Application
(Millions of US Dollars)

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Electronic Data Processing	86	109	97	93	171	303	409	453	389	394	480	28.7%	9.6%	34.9%
Communications	243	268	298	295	325	460	578	676	752	859	928	13.6%	15.1%	25.7%
Industrial	166	153	156	146	141	143	183	196	320	351	394	-2.9%	22.4%	27.9%
Consumer	66	78	73	67	75	85	106	110	87	101	113	5.2%	5.9%	24.7%
Military and Civil Aerospace	55	48	41	39	55	61	78	83	80	91	88	2.1%	7.4%	26.8%
Automotive	9	9	10	9	12	15	21	23	25	28	33	12.0%	16.6%	36.5%
Total	$625	$665	$675	$650	$779	$1,068	$1,375	$1,541	$1,654	$1,825	$2,036	11.3%	13.8%	28.7%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 6-2
Nordic Semiconductor Consumption by Application
As a Percentage of Total Nordic Region

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	13.7%	16.4%	14.4%	14.3%	22.0%	28.4%	29.7%	29.4%	23.5%	21.6%	23.6%
Communications	38.9%	40.3%	44.1%	45.4%	41.7%	43.1%	42.1%	43.9%	45.5%	47.1%	45.6%
Industrial	26.6%	23.0%	23.1%	22.4%	18.1%	13.4%	13.3%	12.7%	19.4%	19.2%	19.4%
Consumer	10.5%	11.8%	10.8%	10.3%	9.6%	7.9%	7.7%	7.1%	5.3%	5.5%	5.5%
Military and Civil Aerospace	8.9%	7.2%	6.1%	6.1%	7.1%	5.7%	5.7%	5.4%	4.8%	5.0%	4.3%
Automotive	1.4%	1.3%	1.4%	1.4%	1.5%	1.4%	1.5%	1.5%	1.5%	1.6%	1.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

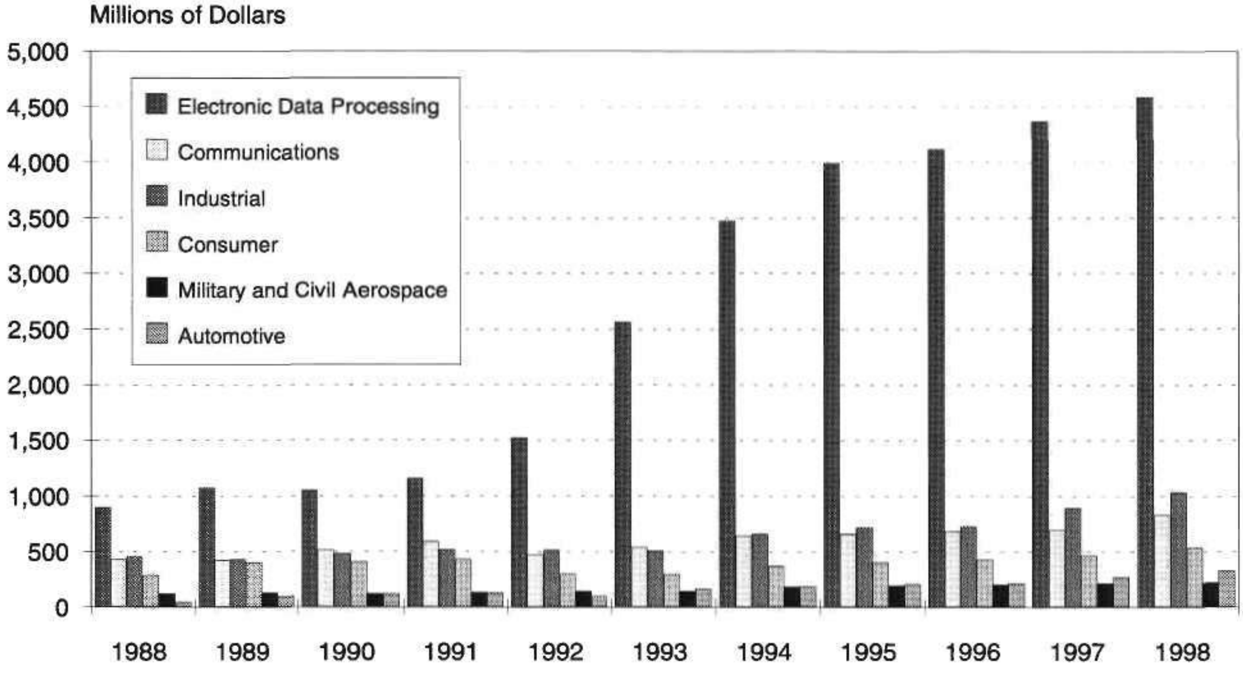
Table 6-3
Nordic Semiconductor Consumption by Application
As a Percentage of Total European Market

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	3.4%	3.7%	3.3%	3.0%	4.3%	5.1%	5.4%	5.2%	4.2%	3.8%	4.1%
Communications	14.0%	14.0%	12.6%	11.5%	11.4%	12.7%	13.6%	14.7%	15.4%	16.4%	16.2%
Industrial	10.2%	9.1%	8.1%	7.4%	6.7%	6.3%	6.6%	6.5%	10.2%	10.3%	10.4%
Consumer	4.3%	4.4%	3.9%	3.4%	4.4%	4.5%	4.7%	4.5%	3.4%	3.6%	3.6%
Military and Civil Aerospace	11.0%	9.6%	8.6%	8.1%	11.3%	12.0%	13.1%	13.1%	12.3%	13.1%	11.6%
Automotive	1.6%	1.4%	1.2%	1.0%	1.1%	1.2%	1.4%	1.3%	1.4%	1.4%	1.5%
Total	7.4%	7.0%	6.5%	5.9%	6.4%	6.9%	7.2%	7.3%	7.4%	7.4%	7.4%

Source: Dataquest (September 1994 Estimates)

Section 7: UK and Ireland

Figure 7
UK and Ireland Semiconductor Consumption by End-Use Application, Market Forecast



Source: Dataquest (September 1994 Estimates)

Table 7-1
UK and Ireland Semiconductor Consumption by Application
(Millions of US Dollars)

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Electronic Data Processing	892	1,073	1,050	1,157	1,523	2,561	3,471	3,989	4,117	4,370	4,585	23.5%	12.3%	35.5%
Communications	430	425	516	591	472	536	639	656	679	692	826	4.5%	9.0%	19.2%
Industrial	455	431	481	518	512	508	655	716	721	891	1,032	2.3%	15.2%	28.7%
Consumer	288	399	406	430	298	294	369	398	425	464	534	0.4%	12.7%	25.9%
Military and Civil Aerospace	120	126	118	131	143	143	180	193	201	215	222	3.5%	9.2%	26.2%
Automotive	45	93	114	127	97	163	184	207	213	274	330	29.6%	15.1%	12.9%
Total	$2,230	$2,547	$2,686	$2,954	$3,045	$4,206	$5,499	$6,160	$6,356	$6,904	$7,528	13.5%	12.3%	30.7%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 7-2
UK and Ireland Semiconductor Consumption by Application
As a Percentage of Total UK and Ireland Region

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	40.0%	42.1%	39.1%	39.2%	50.0%	60.9%	63.1%	64.8%	64.8%	63.3%	60.9%
Communications	19.3%	16.7%	19.2%	20.0%	15.5%	12.8%	11.6%	10.7%	10.7%	10.0%	11.0%
Industrial	20.4%	16.9%	17.9%	17.5%	16.8%	12.1%	11.9%	11.6%	11.3%	12.9%	13.7%
Consumer	12.9%	15.6%	15.1%	14.5%	9.8%	7.0%	6.7%	6.5%	6.7%	6.7%	7.1%
Military and Civil Aerospace	5.4%	5.0%	4.4%	4.4%	4.7%	3.4%	3.3%	3.1%	3.2%	3.1%	2.9%
Automotive	2.0%	3.7%	4.3%	4.3%	3.2%	3.9%	3.4%	3.4%	3.3%	4.0%	4.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

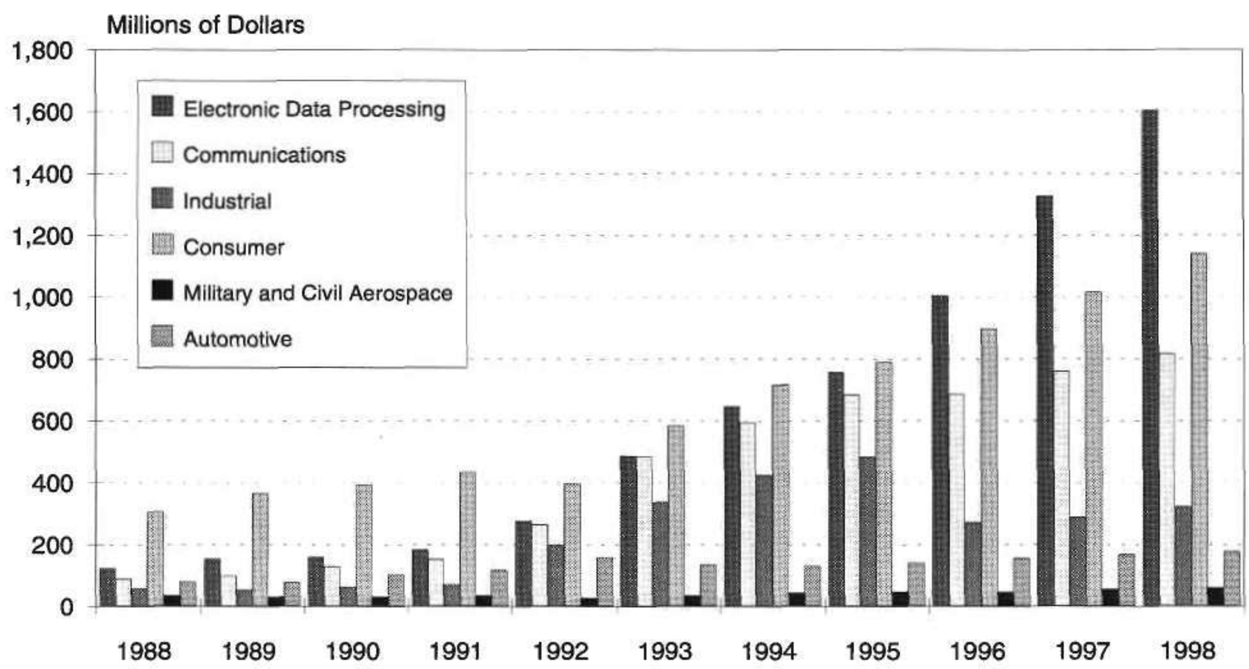
Table 7-3
UK and Ireland Semiconductor Consumption by Application
As a Percentage of Total European Market

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	35.1%	36.2%	35.4%	36.9%	38.6%	43.2%	45.4%	46.2%	44.2%	42.0%	39.2%
Communications	24.8%	22.2%	21.9%	23.0%	16.5%	14.9%	15.0%	14.3%	13.9%	13.2%	14.4%
Industrial	28.0%	25.6%	25.1%	26.2%	24.2%	22.3%	23.7%	23.8%	22.9%	26.2%	27.3%
Consumer	18.9%	22.2%	21.6%	22.0%	17.3%	15.5%	16.5%	16.4%	16.4%	16.5%	17.0%
Military and Civil Aerospace	23.8%	25.3%	24.8%	26.9%	29.3%	28.0%	30.4%	30.5%	30.8%	31.1%	29.3%
Automotive	8.0%	14.6%	14.1%	14.3%	8.8%	13.0%	12.0%	12.0%	11.6%	13.5%	14.4%
Total	26.3%	26.8%	25.8%	26.8%	24.9%	27.2%	28.9%	29.3%	28.3%	28.1%	27.5%

Source: Dataquest (September 1994 Estimates)

Section 8: Rest of Europe

Figure 8
Rest of Europe Semiconductor Consumption by End-Use Application, Market Forecast



Source: Dataquest (September 1994 Estimates)

Table 8-1
Rest of Europe Semiconductor Consumption by Application
(Millions of US Dollars)

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Electronic Data Processing	122	154	159	183	277	485	646	757	1,004	1,326	1,604	31.7%	27.0%	33.1%
Communications	90	100	128	152	265	484	595	684	686	759	816	40.0%	11.0%	22.9%
Industrial	57	53	63	70	198	337	425	483	271	288	322	42.4%	-0.9%	26.2%
Consumer	305	365	394	433	397	583	717	790	897	1,016	1,141	13.8%	14.4%	23.0%
Military and Civil Aerospace	35	31	31	35	26	35	43	48	46	56	61	-0.2%	11.5%	22.2%
Automotive	79	78	101	118	160	136	130	140	157	167	177	11.4%	5.4%	-4.3%
Total	$690	$781	$875	$991	$1,323	$2,060	$2,556	$2,903	$3,165	$3,612	$4,122	24.5%	14.9%	24.1%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 8-2
Rest of Europe Semiconductor Consumption by Application
As a Percentage of Total Rest of Europe Region

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	17.7%	19.7%	18.2%	18.4%	20.9%	23.6%	25.3%	26.1%	31.7%	36.7%	38.9%
Communications	13.1%	12.7%	14.6%	15.4%	20.0%	23.5%	23.3%	23.6%	21.7%	21.0%	19.8%
Industrial	8.3%	6.8%	7.1%	7.1%	15.0%	16.3%	16.6%	16.6%	8.6%	8.0%	7.8%
Consumer	44.2%	46.8%	45.0%	43.7%	30.0%	28.3%	28.1%	27.2%	28.3%	28.1%	27.7%
Military and Civil Aerospace	5.1%	3.9%	3.5%	3.6%	2.0%	1.7%	1.7%	1.7%	1.5%	1.5%	1.5%
Automotive	11.5%	10.0%	11.6%	11.9%	12.1%	6.6%	5.1%	4.8%	5.0%	4.6%	4.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	96.7%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

Table 8-3
Rest of Europe Semiconductor Consumption by Application
As a Percentage of Total European Market

Segment	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Electronic Data Processing	4.8%	5.2%	5.4%	5.8%	7.0%	8.2%	8.5%	8.8%	10.8%	12.7%	13.7%
Communications	5.2%	5.2%	5.4%	5.9%	9.3%	13.4%	14.0%	14.9%	14.0%	14.5%	14.3%
Industrial	3.5%	3.1%	3.3%	3.5%	9.4%	14.8%	15.4%	16.0%	8.6%	8.5%	8.5%
Consumer	20.0%	20.4%	20.9%	22.2%	23.1%	30.9%	32.0%	32.5%	34.6%	36.1%	36.4%
Military and Civil Aerospace	7.0%	6.2%	6.4%	7.2%	5.3%	6.9%	7.2%	7.6%	7.1%	8.0%	8.0%
Automotive	14.2%	12.2%	12.5%	13.2%	14.5%	10.8%	8.4%	8.1%	8.5%	8.3%	7.7%
Total	8.1%	8.2%	8.4%	9.0%	10.8%	13.3%	13.4%	13.8%	14.1%	14.7%	15.0%

Source: Dataquest (September 1994 Estimates)

Section 9: All Segments

Table 9-1
European Semiconductor Consumption by Region/Country
(Millions of US Dollars)

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Benelux	504	485	542	556	610	730	798	864	903	972	1,093	7.7%	8.4%	9.3%
France	1,210	1,351	1,521	1,444	1,453	1,730	1,889	2,087	2,232	2,440	2,708	7.4%	9.4%	9.2%
Italy	982	1,056	1,151	1,079	1,280	1,457	1,741	1,845	1,991	1,981	2,096	8.2%	7.5%	19.5%
Nordic	625	665	675	650	779	1,068	1,375	1,541	1,654	1,825	2,036	11.3%	13.8%	28.7%
UK and Ireland	2,230	2,547	2,686	2,954	3,045	4,206	5,499	6,160	6,356	6,907	7,528	13.5%	12.3%	30.7%
Germany	2,250	2,613	2,965	3,340	3,728	4,235	5,178	5,626	6,240	6,835	7,808	13.5%	13.0%	22.3%
Rest of Europe	690	781	875	991	1,323	2,060	2,556	2,902	3,061	3,612	4,120	24.5%	14.9%	24.1%
Total	$8,491	$9,498	$10,415	$11,014	$12,218	$15,486	$19,036	$21,025	$22,438	$24,572	$27,389	12.8%	12.1%	22.9%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 9-2
European Semiconductor Consumption by Region/Country
As a Percentage of Total European Region

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Benelux	5.9%	5.1%	5.2%	5.0%	5.0%	4.7%	4.2%	4.1%	4.0%	4.0%	4.0%
France	14.3%	14.2%	14.6%	13.1%	11.9%	11.2%	9.9%	9.9%	9.9%	9.9%	9.9%
Italy	11.6%	11.1%	11.1%	9.8%	10.5%	9.4%	9.1%	8.8%	8.9%	8.1%	7.7%
Nordic	7.4%	7.0%	6.5%	5.9%	6.4%	6.9%	7.2%	7.3%	7.4%	7.4%	7.4%
UK and Ireland	26.3%	26.8%	25.8%	26.8%	24.9%	27.2%	28.9%	29.3%	28.3%	28.1%	27.5%
Germany	26.5%	27.5%	28.5%	30.3%	30.5%	27.3%	27.2%	26.8%	27.8%	27.8%	28.5%
Rest of Europe	8.1%	8.2%	8.4%	9.0%	10.8%	13.3%	13.4%	13.8%	13.6%	14.7%	15.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

Section 10: Electronic Data Processing

Table 10-1
European Electronic Data Processing Semiconductor Consumption by Region/Country
(Millions of US Dollars)

Country/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Benelux	120	134	136	140	159	240	275	304	301	347	418	14.8%	11.7%	14.5%
France	327	361	372	353	350	458	515	533	575	684	736	7.0%	10.0%	12.3%
Italy	383	452	455	426	515	678	787	855	918	918	1,013	12.1%	8.3%	16.1%
Nordic	86	109	97	93	171	303	409	453	389	394	480	28.7%	9.6%	34.9%
UK and Ireland	892	1,073	1,050	1,157	1,523	2,561	3,471	3,989	4,117	4,370	4,585	23.5%	12.3%	35.5%
Germany	610	682	694	784	951	1,209	1,537	1,739	2,020	2,363	2,870	14.7%	18.9%	27.2%
Rest of Europe	122	154	159	183	277	485	646	757	1,004	1,326	1,604	31.7%	27.0%	33.1%
Total	$2,540	$2,965	$2,963	$3,136	$3,946	$5,935	$7,640	$8,629	$9,324	$10,402	$11,705	18.5%	14.5%	28.7%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 10-2
European Electronic Data Processing Semiconductor Consumption by Region/Country As a Percentage of Total European Electronic Data Processing Market

Country/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Benelux	4.7%	4.5%	4.6%	4.5%	4.0%	4.0%	3.6%	3.5%	3.2%	3.3%	3.6%
France	12.9%	12.2%	12.6%	11.3%	8.9%	7.7%	6.7%	6.2%	6.2%	6.6%	6.3%
Italy	15.1%	15.2%	15.4%	13.6%	13.1%	11.4%	10.3%	9.9%	9.8%	8.8%	8.7%
Nordic	3.4%	3.7%	3.3%	3.0%	4.3%	5.1%	5.4%	5.2%	4.2%	3.8%	4.1%
UK and Ireland	35.1%	36.2%	35.4%	36.9%	38.6%	43.2%	45.4%	46.2%	44.2%	42.0%	39.2%
Germany	24.0%	23.0%	23.4%	25.0%	24.1%	20.4%	20.1%	20.1%	21.7%	22.7%	24.5%
Rest of Europe	4.8%	5.2%	5.4%	5.8%	7.0%	8.2%	8.5%	8.8%	10.8%	12.7%	13.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

Section 11: Communications

Table 11-1
European Communications Semiconductor Consumption by Region/Country
(Millions of US Dollars)

Country/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Benelux	121	118	149	159	169	199	211	229	257	271	290	10.5%	7.8%	6.0%
France	271	283	363	357	372	455	477	550	628	659	725	10.9%	9.8%	4.8%
Italy	178	209	262	255	278	298	381	394	412	426	441	10.9%	8.1%	27.7%
Nordic	243	268	298	295	325	460	578	676	752	859	928	13.6%	15.1%	25.7%
UK and Ireland	430	425	516	591	472	536	639	656	679	692	826	4.5%	9.0%	19.2%
Germany	403	512	646	758	973	1,177	1,380	1,404	1,467	1,573	1,696	23.9%	7.6%	17.2%
Rest of Europe	90	100	128	152	265	484	595	684	686	759	816	40.0%	11.0%	22.9%
Total	$1,736	$1,915	$2,362	$2,567	$2,854	$3,611	$4,262	$4,593	$4,881	$5,240	$5,721	15.8%	9.6%	18.0%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 11-2
European Communications Semiconductor Consumption by Region/Country
As a Percentage of Total European Communications Market

Country/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Benelux	7.0%	6.2%	6.3%	6.2%	5.9%	5.5%	5.0%	5.0%	5.3%	5.2%	5.1%
France	15.6%	14.8%	15.3%	13.9%	13.0%	12.6%	11.2%	12.0%	12.9%	12.6%	12.7%
Italy	10.2%	10.9%	11.1%	9.9%	9.7%	8.3%	8.9%	8.6%	8.4%	8.1%	7.7%
Nordic	14.0%	14.0%	12.6%	11.5%	11.4%	12.7%	13.6%	14.7%	15.4%	16.4%	16.2%
UK and Ireland	24.8%	22.2%	21.9%	23.0%	16.5%	14.9%	15.0%	14.3%	13.9%	13.2%	14.4%
Germany	23.2%	26.7%	27.4%	29.5%	34.1%	32.6%	32.4%	30.6%	30.1%	30.0%	29.6%
Rest of Europe	5.2%	5.2%	5.4%	5.9%	9.3%	13.4%	14.0%	14.9%	14.0%	14.5%	14.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

Section 12: Industrial

Table 12-1
European Industrial Semiconductor Consumption by Region/Country
(Millions of US Dollars)

Country/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Benelux	140	115	133	133	143	147	161	172	186	188	209	1.1%	7.2%	9.0%
France	225	237	279	259	243	249	265	283	273	285	284	2.0%	2.6%	6.6%
Italy	168	155	178	163	186	174	202	208	226	209	207	0.7%	3.6%	16.4%
Nordic	166	153	156	146	141	143	183	196	320	351	394	-2.9%	22.4%	27.9%
UK and Ireland	455	431	481	518	512	508	655	716	721	891	1,032	2.3%	15.2%	28.7%
Germany	414	541	627	691	689	724	872	957	1,152	1,185	1,328	11.8%	12.9%	20.5%
Rest of Europe	57	53	63	70	198	337	425	483	271	288	322	42.4%	-0.9%	26.2%
Total	$1,625	$1,685	$1,917	$1,979	$2,112	$2,282	$2,763	$3,015	$3,149	$3,397	$3,776	7.0%	10.6%	21.1%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 12-2
European Industrial Semiconductor Consumption by Region/Country
As a Percentage of Total European Industrial Market

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Benelux	8.6%	6.8%	6.9%	6.7%	6.8%	6.5%	5.8%	5.7%	5.9%	5.5%	5.5%
France	13.9%	14.1%	14.6%	13.1%	11.5%	10.9%	9.6%	9.4%	8.7%	8.4%	7.5%
Italy	10.3%	9.2%	9.3%	8.2%	8.8%	7.6%	7.3%	6.9%	7.2%	6.1%	5.5%
Nordic	10.2%	9.1%	8.1%	7.4%	6.7%	6.3%	6.6%	6.5%	10.2%	10.3%	10.4%
UK and Ireland	28.0%	25.6%	25.1%	26.2%	24.2%	22.3%	23.7%	23.8%	22.9%	26.2%	27.3%
Germany	25.5%	32.1%	32.7%	34.9%	32.6%	31.7%	31.6%	31.7%	36.6%	34.9%	35.2%
Rest of Europe	3.5%	3.1%	3.3%	3.5%	9.4%	14.8%	15.4%	16.0%	8.6%	8.5%	8.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

Section 13: Consumer

Table 13-1
European Consumer Semiconductor Consumption by Region/Country
(Millions of US Dollars)

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Benelux	76	80	85	84	96	97	102	106	104	109	119	5.2%	4.0%	4.5%
France	177	205	220	201	205	204	211	260	274	279	308	2.9%	8.6%	3.8%
Italy	116	144	151	136	162	147	168	168	213	204	203	4.8%	6.7%	14.4%
Nordic	66	78	73	67	75	85	106	110	87	101	113	5.2%	5.9%	24.7%
UK and Ireland	288	399	406	430	298	294	369	398	425	464	534	0.4%	12.7%	25.9%
Germany	499	523	554	600	485	480	565	602	593	644	718	-0.8%	8.4%	17.6%
Rest of Europe	305	365	394	433	397	583	717	790	897	1,016	1,141	13.8%	14.4%	23.0%
Total	$1,526	$1,795	$1,883	$1,951	$1,718	$1,889	$2,238	$2,434	$2,595	$2,818	$3,136	4.4%	10.7%	18.5%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 13-2
European Consumer Semiconductor Consumption by Region/Country
As a Percentage of Total European Consumer Market

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Benelux	5.0%	4.5%	4.5%	4.3%	5.6%	5.2%	4.5%	4.4%	4.0%	3.9%	3.8%
France	11.6%	11.4%	11.7%	10.3%	11.9%	10.8%	9.4%	10.7%	10.6%	9.9%	9.8%
Italy	7.6%	8.0%	8.0%	7.0%	9.4%	7.8%	7.5%	6.9%	8.2%	7.2%	6.5%
Nordic	4.3%	4.4%	3.9%	3.4%	4.4%	4.5%	4.7%	4.5%	3.4%	3.6%	3.6%
UK and Ireland	18.9%	22.2%	21.6%	22.0%	17.3%	15.5%	16.5%	16.4%	16.4%	16.5%	17.0%
Germany	32.7%	29.1%	29.4%	30.8%	28.2%	25.4%	25.2%	24.7%	22.9%	22.9%	22.9%
Rest of Europe	20.0%	20.4%	20.9%	22.2%	23.1%	30.9%	32.0%	32.5%	34.6%	36.1%	36.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

Section 14: Military and Civil Aerospace

Table 14-1
European Military and Civil Aerospace Semiconductor Consumption by Region/Country (Millions of US Dollars)

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Benelux	41	32	31	32	33	34	36	39	41	43	41	-3.4%	3.9%	6.1%
France	150	182	180	172	155	160	170	179	167	181	229	1.3%	7.4%	5.8%
Italy	58	52	50	47	42	41	47	48	60	57	49	-6.5%	3.4%	12.7%
Nordic	55	48	41	39	55	61	78	83	80	91	88	2.1%	7.4%	26.8%
UK and Ireland	120	126	118	131	143	143	180	193	201	215	222	3.5%	9.2%	26.2%
Germany	45	28	27	31	34	35	40	44	56	50	68	-5.1%	14.5%	16.8%
Rest of Europe	35	31	31	35	26	35	43	48	46	56	61	-0.2%	11.5%	22.2%
Total	$505	$498	$478	$488	$488	$510	$594	$633	$652	$693	$758	0.2%	8.2%	16.5%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 14-2
European Military and Civil Aerospace Semiconductor Consumption by Region/Country
As a Percentage of Total European Military and Civil Aerospace Market

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Benelux	8.1%	6.4%	6.5%	6.6%	6.8%	6.7%	6.1%	6.1%	6.4%	6.2%	5.5%
France	29.7%	36.5%	37.6%	35.2%	31.8%	31.5%	28.6%	28.2%	25.6%	26.1%	30.2%
Italy	11.5%	10.4%	10.4%	9.6%	8.6%	8.1%	7.9%	7.5%	9.2%	8.3%	6.5%
Nordic	11.0%	9.6%	8.6%	8.1%	11.3%	12.0%	13.1%	13.1%	12.3%	13.1%	11.6%
UK and Ireland	23.8%	25.3%	24.8%	26.9%	29.3%	28.0%	30.4%	30.5%	30.8%	31.1%	29.3%
Germany	8.9%	5.6%	5.7%	6.3%	7.0%	6.8%	6.8%	6.9%	8.6%	7.2%	9.0%
Rest of Europe	7.0%	6.2%	6.4%	7.2%	5.3%	6.9%	7.2%	7.6%	7.1%	8.0%	8.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

Section 15: Transportation

Table 15-1
European Transportation Semiconductor Consumption by Region/Country
(Millions of US Dollars)

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR 88>93	CAGR 93>98	AGR 93>94
Benelux	7	6	8	8	10	12	13	14	13	14	16	12.0%	7.2%	12.9%
France	61	83	107	103	128	204	252	283	315	352	426	27.5%	15.9%	23.3%
Italy	80	44	55	52	97	119	156	173	163	166	183	8.3%	9.1%	31.5%
Nordic	9	9	10	9	12	15	21	23	25	28	33	12.0%	16.6%	36.5%
UK and Ireland	45	93	114	127	97	163	184	207	213	274	330	29.6%	15.1%	12.9%
Germany	280	327	417	476	596	610	783	881	952	1,020	1,128	16.9%	13.1%	28.3%
Rest of Europe	79	78	101	118	160	136	130	140	157	167	177	11.4%	5.4%	-4.3%
Total	$559	$640	$812	$893	$1,100	$1,259	$1,539	$1,721	$1,837	$2,022	$2,293	17.6%	12.7%	22.2%

AGR = annual growth rate
CAGR = compound annual growth rate
Source: Dataquest (September 1994 Estimates)

Table 15-2
European Transportation Semiconductor Consumption by Region/Country
As a Percentage of Total European Transportation Market

County/Region	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Benelux	1.2%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%	0.7%	0.7%
France	10.8%	12.9%	13.2%	11.5%	11.6%	16.2%	16.3%	16.5%	17.2%	17.4%	18.6%
Italy	14.2%	6.9%	6.8%	5.9%	8.8%	9.4%	10.1%	10.0%	8.9%	8.2%	8.0%
Nordic	1.6%	1.4%	1.2%	1.0%	1.1%	1.2%	1.4%	1.3%	1.4%	1.4%	1.5%
UK and Ireland	8.0%	14.6%	14.1%	14.3%	8.8%	13.0%	12.0%	12.0%	11.6%	13.5%	14.4%
Germany	50.0%	51.2%	51.4%	53.3%	54.2%	48.5%	50.9%	51.2%	51.8%	50.4%	49.2%
Rest of Europe	14.2%	12.2%	12.5%	13.2%	14.5%	10.8%	8.4%	8.1%	8.5%	8.3%	7.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Dataquest (September 1994 Estimates)

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Semiconductors

Preliminary High-Volume Electronic Equipment Unit Production Forecast and Semiconductor Analysis—Europe

Market Statistics

1994

Program: Semiconductor Application Markets Europe
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Chapter 1
Introduction and Definitions

Introduction

This Market Statistics report represents our first preliminary forecast for European electronic systems by value, unit volume, semiconductor content and market forecast. Dataquest has selected 21 key application systems that have high-volume production worldwide. These key systems are identified by Dataquest as being leading indicators of semiconductor consumption trends by end-application market segment. The data are derived from research by Dataquest analysts in all its four major regions: United States, Japan, Europe, and Asia/Pacific.

The 21 leading indicators selected by Dataquest are as follows:

- **Electronic Data Processing**:
    1. Personal computers
    2. Workstations
    3. Rigid disk drives
    4. Optical disk drives
    5. Page (laser) printers
    6. Serial printers
- **Communications**:
    7. Fax machines
    8. LAN cards
    9. Modems
    10. Answering machines
    11. Corded telephones
    12. Cordless telephones
    13. Central office (CO)/premise line cards
    14. Cellular telephones
    15. Pagers
- **Consumer**:
    16. Personal/portable stereos
    17. Color televisions
    18. Videocassette recorders
    19. Camcorders

- **Automotive:**
  20. Auto stereos
  21. Engine control units

This report contains detailed information on Dataquest's view of European electronic equipment production. Electronic equipment production is an important determinant of semiconductor market activity because semiconductor demand is derived, in part, from the underlying demand for the systems that use semiconductors. Therefore, the forecast of expected electronics systems production is an essential component to assessing future semiconductor market activity.

The data consist of tables detailing the spring 1994 electronics equipment production forecast. European production is estimated for the years 1992 to 1998. Production tables contain both historical data and forecasts. In most tables, historical data begin with 1992 and end with 1993, while forecast data provide estimates for 1994 through 1998. Tables detail the type of production data by system application market and unit of measure.

Exchange Rates

Dataquest uses an average annual exchange rate for each European country for converting revenue to US dollar values. When forecasting electronic equipment production, it is important to maintain consistency and continuity, thus we maintain exchange rates at constant 1993 calendar year. This prevents any inconsistencies in the conversion of growth projections and currency fluctuations. The 1993 exchange rate estimate uses actual average monthly exchange rates from January through December (these data are gathered and supplied by the Dun & Bradstreet Corporation). The annual rate is estimated as the arithmetic mean of the 12 monthly rates. Exchange rates for 1993 are provided below for your reference (Table 1-1). Exchange rates for historical years are available on request.

Table 1-1
1993 Exchange Rates Table

	Foreign Currency per US Dollar	US Dollar per Foreign Currency
Austria (Schilling)	11.65	0.08180
Belgium (Franc)	34.67	0.02778
Denmark (Krone)	6.4901	0.1478
ECU	0.858	1.11647
Finland (Markka)	5.7317	0.17671
France (Franc)	5.6717	0.16930
Germany (Mark)	1.6556	0.5752
United Kingdom (Pound)	0.6763	1.4917
Greece (Drachma)	229.33	0.004004
Hong Kong (Dollar)	7.7235	0.12945
Ireland (Punt)	0.6829	1.4266
Italy (Lira)	1,577.85	0.0005886
Netherlands (Gulden)	1.8583	0.5137
Norway (Krone)	7.1054	0.1334
Portugal (Escudo)	161.08	0.005687
Spain (Peseta)	127.87	0.007058
Sweden (Krona)	7.8217	0.1232
Switzerland (Franc)	1.4803	0.6785

Source: Dun & Bradstreet, Dataquest (August 1994)

Regional Definitions

- **Europe**: Western Europe includes Benelux (Belgium, Netherlands, Luxembourg), France, Italy, Germany (including former East Germany), Scandinavia (Denmark, Finland, Norway, Sweden, and Iceland), United Kingdom and Eire (Ireland), and Rest of Western Europe (Austria, Gibraltar, Greece, Liechtenstein, Malta, Monaco, Portugal, San Marino, Spain, Switzerland, Turkey, Andorra and Vatican City, Eastern Europe)
    - *Eastern Europe*: includes Albania, Bulgaria, Czech Republic, Slovakia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Republics of former Yugoslavia, Ukraine, Belarus, Georgia, Russian Federation, Moldova, Armenia, Azerbaijan, Kazakhstan, Uzbekistan, Tajikistan, Kyrgyzstan, Turkmenistan

Line Item Definitions

The objective of analysing electronic systems production is to estimate its important implications for semiconductor consumption.

The value of production is estimated as factory revenue. Dataquest defines factory revenue as the money exchange value of the commodity transaction between the original equipment manufacturer and the point of entry into distribution. In the case of a direct sale that involves no distribution—as is the case with military systems—factory revenue is equal to the final user cost, net of sales taxes. For the purposes of this report Dataquest defines factory revenue as the derived production revenue from the factory value.

The equipment production data presented here are used in conjunction with estimated average semiconductor content derived from electronic equipment teardown analysis and in some cases from other electronic equipment manufacturing industry sources. We have interviewed more than 200 leading electronics manufacturers that have given us proprietary information on their semiconductor procurement, their captive production, and their relationships to the equipment or divisions in which the devices are used.

Data Sources

The historical information presented in the production data has been consolidated from a variety of sources, each of which focuses on a specific part of the market. From time to time, we conduct production surveys for specific types of electronic equipment and the data gathered are also incorporated into the database. Our other sources include the following:

- Dataquest's estimates of systems manufacturers end-user revenue
- Trade association data
- Various European Union and government agency statistics

- Japanese government and trade association (MITI, MOF, and EIAJ) intelligence
- Estimates presented by knowledgeable and reliable industry spokespersons
- Published product literature and prices
- Other Dataquest research groups (including Computer Systems and Peripherals, Telecommunications and Document Management)

Unlike in Japan and the United States where government bodies supply regular production statistics, Europe-wide statistical programs are in their infancy. We believe, therefore, that the estimates presented here are the most reliable and meaningful generally as applied to the components manufacturers.

Forecast Methodology

Dataquest uses a variety of forecasting techniques (both qualitative and quantitative) that vary by technology area. Dataquest follows a three-step process to forecast electronic equipment production. First, current and expected future worldwide and European macroeconomic conditions are assessed and forecast. Dun & Bradstreet Corporation information is used to develop the macroeconomic forecasts for the world's major economies—the Group of Seven (G7) countries. This forecast identifies trends in the economic health of the world's leading consumers and producers of electronic equipment. Using this forecast in conjunction with input from other Dataquest industry sources (as identified earlier), Dataquest estimates the overall business climates in which the electronic systems market will operate.

Second, Dataquest analyses and forecasts the significant long-range trend and outlook in the various electronic system research groups (within Dataquest). This establishes a five-year trend growth path for electronic system production.

The final step in the forecast process is to reconcile expected fluctuations about market trends so that the two do not inexplicably diverge. Dataquest anticipates that in the absence of shocks to the market, market fluctuations converge toward a long-term trend.

Because the time series data contained in this document comprise, in general, annual observations, and are sparse in terms of the number of observations, the data generally do not satisfy the requirements of quantitative empirical techniques such as econometric or statistical time series models. Therefore, in most cases, we have used judgmental models (that is, intuitive judgments, expert opinions, and subjective probabilities) or technological models (that is, curve fitting and the use of analogous data).

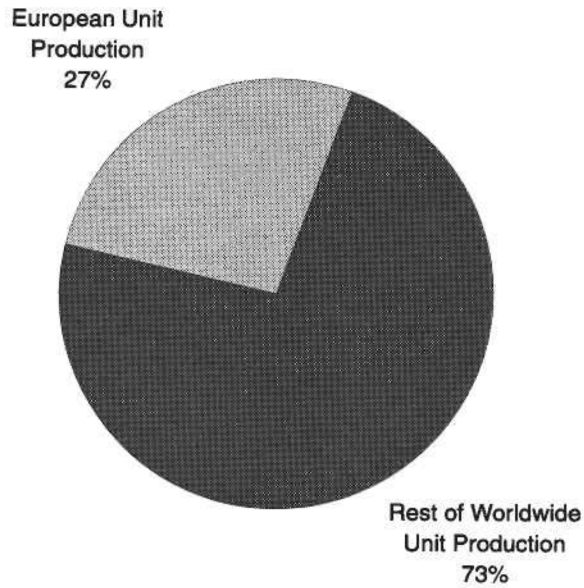
Chapter 2
Electronic Data Processing

Table 2-1
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—PCs

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
PCs								
Units (K)	7,712	10,200	12,250	13,645	14,830	16,800	18,150	12.2%
Factory ASP ($)	1,275	1,203	1,169	1,262	1,143	1,081	1,084	-2.1%
Factory Revenue ($M)	9,835	12,274	14,318	17,226	16,952	18,168	19,680	9.9%
Semiconductor Content* ($)	274	305	350	450	450	470	470	9.0%
Semiconductor TAM ($M)	2,114	3,111	4,288	6,140	6,674	7,896	8,531	22.4%

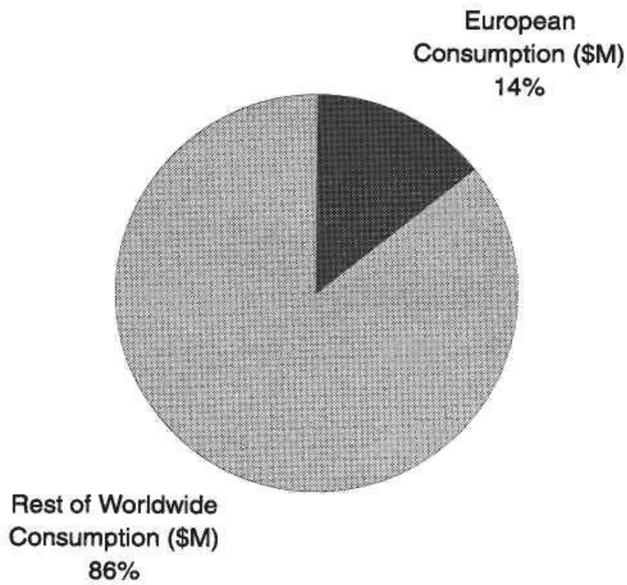
* Includes graphics, SIO/PIO, storage adapters and memory SIMMs
Source: Dataquest (August 1994 Estimates)

Figure 2-1a
1994 European Unit PC Production as Percentage of Worldwide Unit PC Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 2-1b
1994 European PC Semiconductor Consumption as Percentage of Worldwide PC Semiconductor Consumption



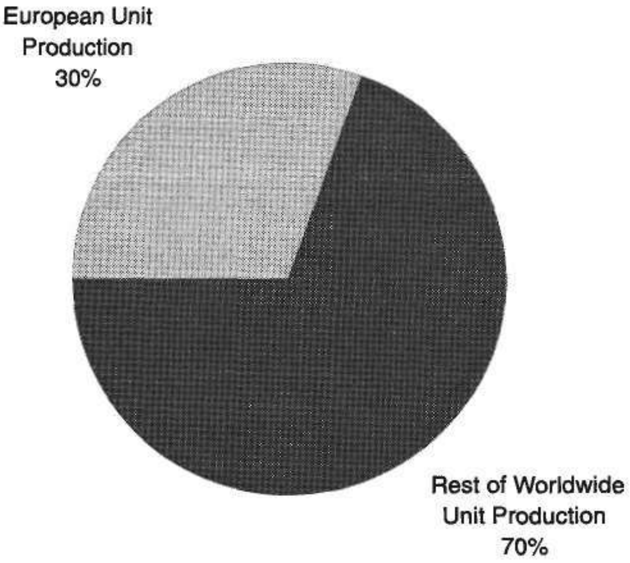
Source: Dataquest (August 1994 Estimates)

Table 2-2
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—Workstations

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Workstations								
Units (K)	163	183	211	245	289	346	387	16.2%
Factory ASP ($)	11,245	9,590	9,313	8,592	8,000	7,997	8,385	-2.7%
Factory Revenue ($M)	1,833	1,755	1,965	2,105	2,312	2,767	3,245	13.1%
Semiconductor Content ($)	1,276	1,245	1,233	1,226	1,218	1,210	1,200	-0.7%
Semiconductor TAM ($M)	208	228	260	300	352	419	464	15.3%

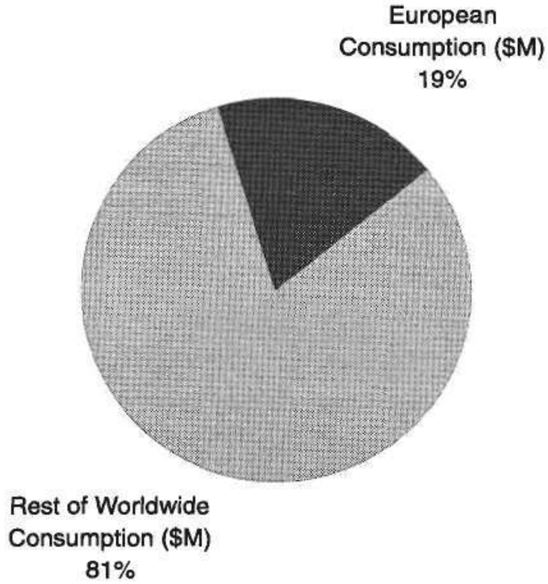
Source: Dataquest (August 1994 Estimates)

Figure 2-2a
1994 European Unit Workstation Production as Percentage of Worldwide Unit Workstation Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 2-2b
1994 European Workstation Semiconductor Consumption as Percentage of Worldwide Workstation Semiconductor Consumption



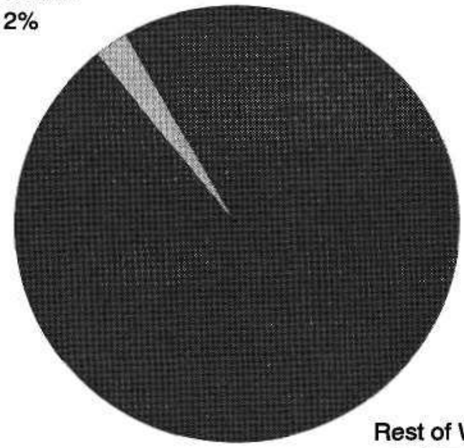
Source: Dataquest (August 1994 Estimates)

Table 2-3
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—Rigid Disk Drives

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Rigid Disk Drives								
Units (K)	1,131	1,210	1,358	1,494	1,735	2,009	2,210	12.8%
Factory ASP ($)	1,106	1,360	1,485	1,524	1,311	1,255	1,239	-1.8%
Factory Revenue ($M)	1,251	1,645	2,017	2,277	2,275	2,522	2,738	10.7%
Semiconductor Content ($)	110	120	135	140	135	130	125	0.8%
Semiconductor TAM ($M)	124	145	183	209	234	261	276	13.7%

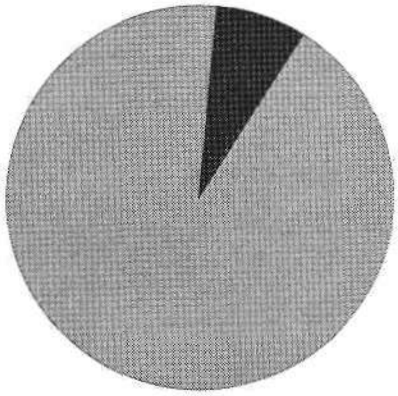
Source: Dataquest (August 1994 Estimates)

Figure 2-3a
1994 European Unit Rigid Disk Drive Production as Percentage of Worldwide Unit Rigid Disk Drive Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 2-3b
1994 European Rigid Disk Drive Semiconductor Consumption as Percentage of Worldwide Rigid Disk Drive Semiconductor Consumption



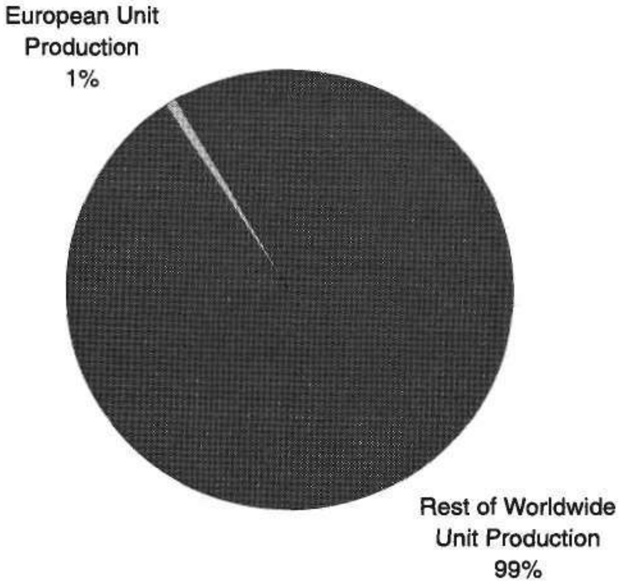
Source: Dataquest (August 1994 Estimates)

Table 2-4
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—Optical Disk Drives

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Optical Disk Drives								
Units (K)	23	66	111	209	269	391	481	48.8%
Factory ASP ($)	565	379	360	287	242	210	195	-12.4%
Factory Revenue ($M)	13	25	40	60	65	82	94	30.3%
Semiconductor Content ($)	120	110	100	95	90	85	80	-6.2%
Semiconductor TAM ($M)	3	7	11	20	24	33	38	39.6%

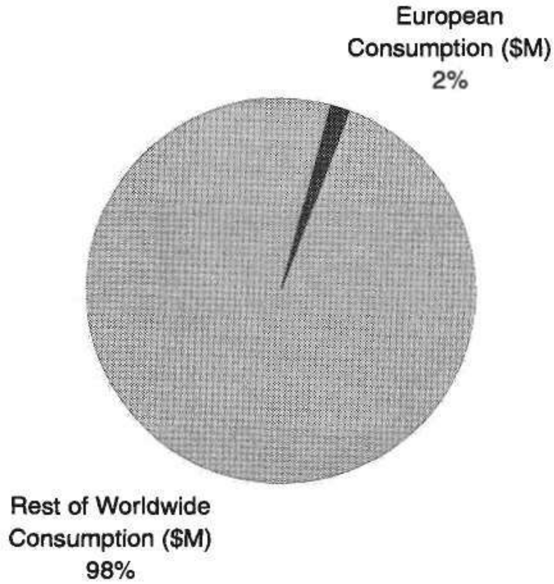
Source: Dataquest (August 1994 Estimates)

Figure 2-4a
1994 European Unit Optical Disk Drive Production as Percentage of Worldwide Unit Optical Disk Drive Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 2-4b
1994 European Optical Disk Drive Semiconductor Consumption as Percentage of Worldwide Optical Disk Drive Semiconductor Consumption



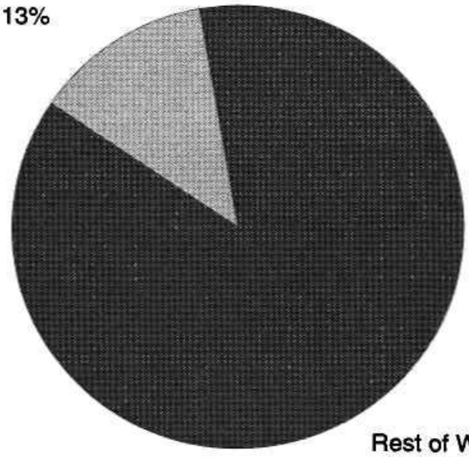
Source: Dataquest (August 1994 Estimates)

Table 2-5
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—Page (Laser) Printers

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Page (Laser) Printers								
Units (K)	630	755	906	1,087	1,251	1,376	1,486	14.5%
Factory ASP ($)	1,075	1,100	1,110	1,120	1,100	1,000	900	-3.9%
Factory Revenue ($M)	677	831	1,006	1,217	1,376	1,376	1,337	10.0%
Semiconductor Content ($)	135	148	148	149	150	136	120	-4.1%
Semiconductor TAM ($M)	85	112	134	162	188	187	178	9.8%

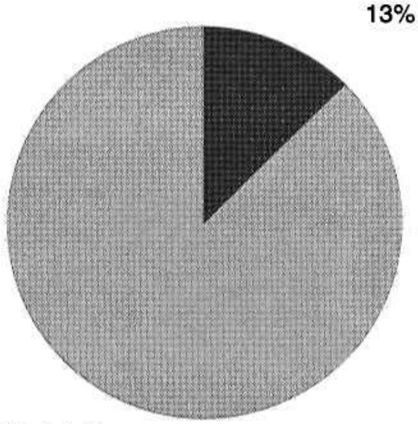
Source: Dataquest (August 1994 Estimates)

Figure 2-5a
1994 European Unit Page Printer Production as Percentage of Worldwide Unit Page Printer Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 2-5b
1994 European Page Printer Semiconductor Consumption as Percentage of Worldwide Page Printer Semiconductor Consumption



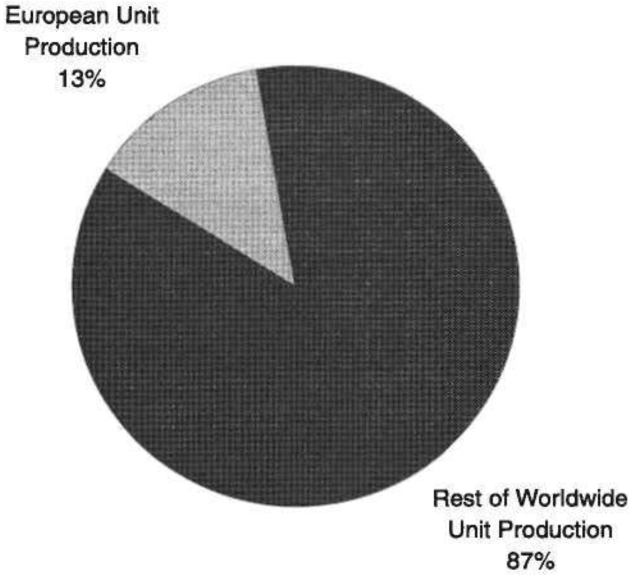
Source: Dataquest (August 1994 Estimates)

Table 2-6
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—Serial Printers

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Serial Printers								
Units (K)	3,651	3,501	3,038	3,013	3,461	4,420	6,268	12.4%
Factory ASP ($)	320	315	305	329	285	275	270	-3.0%
Factory Revenue ($M)	1,168	1,103	927	991	986	1,216	1,692	8.9%
Semiconductor Content ($)	25	26	27	29	31	31	30	2.9%
Semiconductor TAM ($M)	91	91	82	87	107	137	188	15.6%

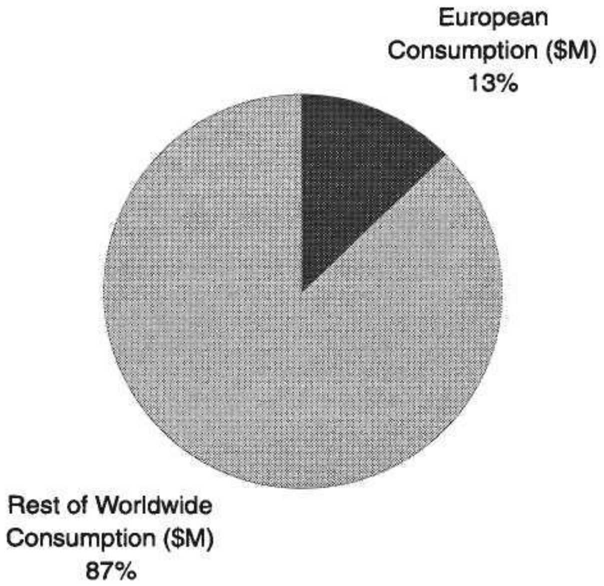
Source: Dataquest (August 1994 Estimates)

Figure 2-6a
1994 European Unit Serial Printer Production as Percentage of Worldwide Unit Serial Printer Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 2-6b
1994 European Serial Printer Semiconductor Consumption as Percentage of Worldwide Serial Printer Semiconductor Consumption



Source: Dataquest (August 1994 Estimates)

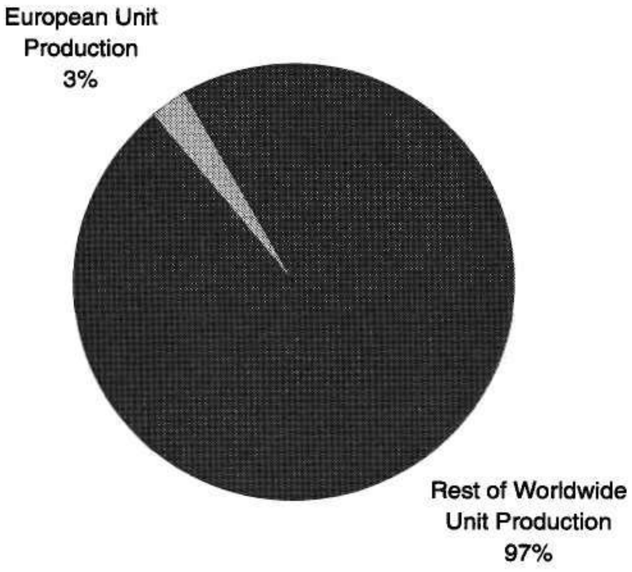
Chapter 3
Communications

Table 3-1
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Fax Machines

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Fax Machines								
Units (K)	120	140	160	168	172	172	172	4.2%
Factory ASP ($)	867	855	840	850	840	800	780	-1.8%
Factory Revenue ($M)	104	120	134	143	145	138	134	2.3%
Semiconductor Content ($)	95	93	92	88	84	80	76	-4.0%
Semiconductor TAM ($M)	11	13	15	15	14	14	13	0.1%

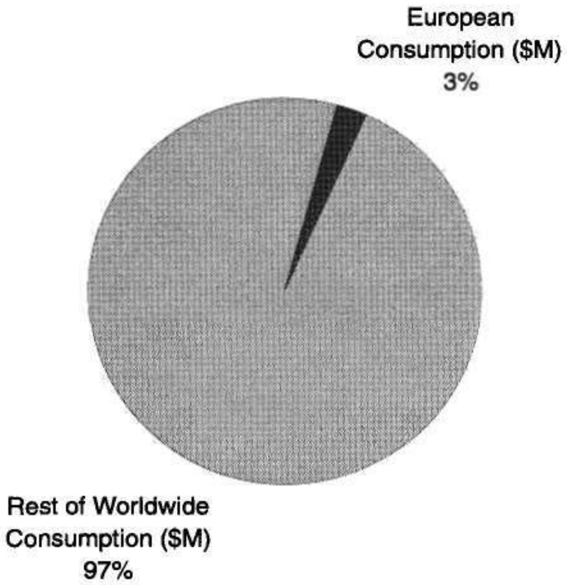
Source: Dataquest (August 1994 Estimates)

Figure 3-1a
1994 European Unit Fax Machine Production as Percentage of Worldwide Unit Fax Machine Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-1b
1994 European Fax Machine Semiconductor Consumption as Percentage of Worldwide Fax Machine Semiconductor Consumption



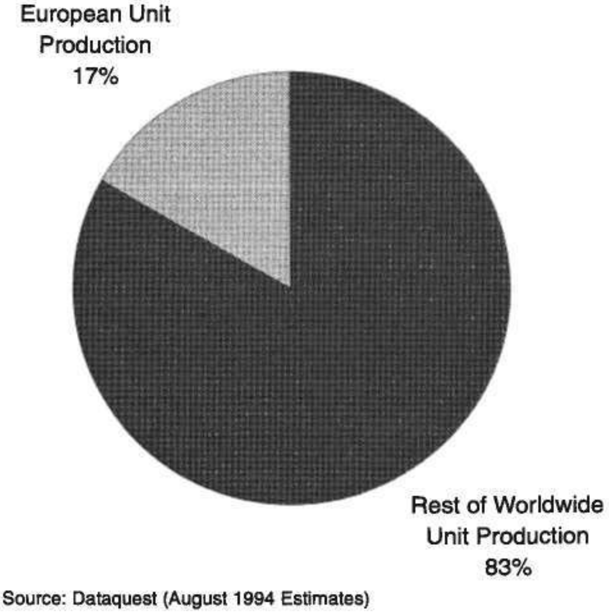
Source: Dataquest (August 1994 Estimates)

Table 3-2
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—LAN Cards

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
LAN Cards								
Units (K)	1,400	2,200	2,845	3,549	4,341	4,884	5,496	20.1%
Factory ASP ($)	253	219	193	172	163	155	149	-7.4%
Factory Revenue ($M)	354	482	548	611	708	758	821	11.2%
Semiconductor Content ($)	26	21	18	16	15	15	16	-5.6%
Semiconductor TAM ($M)	37	47	51	56	64	73	88	13.4%

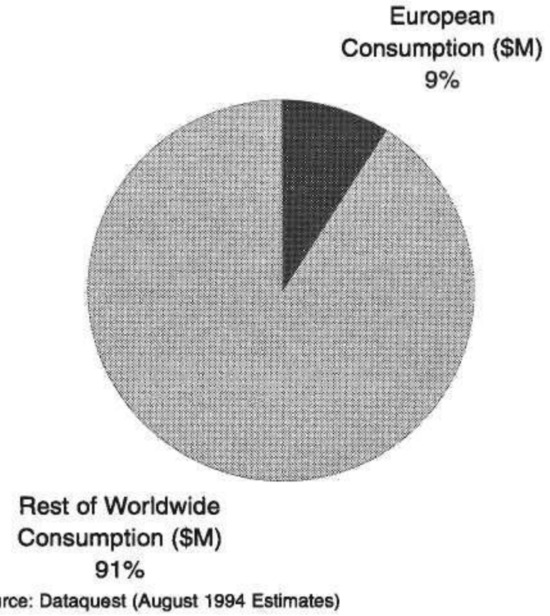
Source: Dataquest (August 1994 Estimates)

Figure 3-2a
1994 European Unit LAN Card Production as Percentage of Worldwide Unit LAN Card Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-2b
1994 European LAN Card Semiconductor Consumption as Percentage of Worldwide LAN Card Semiconductor Consumption



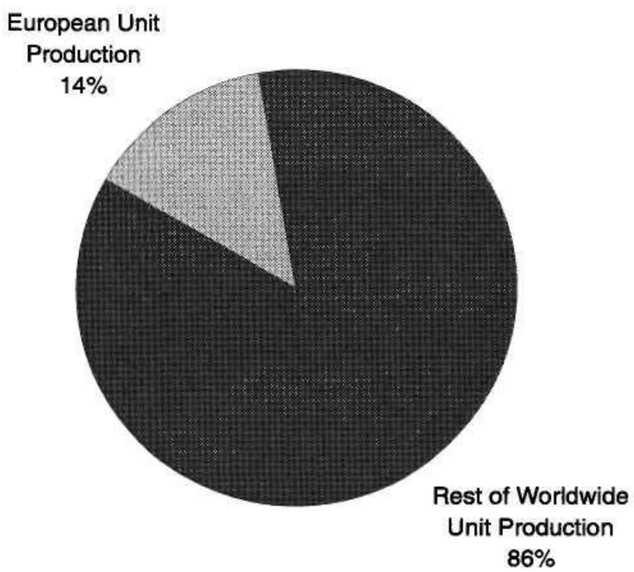
Source: Dataquest (August 1994 Estimates)

Table 3-3
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Modems

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Modems*								
Units (K)	934	985	1,090	1,145	1,157	1,124	1,092	2.1%
Factory ASP ($)	512	555	555	541	525	512	505	-1.9%
Factory Revenue ($M)	478	547	605	620	608	576	552	0.2%
Semiconductor Content* ($)	87	89	86	83	80	76	73	-4.0%
Semiconductor TAM ($M)	81	88	94	95	92	85	79	-2.0%

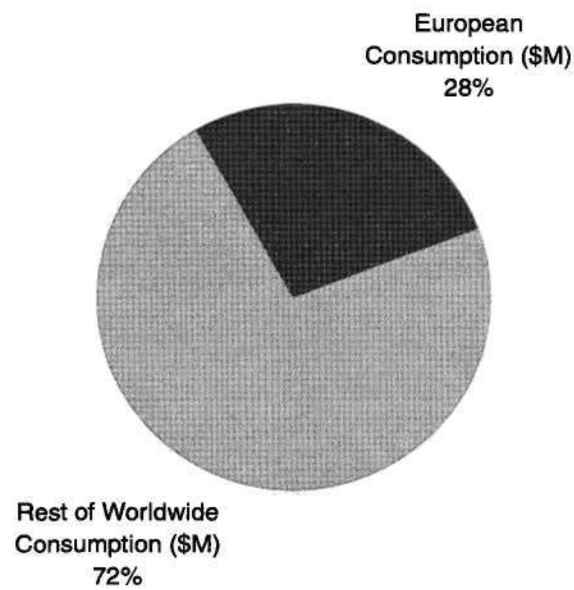
* External and internal, data and fax
Source: Dataquest (August 1994 Estimates)

Figure 3-3a
1994 European Unit Modem Production as Percentage of Worldwide Unit Modem Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-3b
1994 European Modem Semiconductor Consumption as Percentage of Worldwide Modem Semiconductor Consumption



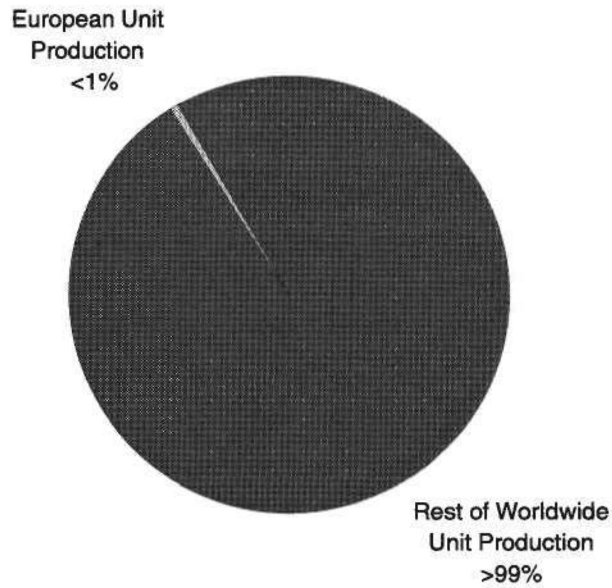
Source: Dataquest (August 1994 Estimates)

Table 3-4
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Answering Machines

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Answering Machines								
Units (K)	83	95	110	212	243	268	295	25.4%
Factory ASP ($)	112	111	110	109	108	107	106	-0.8%
Factory Revenue ($M)	9	11	12	23	26	29	31	24.4%
Semiconductor Content ($)	8	8	8	8	9	9	9	1.7%
Semiconductor TAM ($M)	1	1	1	2	2	2	3	27.6%

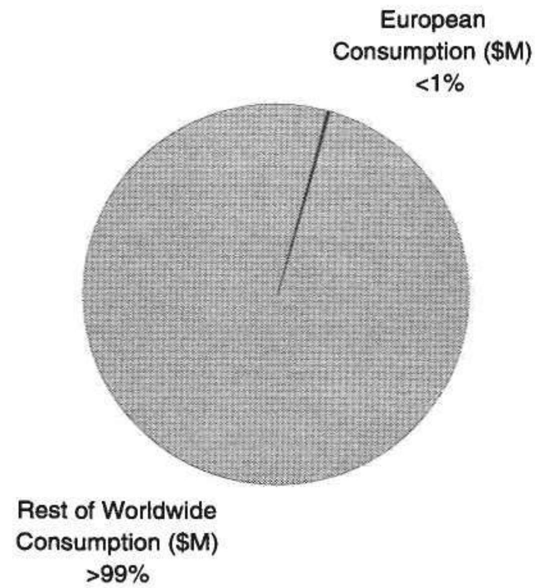
Source: Dataquest (August 1994 Estimates)

Figure 3-4a
1994 European Unit Answering Machine Production as Percentage of Worldwide Unit Answering Machine Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-4b
1994 European Answering Machine Semiconductor Consumption as Percentage of Worldwide Answering Machine Semiconductor Consumption



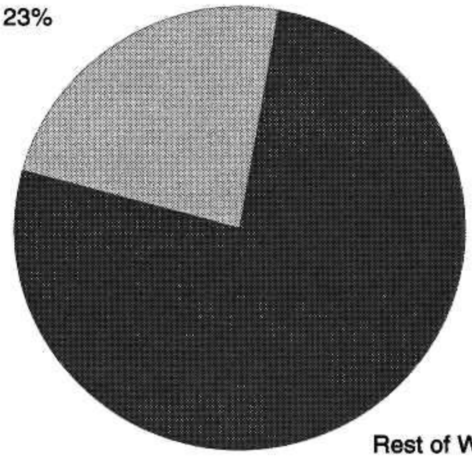
Source: Dataquest (August 1994 Estimates)

Table 3-5
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Corded Telephones

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Corded Telephones								
Units (K)	22,200	22,000	22,000	22,100	21,700	21,720	21,790	-0.2%
Factory ASP ($)	31	33	33	33	33	32	32	-0.9%
Factory Revenue ($M)	699	725	721	728	708	687	687	-1.1%
Semiconductor Content ($)	6	6	6	7	6	7	7	2.4%
Semiconductor TAM ($M)	129	133	139	145	138	143	148	2.2%

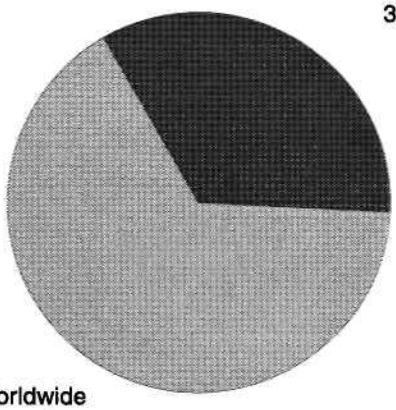
Source: Dataquest (August 1994 Estimates)

Figure 3-5a
1994 European Unit Corded Telephone Production as Percentage of Worldwide Unit Corded Telephone Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-5b
1994 European Corded Telephone Semiconductor Consumption as Percentage of Worldwide Corded Telephone Semiconductor Consumption



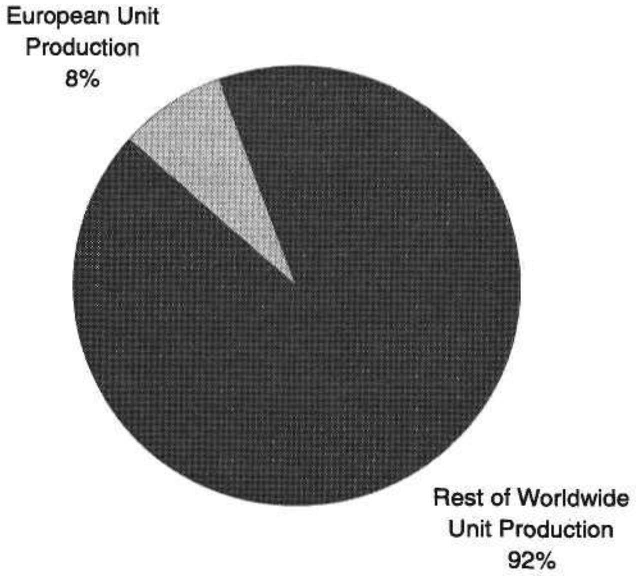
Source: Dataquest (August 1994 Estimates)

Table 3-6
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Cordless Telephones

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Cordless Telephones								
Units (K)	1,765	2,150	2,810	3,365	3,970	4,800	5,964	22.6%
Factory ASP ($)	125	121	116	110	103	99	88	-6.2%
Factory Revenue ($M)	220	260	327	370	407	477	523	15.0%
Semiconductor Content ($)	16	18	17	19	18	19	21	3.5%
Semiconductor TAM ($M)	29	38	48	64	71	93	125	26.9%

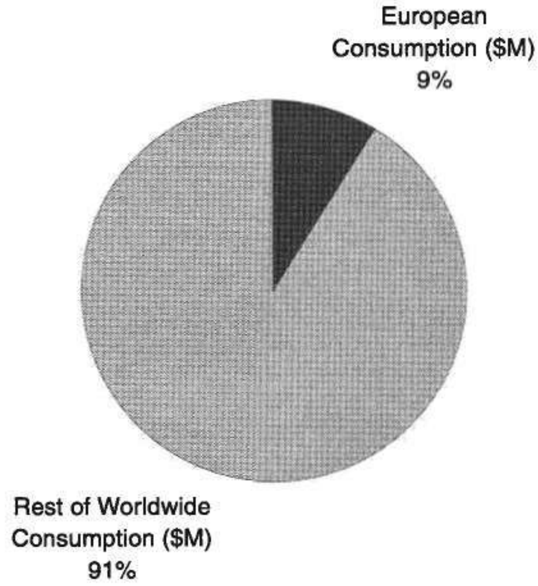
Source: Dataquest (August 1994 Estimates)

Figure 3-6a
1994 European Unit Cordless Telephone Production as Percentage of Worldwide Unit Cordless Telephone Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-6b
1994 European Cordless Telephone Semiconductor Consumption as Percentage of Worldwide Cordless Telephone Semiconductor Consumption



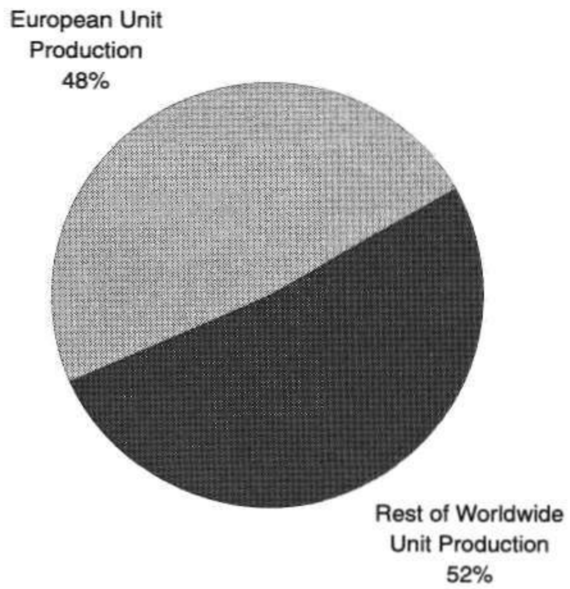
Source: Dataquest (August 1994 Estimates)

Table 3-7
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—CO/Premise Line Cards

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
CO/Premise Line Cards								
Units (K) [Lines]	40,240	39,040	39,430	40,260	40,880	41,290	41,630	1.3%
Factory ASP ($) [per Line]	122	118	113	108	102	97	92	-4.9%
Factory Revenue ($M)	4,908	4,610	4,450	4,333	4,184	4,009	3,823	-3.7%
Semiconductor Content ($)	15	15	15	14	14	14	13	-2.3%
Semiconductor TAM ($M)	604	586	591	564	572	578	541	-1.1%

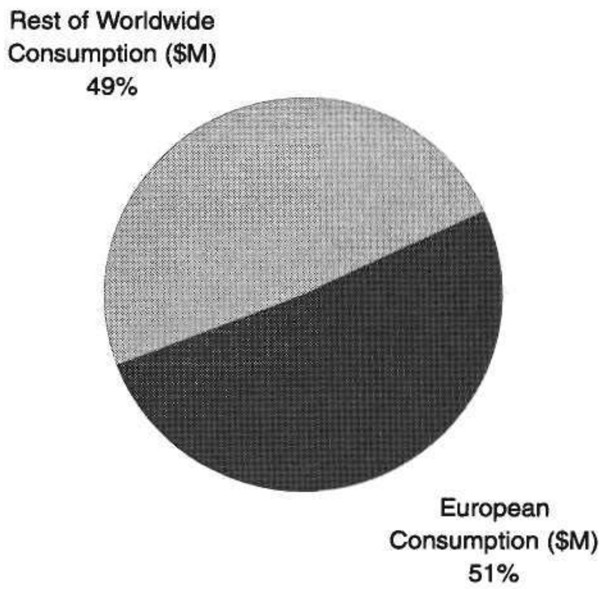
Source: Dataquest (August 1994 Estimates)

Figure 3-7a
1994 European Unit CO/Premise Line Card Production as Percentage of Worldwide Unit CO/Premise Line Card Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-7b
1994 European CO/Premise Line Card Semiconductor Consumption as Percentage of Worldwide CO/Premise Line Card Semiconductor Consumption



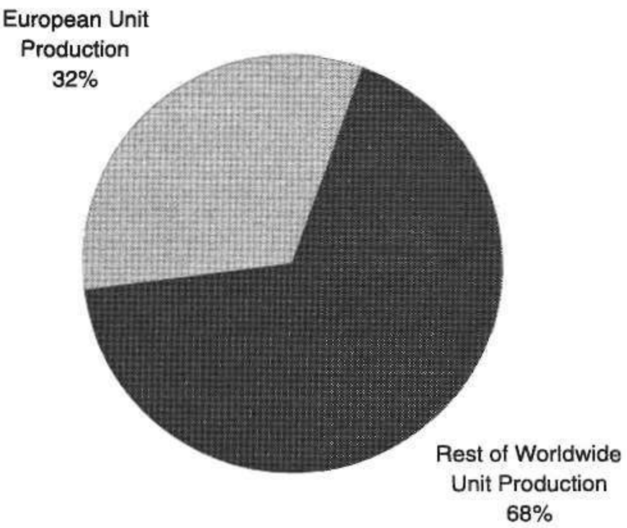
Source: Dataquest (August 1994 Estimates)

Table 3-8
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Cellular Telephones

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Cellular Telephones								
Units (K)	2,260	4,090	4,510	5,700	7,390	9,610	11,080	22.1%
Factory ASP ($)	261	330	287	275	278	277	258	-4.8%
Factory Revenue ($M)	590	1,350	1,296	1,570	2,055	2,660	2,860	16.2%
Semiconductor Content ($)	101	110	114	99	88	75	64	-10.3%
Semiconductor TAM ($M)	228	450	514	564	650	721	709	9.5%

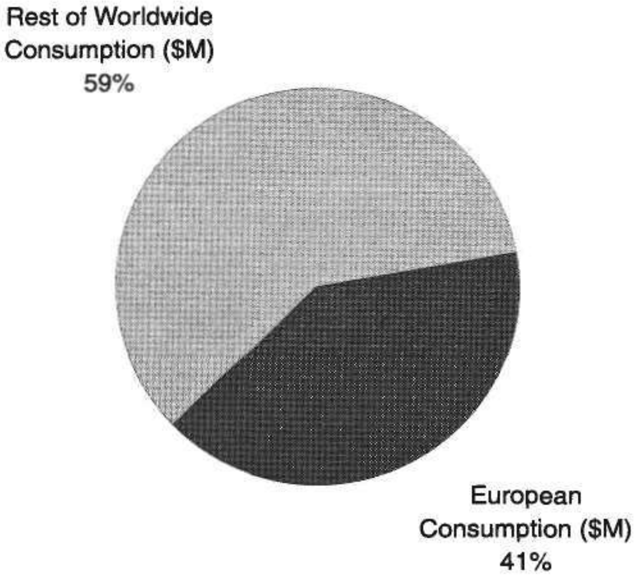
Source: Dataquest (August 1994 Estimates)

Figure 3-8a
1994 European Unit Cellular Telephone Production as Percentage of Worldwide Unit Cellular Telephone Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-8b
1994 European Cellular Telephone Semiconductor Consumption as Percentage of Worldwide Cellular Telephone Semiconductor Consumption



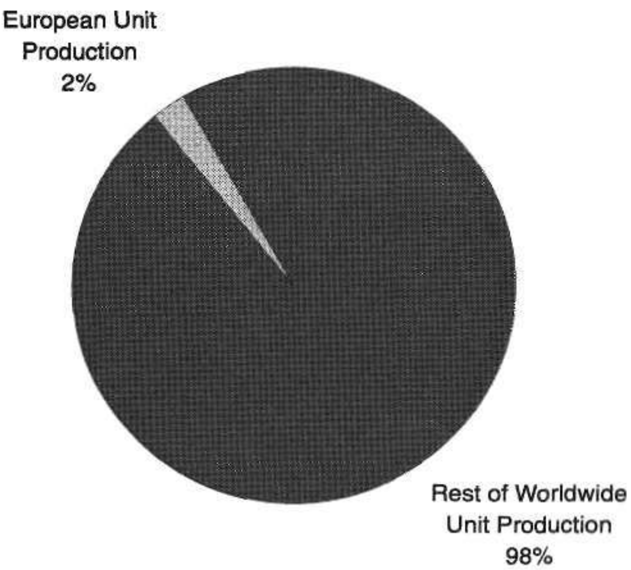
Source: Dataquest (August 1994 Estimates)

Table 3-9
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Pagers

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Pagers								
Units (K)	370	450	537	640	805	1,085	940	15.9%
Factory ASP ($)	40	37	35	33	30	30	29	-5.1%
Factory Revenue ($M)	15	17	19	21	24	33	27	10.0%
Semiconductor Content ($)	10	10	9	9	8	8	8	-5.6%
Semiconductor TAM ($M)	4	5	5	6	6	9	7	9.4%

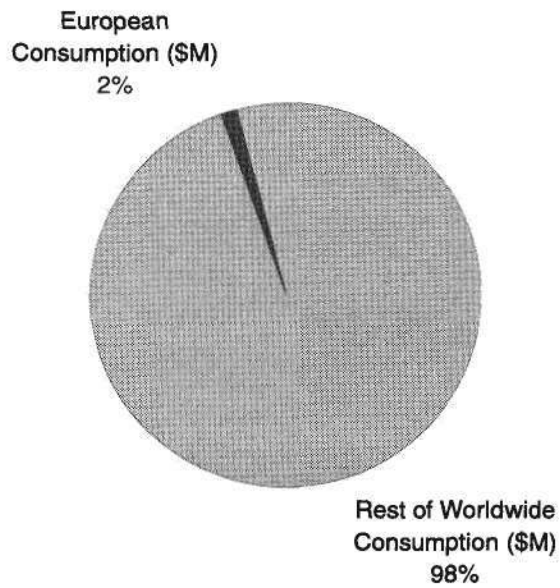
Source: Dataquest (August 1994 Estimates)

Figure 3-9a
1994 European Unit Pager Production as Percentage of Worldwide Unit Pager Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 3-9b
1994 European Pager Semiconductor Consumption as Percentage of Worldwide Pager Semiconductor Consumption



Source: Dataquest (August 1994 Estimates)

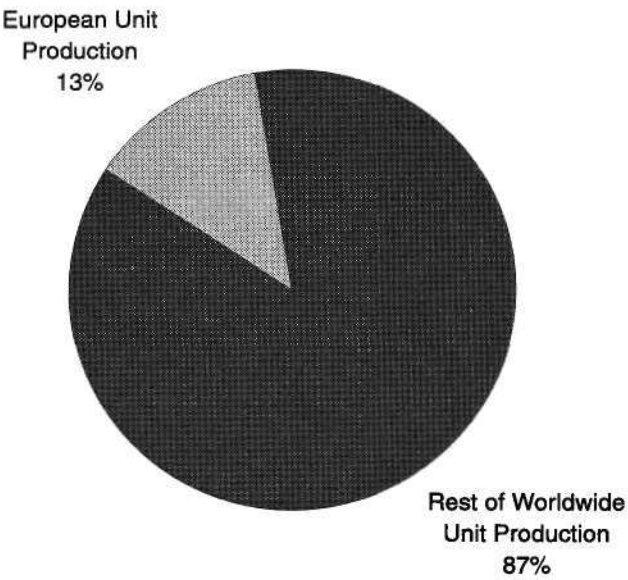
Chapter 4
Consumer

Table 4-1
High-Volume Electronic Equipment Production
Region: Europe
Category: Consumer—Personal/Portable Stereos

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Personal/Portable Stereos								
Units (K)	15,303	15,333	15,366	15,383	15,400	15,396	15,398	0.1%
Factory ASP ($)	22	21	21	21	21	21	21	0.0%
Factory Revenue ($M)	340	321	317	316	319	319	323	0.1%
Semiconductor Content ($)	11	11	12	12	12	13	13	2.8%
Semiconductor TAM ($M)	168	169	184	188	191	192	194	2.8%

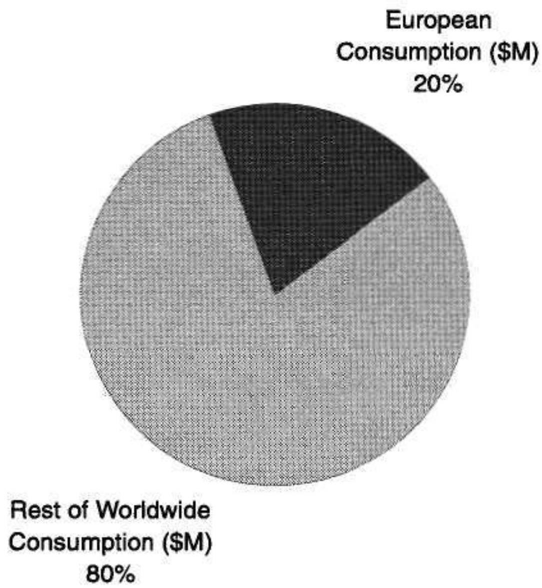
Source: Dataquest (August 1994 Estimates)

Figure 4-1a
1994 European Unit Personal/Portable Stereo Production as Percentage of Worldwide Unit Personal/Portable Stereo Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 4-1b
1994 European Personal/Portable Stereo Semiconductor Consumption as Percentage of Worldwide Personal/Portable Stereo Semiconductor Consumption



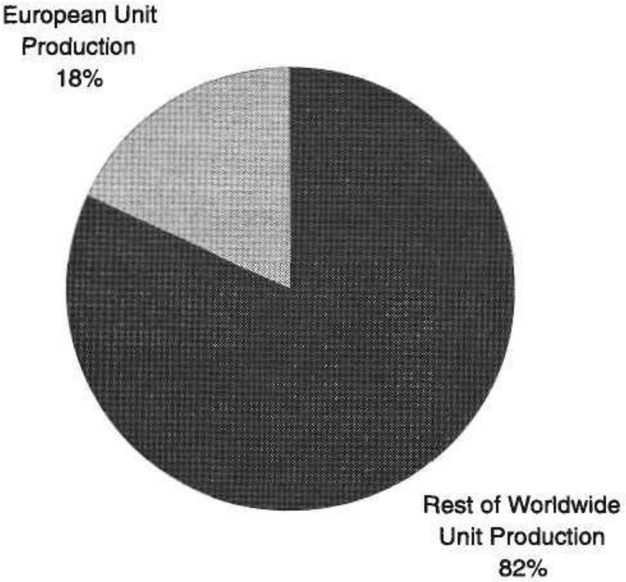
Source: Dataquest (August 1994 Estimates)

Table 4-2
High-Volume Electronic Equipment Production
Region: Europe
Category: Consumer—Color TVs

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Color TVs								
Units (K)	18,496	19,550	19,670	20,000	20,000	21,000	21,000	1.4%
Factory ASP ($)	168	163	183	190	202	203	215	5.7%
Factory Revenue ($M)	3,111	3,187	3,604	3,809	4,037	4,265	4,515	7.2%
Semiconductor Content ($)	44	44	43	42	44	44	48	1.5%
Semiconductor TAM ($M)	820	867	843	850	873	928	1,006	3.0%

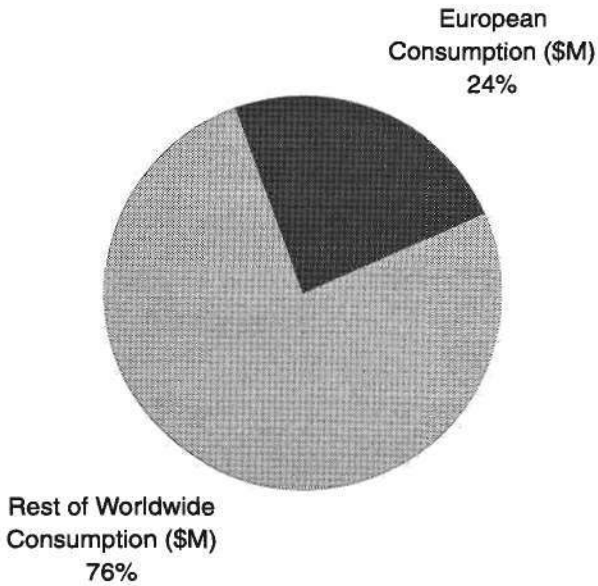
Source: Dataquest (August 1994 Estimates)

Figure 4-2a
1994 European Unit Color TV Production as Percentage of Worldwide Unit Color TV Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 4-2b
1994 European Color TV Semiconductor Consumption as Percentage of Worldwide Color TV Semiconductor Consumption



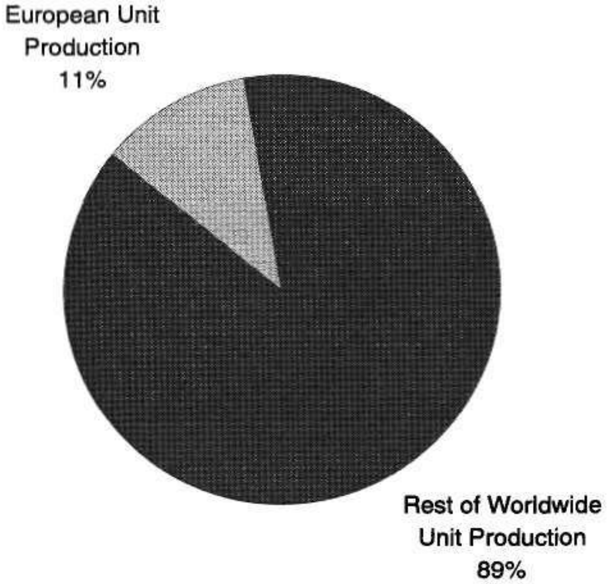
Source: Dataquest (August 1994 Estimates)

Table 4-3
High-Volume Electronic Equipment Production
Region: Europe
Category: Consumer—VCRs

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
VCRs								
Units (K)	6,258	6,257	6,257	6,300	6,400	6,500	7,000	2.3%
Factory ASP ($)	155	174	186	191	207	214	206	3.4%
Factory Revenue ($M)	968	1,090	1,161	1,205	1,327	1,390	1,443	5.8%
Semiconductor Content ($)	48	48	48	49	49	50	49	0.4%
Semiconductor TAM ($M)	300	302	301	306	316	326	345	2.7%

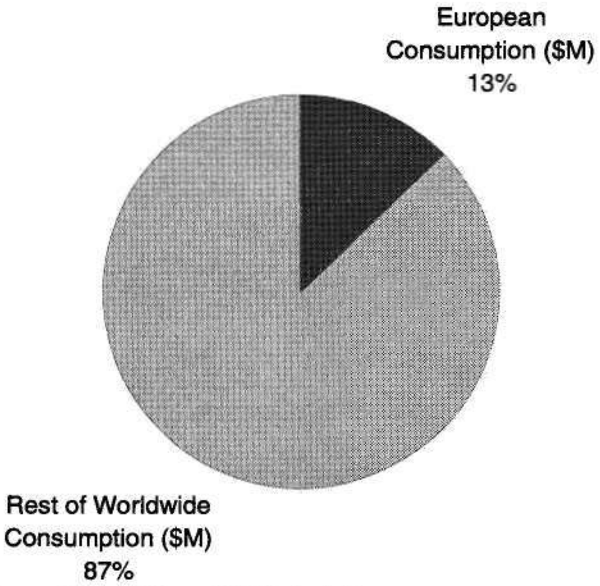
Source: Dataquest (August 1994 Estimates)

Figure 4-3a
1994 European Unit VCR Production as Percentage of Worldwide Unit VCR Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 4-3b
1994 European VCR Semiconductor Consumption as Percentage of Worldwide VCR Semiconductor Consumption



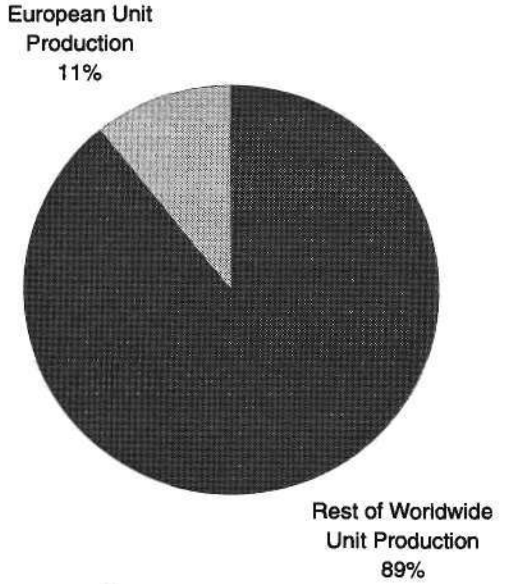
Source: Dataquest (August 1994 Estimates)

Table 4-4
High-Volume Electronic Equipment Production
Region: Europe
Category: Consumer—Camcorders

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Camcorders								
Units (K)	600	900	1,000	1,200	1,500	1,750	2,000	17.3%
Factory ASP ($)	620	407	372	302	237	219	212	-12.2%
Factory Revenue ($M)	372	366	372	362	356	383	424	3.0%
Semiconductor Content ($)	101	96	91	90	89	88	86	-2.1%
Semiconductor TAM ($M)	61	87	91	107	133	154	173	14.8%

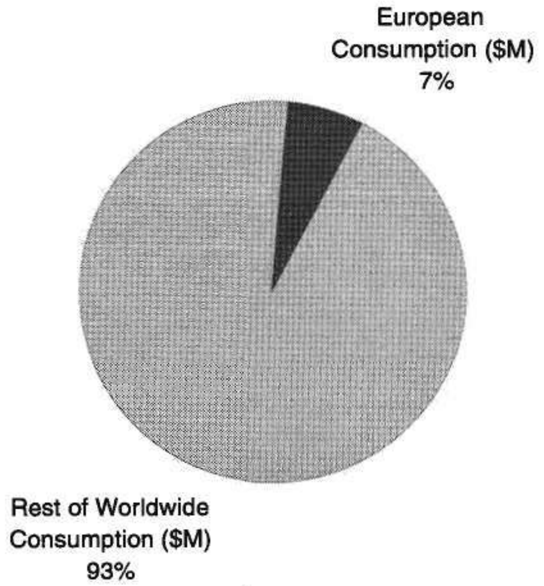
Source: Dataquest (August 1994 Estimates)

Figure 4-4a
1994 European Unit Camcorder Production as Percentage of Worldwide Unit Camcorder Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 4-4b
1994 European Camcorder Semiconductor Consumption as Percentage of Worldwide Camcorder Semiconductor Consumption



Source: Dataquest (August 1994 Estimates)

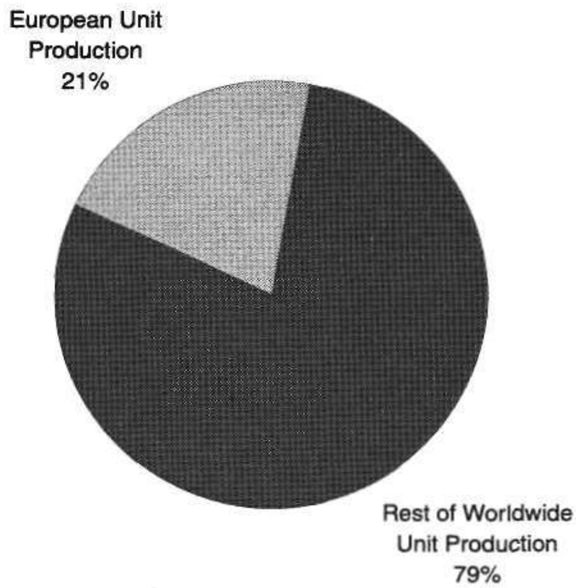
Chapter 5
Automotive

Table 5-1
High-Volume Electronic Equipment Production
Region: Europe
Category: Automotive—Auto Stereos (All)

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Auto Stereos (All)								
Units (K)	10,750	11,500	12,000	12,250	12,500	12,400	12,600	1.8%
Factory ASP ($)	56	56	58	60	62	65	67	3.5%
Factory Revenue ($M)	602	648	700	735	772	805	843	5.4%
Semiconductor Content ($)	14	14	14	14	14	14	14	0.0%
Semiconductor TAM ($M)	155	161	162	165	170	171	176	1.8%

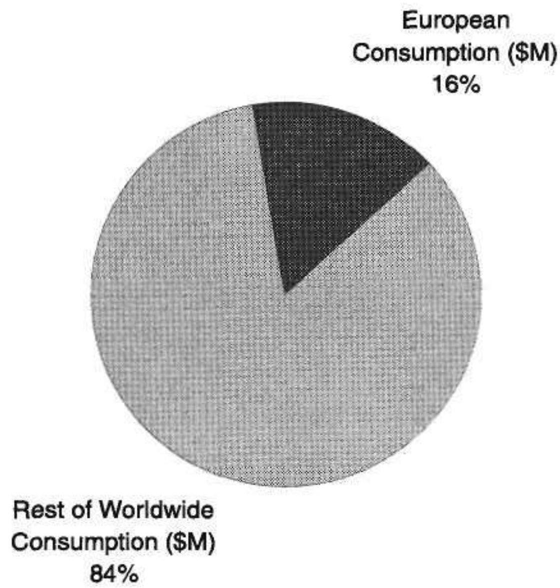
Source: Dataquest (August 1994 Estimates)

Figure 5-1a
1994 European Unit Auto Stereo Production as Percentage of Worldwide Unit Auto Stereo Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 5-1b
1994 European Auto Stereo Semiconductor Consumption as Percentage of Worldwide Auto Stereo Semiconductor Consumption



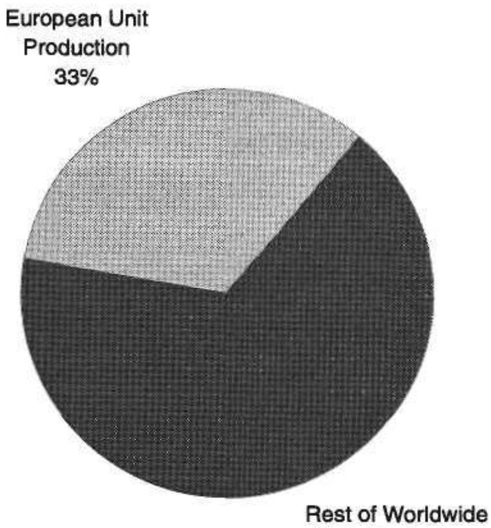
Source: Dataquest (August 1994 Estimates)

Table 5-2
High-Volume Electronic Equipment Production
Region: Europe
Category: Automotive—Engine Control Units

	1992	1993	1994	1995	1996	1997	1998	CAGR 1993-98
Engine Control Units								
Units (K)	7,550	10,000	12,000	12,500	13,000	13,500	14,000	7.0%
Factory ASP ($)	132	150	158	160	162	163	164	1.8%
Factory Revenue ($M)	1,000	1,500	1,900	1,995	2,100	2,200	2,300	8.9%
Semiconductor Content ($)	35	30	29	28	28	27	27	-2.1%
Semiconductor TAM ($M)	264	300	348	350	364	365	378	4.7%

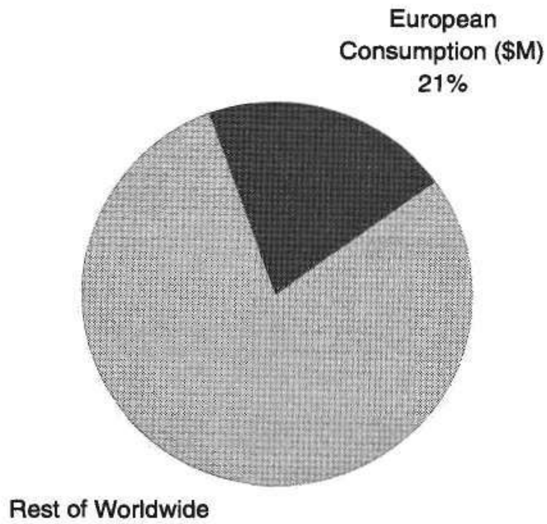
Source: Dataquest (August 1994 Estimates)

Figure 5-2a
1994 European Unit Engine Control Unit Production as Percentage of Worldwide Unit Engine Control Unit Production Forecast



Source: Dataquest (August 1994 Estimates)

Figure 5-2b
1994 European Engine Control Unit Semiconductor Consumption as Percentage of Worldwide Engine Control Unit Semiconductor Consumption



Source: Dataquest (August 1994 Estimates)

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Semiconductors

Semiconductor Trends in the European Communications, EDP, Consumer and Transportation Markets

Market Trends

1994

Program: Semiconductor Application Markets Europe
Product Code: SAMM-EU-MT-9401
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Chapter 1
European Equipment Production

Introduction

This Market Trends report provides an overview of European equipment production, and identifies the market trends that influence this production, with comment on its importance to the semiconductor industry. The report covers five key areas in the following chapters:

- Firstly, **chapter 1** provides an overview of European equipment production in relationship to worldwide equipment production.
- **Chapter 2** analyses the surge in growth of the European electronic data processing (EDP) market and production and how it has become the dominant driver of the European semiconductor market.
- **Chapter 3** outlines the importance of the communications sector with Europe as a major production region and its companies' continued domination of the worldwide market.
- **Chapter 4** provides an overview of the European consumer electronics market and the current importance of TV on semiconductor demand.
- Lastly, **chapter 5** on transportation reviews one of the fastest-growing equipment production segments of all. Europe, already the world region with the largest car unit production, will provide an ever-increasing market opportunity for semiconductor vendors.

Forecast Assumptions

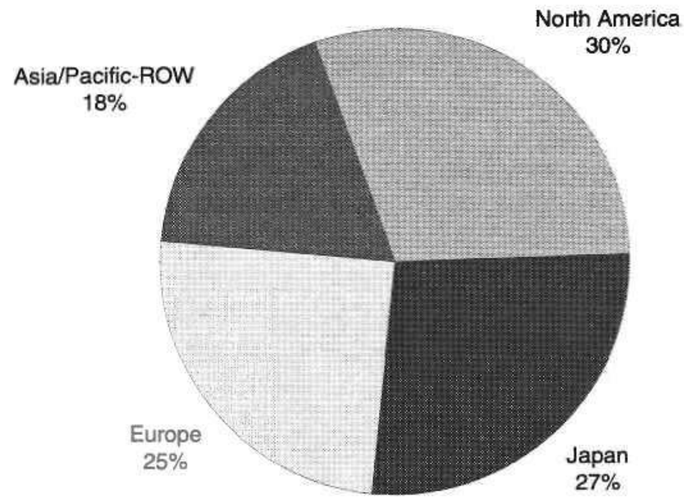
European equipment production is set to grow from a 1993 total of $157 billion to $198 billion in 1998, a compound annual growth rate (CAGR) of 4.7 percent. Figure 1-1 show the relative sizes of equipment production value in each of the world's regions. Europe's 25 percent share of world equipment production has remained fairly constant since 1988 and is forecast to continue at just below 25 percent out to 1998.

Regional Trends

This analysis of European electronic equipment production trends is performed against a background of increased economic optimism in the region. While Germany continues to struggle under the burden of unification, other national economies are showing signs of growth. Recovery in France, the United Kingdom, Italy and other countries is in turn aiding German recovery. The growth rates forecast for the major European countries are as follows:

- Germany's real gross domestic product (GDP) is forecast to grow 1.0 percent in 1994, reversing a 1.4 percent contraction in 1993, and to accelerate to 1.9 percent in 1995. European businesses generally have higher expectations for improvements in higher sales, profit and selling prices.

Figure 1-1
Worldwide 1993 Electronic Equipment Production by Region



Source: Dataquest (June1994 Estimates)

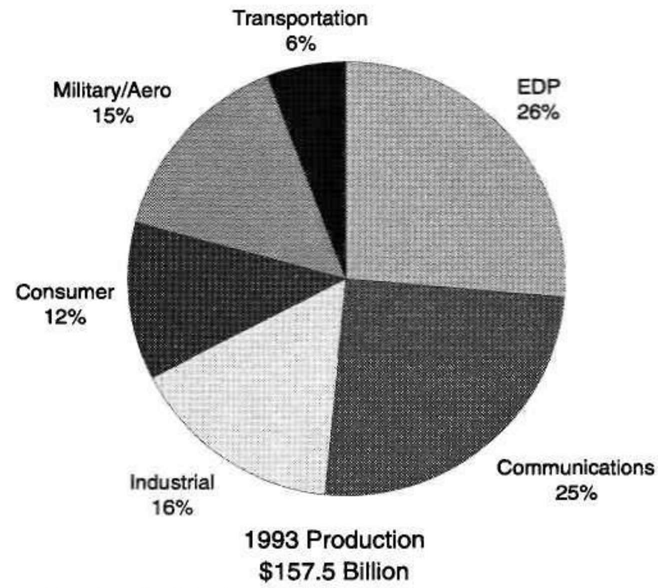
- The United Kingdom's real GDP is forecast to grow 2.5 percent in 1994, up from 1.9 percent in 1993, and to accelerate to 2.7 percent in 1995.
- France's GDP is forecast to grow 1.0 percent in 1994, reversing a 0.8 percent contraction in 1993, and to accelerate to 2.3 percent in 1995.
- Italy's real GDP is forecast to grow 1.6 percent in 1994, reversing a 0.4 percent contraction in 1993, and to accelerate to 2.4 percent in 1995.

Application Trends

Figure 1-2 shows the relative sizes of the application sectors in Europe. The primary assumptions used in this forecast of equipment production are as follows:

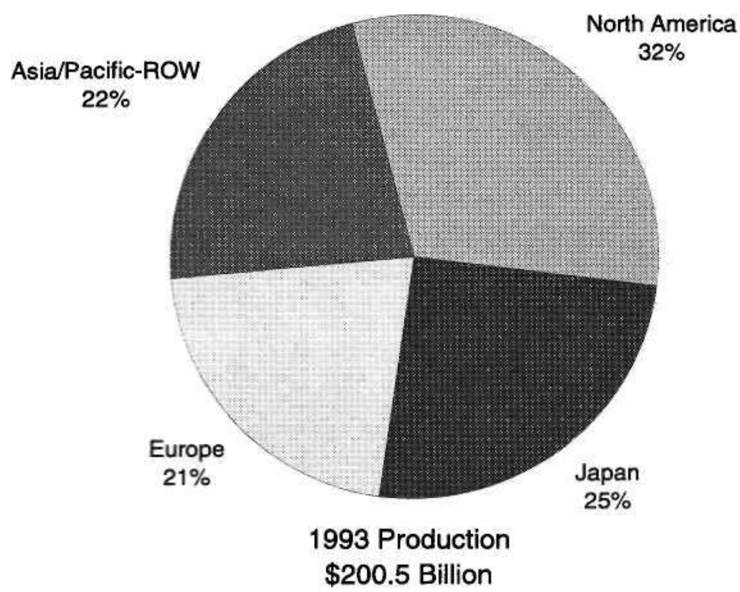
- **Electronic Data Processing**
  - The PC production boom will continue, assisted by the development of new Central and Eastern European markets. Larger computer systems production will retard overall market growth. Smart card production will increase sharply, Europe remaining the world leader for production.
  - Although EDP continues to dominate the European equipment market production outlook, Figure 1-3 illustrates that Europe's production now accounts for 21 percent of the worldwide production of EDP equipment for 1993, a fall of 2 percent since 1989. This trend is set to continue for the forecast period, and by 1998 Europe's share will have fallen to 20 percent. The

Figure 1-2
European 1993 Electronic Equipment Production by Application



Source: Dataquest (June1994 Estimates)

Figure 1-3
Worldwide 1993 Electronic Data Processing Equipment by Region

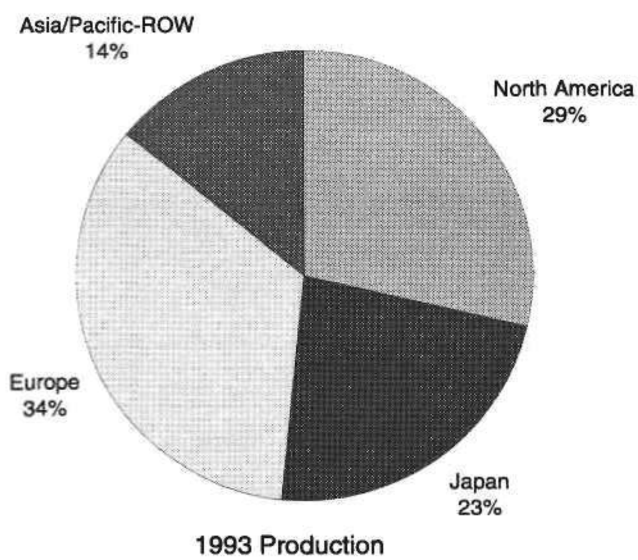


Source: Dataquest (June 1994 Estimates)

Asia/Pacific–Rest of World (ROW) share will increase at the expense of all regions, increasing its share to 36 percent by 1998. There are areas of strength within the European EDP equipment production, however, including personal computers, workstations, smart cards and some storage devices.

- **Communications**
  - There will be very strong growth in demand for cellular handsets and infrastructure. Europe will also benefit from production of GSM cellular equipment for export markets, particularly the Middle East and Asia. Communications production will also benefit from the expansion of cable and satellite services because of the introduction of digital services, although this will occur toward the end of the forecast period. Public telecommunications equipment will continue to grow steadily, but the equipment production value will continue to be impacted by price erosion as the market is further liberalized.
  - Europe's continued domination of the world's communications equipment production, as shown in Figure 1-4, will continue until the end of the forecast period, 1998. This domination affirms Europe as the world's center of excellence for telecommunications. The telecoms sector provides equipment makers with significant export revenue, derived primarily from the Asia/Pacific–ROW region. This export success is the result of long-term high levels of investment in R&D, producing world-beating solutions in public telecoms and, more recently, mobile communications. However, due to the growth in demand for telecommunications infrastructure in these regions, there is a

Figure 1-4
Worldwide 1993 Communications Equipment Production by Region

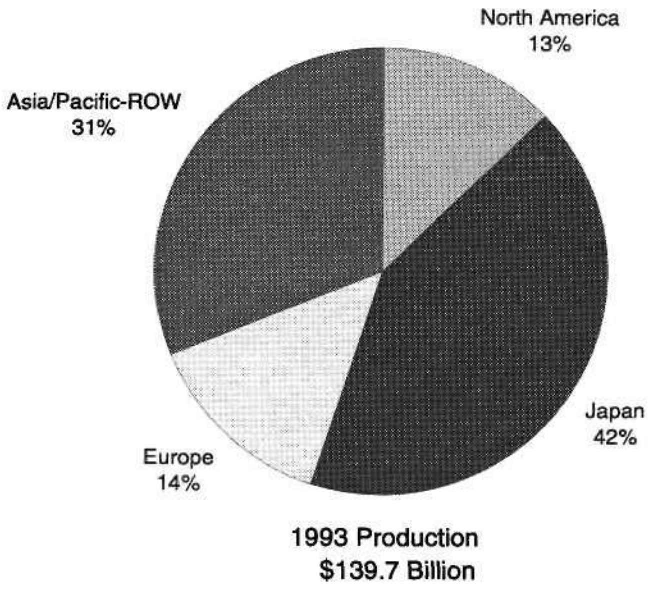


Source: Dataquest (June1994 Estimates)

trend to establish joint ventures and subsidiaries in countries which have major expansion programs. This trend towards more local production by European companies may affect future production levels.

- **Consumer**
  - To date, most European consumer electronics production has been bulky equipment that has been expensive to transport, and premium-tariff-attracting products: white goods and brown goods (mainly video). Shifts in production locations are occurring, however. TV and VCR production in Europe has shifted into and outside of Europe with, for example, Thomson moving substantial amounts of TV and VCR production out of the United Kingdom and Germany to its plants in Singapore. Conversely, additional investment by Samsung, Sony and Matsushita in Europe has occurred. Overall, TV production is fairly constant while VCR production is more volatile.
  - Figure 1-5 shows that Europe's consumer electronics industry is the third-largest region by value worldwide and is forecast to contract in size relative to other regions by 1998. Dataquest believes that world consumer electronic manufacturing is currently dominated by Japanese manufacturing. Dataquest forecasts that the low-cost manufacturing base of emerging developing countries in Asia/Pacific and other ROW regions will attract investment and manufacturing capacity for consumer electronic equipment. By 1998, we forecast that the Asia/Pacific–ROW region will account for the largest proportion of all consumer electronic equipment production worldwide. Although the

Figure 1-5
Worldwide 1993 Consumer Equipment Production by Region

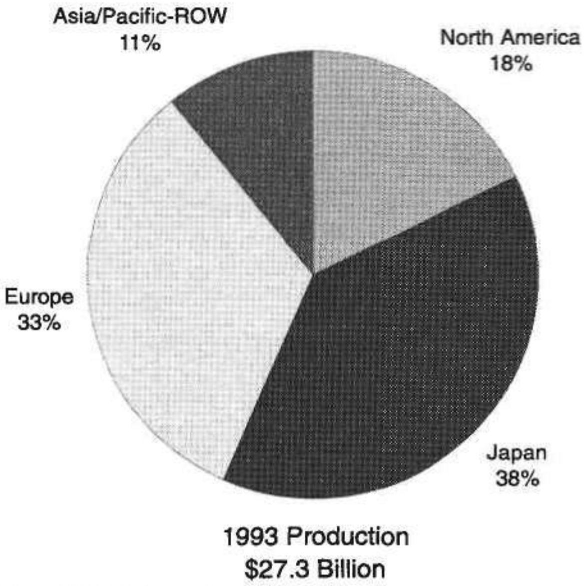


Source: Dataquest (June1994 Estimates)

markets for consumer electronics goods are forecast to flourish in the entire European continent, most of the growth is expected to come from Eastern European countries. The requirements of many of these countries are expected to be satisfied by production from the Asia/Pacific countries.

- **Automotive/Transportation**
  - In the automotive segment, powertrain electronics is now maturing in Europe, with engine control modules installed in locally produced cars at a level of nearly 100 percent, fuelled by emission legislation. Production is also being boosted by high-end in-car entertainment systems. Automotive safety electronics makes further penetration, with more growth anticipated for passenger-side airbags and antilock braking systems (ABS). Car security systems (for example immobilizers, car tracking systems and alarms) are also an area of significant growth.
  - Figure 1-6 shows the 1993 total worldwide transportation (automotive) electronic equipment production, with Europe representing 33 percent of this worldwide production. Europe remains the largest car manufacturing region worldwide, accounting for an estimated 40 percent of world car production. By 1998, European transportation equipment production is forecast to reach $13.1 billion, accounting for 34 percent of worldwide production. Most of the decline in Europe's contribution to world production is attributable to the developing industries in Korea, Taiwan and other parts of the Far East. Japan is the next-largest electronic equipment producer for transportation applications.

Figure 1-6
Worldwide 1993 Transportation Equipment Production by Region



Source: Dataquest (June1994 Estimates)

Chapter 2
Semiconductor Demand in the European EDP Market

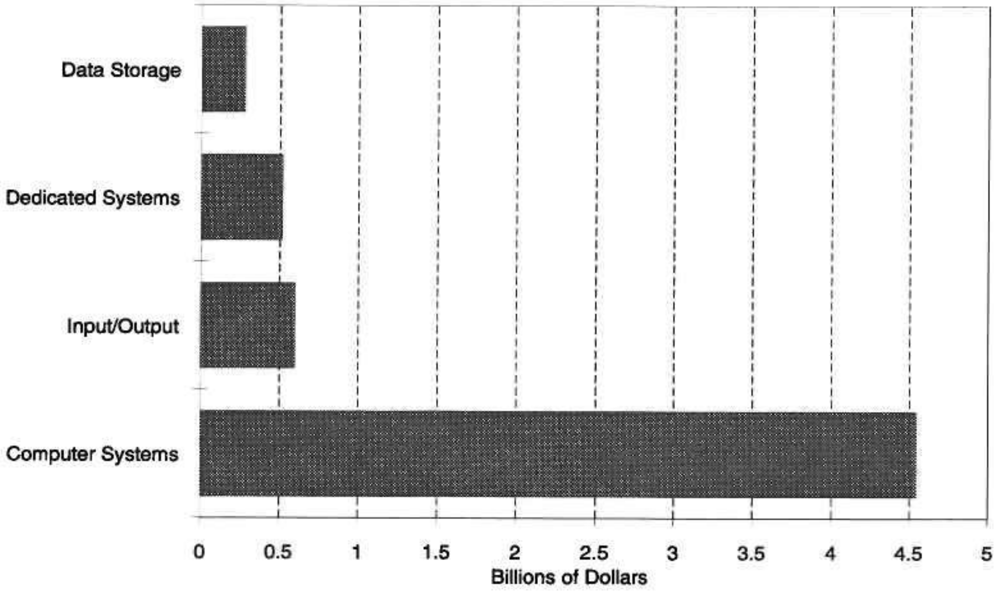
Market Overview

Semiconductor Demand Overview

Dataquest estimates that the 1993 market for semiconductors in EDP equipment in Europe was worth $5.9 billion. Figure 2-1 illustrates this semiconductor consumption by segment within EDP. As expected, computer systems make up the bulk of the demand, being 77 percent of the overall EDP semiconductor consumption and 29 percent of the total semiconductor consumption in Europe.

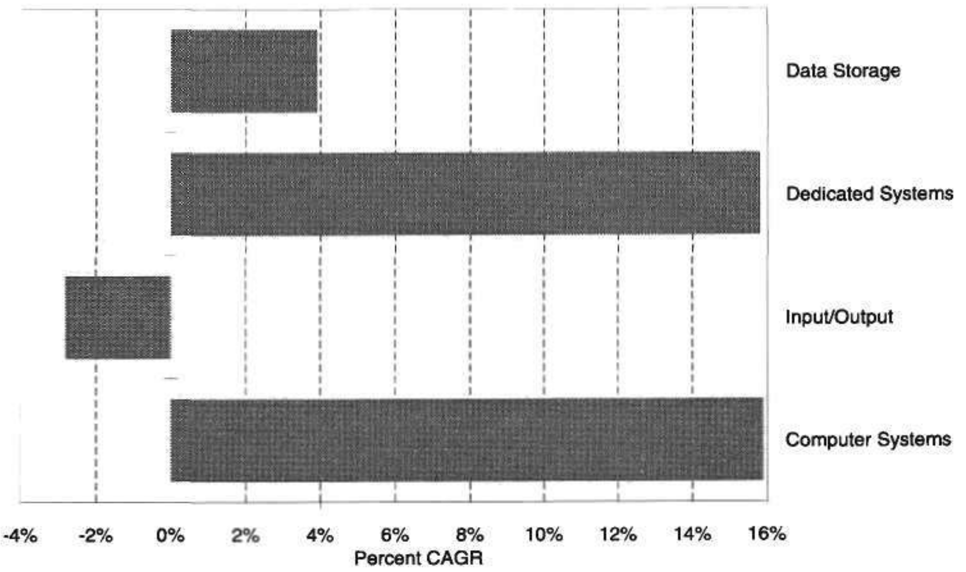
Figure 2-2 shows the CAGR forecast for semiconductor consumption between 1993 and 1998. Again, the growth is dominated by the computer systems segment, which will grow with a CAGR of 16 percent to reach $9.5 billion by 1998. Of the other segments, dedicated systems will grow strongly as well (16 percent for the forecast period), powered by increases in printer and copier production, and the expected high growth and semiconductor consumption by the smart card industry. The worldwide smart card market will grow from 300 million cards in 1993 to more than 2 billion cards in 1998, powering demand for nonvolatile memory and microcontrollers.

Figure 2-1
European 1993 Electronic Data Processing Semiconductor Consumption by Segment



Source: Dataquest (June 1994 Estimates)

Figure 2-2
European Electronic Data Processing Semiconductor Consumption by Segment—Forecast CAGR 1993-1998



Source: Dataquest (June 1994 Estimates)

Table 2-1 illustrates the top 10 companies' sales of computer systems in Europe in 1993. Of the top 10, 7 are of North American origin, and only 2 are European companies, with ICL mostly owned by Fujitsu of Japan. The continuing importance of the US companies is especially evident in the European market. Many North American multinational companies have situated production plants in Europe, and provide large semiconductor demand for semiconductor suppliers in Europe. However, in order to be successful in shipping semiconductors to these companies in Europe, the design-in of semiconductors is in the region of origin of the company. In the EDP segment, it is therefore vital to have a strong presence in the US market in order to obtain these crucial design-ins.

European Electronic Data Processing Production Overview

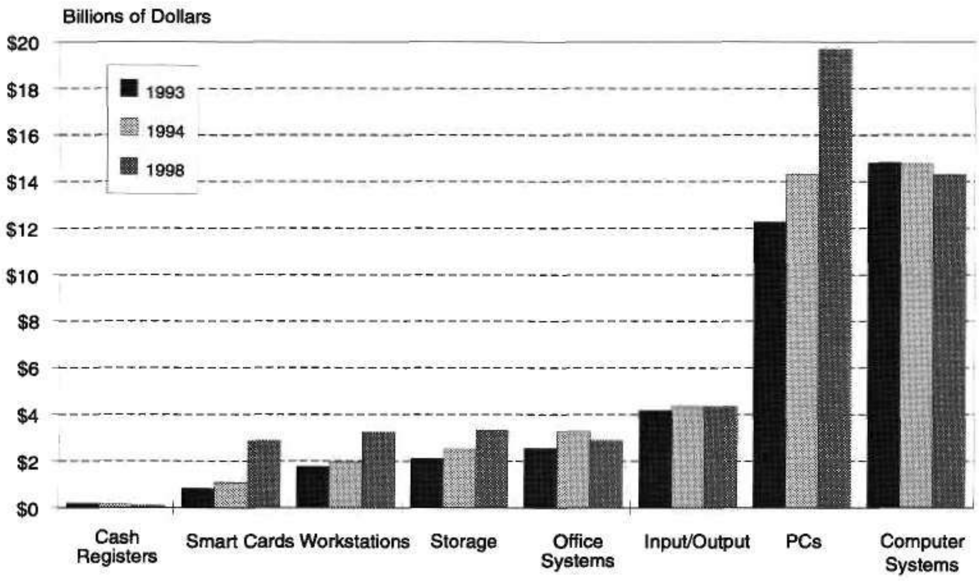
Figure 2-3 illustrates the outlook for effective European EDP equipment production for 1993, 1994 and 1998. EDP equipment production is worth more than $42 billion in 1994, almost 27 percent of the total Equipment production in Europe. The EDP segment will hold this percentage throughout the forecast period, reaching almost $51 billion in 1998. PC production, which represents 34 percent of effective European EDP production in 1994, will grow to 39 percent by 1998 to become the largest subsegment, surpassing computer systems (mainframes, minicomputers, and so on). The long-term CAGRs are illustrated in Figure 2-4. Even though PCs will become the largest subsegment, smart cards will show the highest CAGR from

Table 2-1
Top 10 Companies' Revenue from Computer Systems in Europe 1993 (Millions of Dollars)

Company	Revenue
IBM	7,326
Siemens Nixdorf	1,976
Hewlett-Packard	1,732
Digital	1,617
Sun Microsystems	1,199
Bull	1,120
ICL	770
Unisys	720
Comparex	687
Amdahl	566

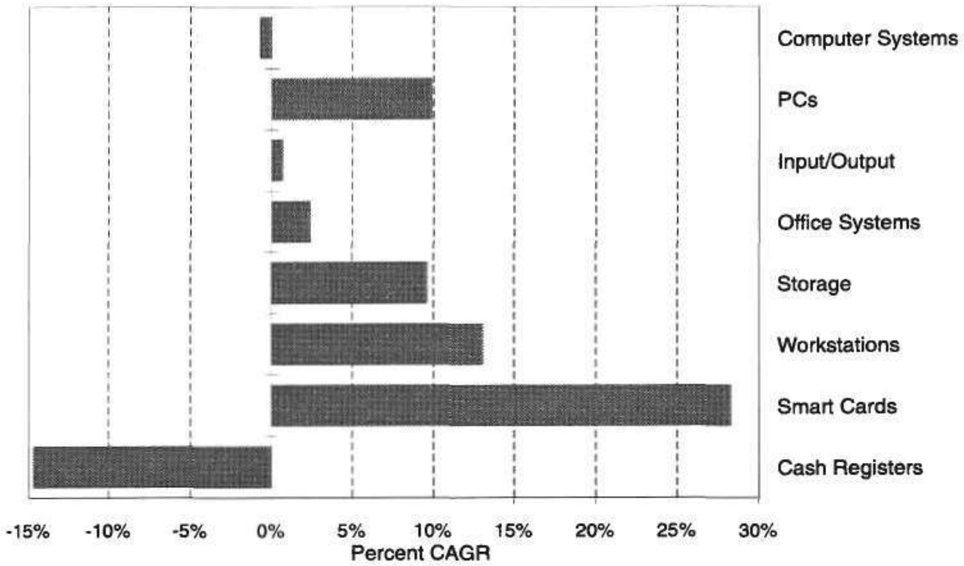
Source: Dataquest (June 1994 Estimates)

Figure 2-3
European Effective Electronic Data Processing Production, 1993, 1994 and 1998



Source: Dataquest (June 1994 Estimates)

Figure 2-4
European Electronic Data Processing Production by Product Type—Forecast CAGR 1993-1998



Source: Dataquest (June 1994 Estimates)

1993 to 1998. Europe is the world's largest production region for chip cards for all applications, and this will continue for the forecast period.

Computer Systems Market Overview

The long-term CAGR outlook for production of computer systems in Europe shows a small decline of 1 percent for the forecast period. Although downsizing of systems has been a recent trend, there are a number of factors that are diminishing the need for corporations to reduce their dependence on larger computer systems, and this will ripple through to the production industry in Europe.

PC Market Overview

Between 1993 and 1998, the production of PCs in Europe will grow with a CAGR of 10 percent, almost double the average growth for the EDP segment. Continued investment by US multinational PC producers and European indigenous companies will result in larger production levels, especially among the major companies.

The European PC market continued its growth in 1993 to reach 10.32 million units shipped in Western Europe (9.49 million in 1992), 8.7 percent over the previous year. However, in revenue terms the market has contracted by 8.8 percent to $20.27 billion ($22.23 billion in 1992), despite the shift to high-end processors and more base memory. This demonstrates the intense price competition that has been raging between vendors in not only the European but also the worldwide PC market since mid-1992. This competition, combined with component supply problems, has meant a tough year for all but the largest manufacturers.

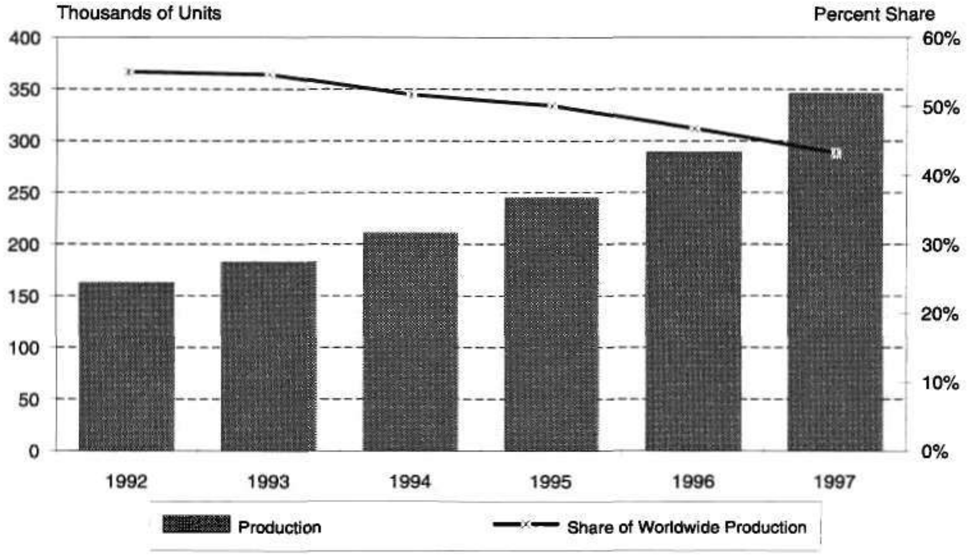
Effective European PC production, that is, where at least memory or microprocessors are purchased in Europe, in 1993 showed a healthy 32.3 percent growth to 10.2 million units (7.7 million in 1992), ahead of shipments growth of 8.7 percent. One of the reasons why production grew above sales is that European manufacturing locations are being used to supply the new markets of Eastern Europe, the Middle East and Africa; for instance, both IBM and Compaq supply these markets from Europe.

Workstations Market Overview

The forecast for production growth of workstations between 1993 and 1998 is 13 percent, the second-largest subsegment growth. Dataquest estimates that Europe may produce more devices than it consumes and become a net exporter within the forecast period.

There are four main workstation producers in Europe—Sun Microsystems, IBM, Digital Equipment and Hewlett-Packard. Figure 2-5 illustrates the production in Europe for all the workstation producers, together with the European share of worldwide production. Dataquest estimates that the top four producers account for an estimated 83 percent of the total figure. During 1993, less than 60 percent of the workstations produced in Europe contained

Figure 2-5
European 1993 Workstation Production, Quantity and Share of Worldwide Production



Source: Dataquest (June 1994 Estimates)

locally procured semiconductors. However, there was a strong shift towards Europe-based workstation production during 1993, corresponding to a 10 percent increase in semiconductor sales for this application.

Office Systems Market Overview

The long-term CAGR for office systems is just over 2 percent. Although a number of companies are involved in manufacturing in Europe, pricing pressure and extreme competition will keep the CAGR small. The main areas within this segment are printers and copiers.

Printers. The electronic printer market in Europe is constantly changing. By the very nature of the products involved, it is vastly affected by its host environments. The 1980s saw major changes in these markets, and printers had to adapt and move with the times. In the past 10 years the industry has seen dot matrix printers reach their zenith and begin to decline, the emergence of page printers as a major force, and the truly spectacular effect of ink jet machines on the total market. The 1990s have dawned as the era of the nonimpact printer.

The success of the nonimpact technologies has not been as simple as their apparent market share would suggest. Many problems had to be overcome, especially with regard to software and compatibility. However, with nonimpact products now finally outselling dot matrix machines, their success is assured.

Antidumping tariffs were introduced during the 1980s for impact (dot matrix) printers, and Japanese companies sited production facilities in Europe after this. Many of these sites now produce nonimpact (laser and ink jet) printers. Printer production trends in Europe will be discussed in detail in a forthcoming *Dataquest Perspective* "Printer Manufacturing in Europe," which will be available in August 1994.

Copiers. The copier market is showing slow overall growth at this time. Specific areas within the total market are fuelling this growth, most notably the higher-featured top end of the copier ranges. Also, there should be growth in the digital copier market. One of the main attributes of the digital copier is its enhanced copy quality, though this would only be appreciated at the high end of the market.

During the 1970s and 1980s, Japanese manufacturers managed to export copiers with more features at lower prices than preceding models available in either Europe or the United States. By the mid-1980s, European manufacturers decided to take action to protect their European business. As a result, by 1987 the European Commission (EC) had imposed antidumping duties, based on the General Agreement on Tariffs and Trade (GATT), requiring that 40 percent of finished copiers were made of parts acquired from sources within the European Union (EU). This agreement was due to expire in February 1992, though at this time there has been no announcement as to any changes to the agreement.

Cash Registers Market Overview

The long-term CAGR for cash registers shows a negative outlook for the forecast period. True cash registers are being replaced quickly by more sophisticated electronic point-of-sale (EPOS) terminals, especially in larger retail chains. Bar code scanners, shelf-edge labelling and other electronic systems are being developed for modern shopping centers, and are mostly based on workstation/minicomputer hardware solutions, with sophisticated bespoke software solutions.

Input /Output Market Overview

Dataquest's forecast CAGR for input/output (I/O) devices indicates a production increase of just 1 percent for the forecast period to 1998. Cheap imports of keyboards will affect production levels in Europe. Scanners, plotters and digitizers have very small production levels in Europe, and Dataquest expects only a small growth in end-customer demand for these technologies.

Storage Market Overview

Storage production in Europe will increase with a CAGR of close to 10 percent between 1993 and 1998. There will be a continued increase in the capacity and reliability of smaller disks (less than 3.5 inch), and the continued emergence of solid-state storage, especially for handheld computing applications. However, rigid disk drives will still account for a large percentage of the market, and be much cheaper per megabyte.

Smart Cards Market Overview

Smart cards and chip cards will continue their production growth in Europe for the forecast period, showing a production CAGR of close to 30 percent. The bulk of historical production of cards in Europe have been for telephone applications, and have been relatively simple. The ease of use, security and available processing power means that future cards will become more powerful and their applications will grow.

Health cards, with patients' histories and other vital and confidential information, will grow very quickly over the next few years in Europe. Every person in Germany will be receiving a card over the next year or so—60 million cards in all. The advent of the "electronic purse" is also close and, as with all financial applications, it will demand high levels of encryption and security.

Vendor Performance

Table 2-2 shows the top 10 semiconductor suppliers to the European EDP segment for 1993. Dataquest has also estimated the companies' 1992 revenue, in order to track individual company growth against the performance of the segment. The EDP segment had a strong

Table 2-2
Top 10 Semiconductor Suppliers to EDP Segment 1992-1993
(Millions of Dollars)

1992 Rank	1993 Rank	Ranked Companies	1992 Sales	1993 Sales	1993/92 Growth
1	1	Intel	1,022	1,892	85.1%
2	2	Samsung	233	433	85.8%
5	3	Texas Instruments	270	340	25.9%
3	4	NEC	245	332	35.5%
4	5	Siemens	241	290	20.3%
8	6	Hitachi	200	279	39.5%
7	7	Motorola	195	265	35.9%
9	8	Toshiba	193	243	25.9%
6	9	Philips Semiconductors	198	190	-4.0%
11	10	SGS-Thomson	150	168	12.0%
		IBM*		403	
		EDP Segment	3,946	5,934	50.4%

* IBM not included prior to 1993
Source: Dataquest (June 1994 Estimates)

year in 1993; and high prices and delivery problems were evident across the industry. Overall, the segment semiconductor consumption grew by 50 percent and 2 companies in the top 10 exceeded this growth.

Intel had another very strong year, growing by more than 85 percent, as PC users switched quickly from 386 processors to higher-priced 486 devices. The other large growth was from Samsung, which benefited from rising average sales prices (ASP) for memory devices, especially DRAMs. Many of the other companies in the top 10 also grew well because of strength in memory/microprocessors. The top 10 companies' share of the total EDP semiconductor has declined very slightly from 75 percent in 1992 to 74 percent in 1993. Dataquest has included the sales of IBM in Europe for the first time for 1993, and the estimate would place it in second position overall within the EDP segment.

Semiconductor Technology Trends in Electronic Data Processing

CPU Trends

Desktop power demands will come from servicing graphical user interface (GUI)– and WYSIWYG-oriented applications; these include:

- Processing—compressing and decompressing
- Store, forward, and read multimedia—object linking and embedding (OLE)–enabled
- Real-time multimedia systems such as desktop videoconferencing

Networking support will increasingly require faster servicing as transfer rates soar (for example, toward 100 Mbit/s over Ethernet), and the size and frequency of transferred files and e-mail soar as well.

There will be many versions of the 486 processor made available as Intel, AMD, Cyrix, SGS-Thomson, and possibly others cover the entire spectrum of price, performance and power consumption. Clock-doubled, -tripled and possibly -quadrupled 486 processors will be available, with speeds ranging from 20 MHz to in excess of 100 MHz. Pentium processors are emerging as popular DOS server processors—future variants and their pricing curves will be used to defend Intel's market share and customer base.

Multiprocessing will enter the world of PCs during the coming years as motherboards accommodate "OverDrive"–style processors that share the computing load with another microprocessor.

The Digital Video Explosion

Video CODEC ICs are a subsegment of graphics and imaging controllers, the largest segment of MOS microperipherals, which in turn is the smallest segment of microcomponents. Graphics and video controllers are devices that typically interface to some form of system bus to interpret, convert and control the visual output of systems (computer-generated graphics, live video, and other images), and comprise a variety of graphics controllers, CRT controllers, image conversion chips, video CODEC chips, and other less significant chips. Video CODECs will represent slightly more than $50 million of worldwide revenue for 1993 (Table 2-3), but because of the high projected growth, development efforts are being funded by venture capitalists working with start-up operations, large semiconductor companies, and PC industry companies expecting a tie-in to PC multimedia.

Product Types and Architectures

Video CODEC products are essentially designed to execute an algorithm, of either standard or propriety nature, to perform

Table 2-3
Video CODECs and Decoders, Worldwide Revenue Market Forecast (Millions of Dollars)

Year	Revenue	Growth Rate
1993	54.1	NA
1994	105.9	96%
1995	212.5	101%
1996	348.9	64%
1997	462.6	33%

NA = not applicable
Source: Dataquest (June 1994 Estimates)

decoding (decompression) or encoding (compression) functions. The architectures used to approach these functions follow one of two major courses, programmable or dedicated. The programmable architectures normally spring from general digital signal processing (DSP) cores, using specialized algorithms to implement either one or multiple compression/decompression standards. These are becoming more commonplace in the case of encoders/CODECs, where the overhead of performing any compression outweighs the incremental cost of performing multiple algorithms. However, most decoders in development are being focused on low-cost, single-algorithm, dedicated cores where DSP-type functions are employed but completely functional DSPs are not.

More than any other application, multimedia computing has received the most hype and growth projections based on the false assumption that widespread use of live video on-screen is a natural extension to the use of graphics on-screen. However, several key factors detract from these assumptions and reveal a more likely scenario for the demand of CODECs in PC applications, as follows:

- Live video on-screen is counterproductive in most business applications. Being the most engaging form of visual input, live video will have a tendency to consume a large portion of a person's time. On the other hand, graphics has increased productivity for nearly every type of application.
- The growth of non-computer video games is far outstripping sales of computer games software, and as video games become even more enticing, home computer sales for entertainment will not keep up with the proliferation of CD-based video games.
- The growth of CPU power of computer systems in the next five years will negate the need for separate hardware decoders to play back live video on-screen; thus, only the minor growth driven by computer-based authoring stations will continue into the later 1990s.

The market demand for CODECs is essentially two forms of multimedia computer systems, playback and authoring systems. As current demand levels are low, demand is relatively evenly split among x86 PCs, Macintosh computers and workstations. However, most future unit demand will come from the x86 PC platform because of sheer unit dominance.

Highlights of significant trends and events within multimedia computers are as follows:

- The current high-performance software only provides playback up to 15 frames per second at 320 × 240 resolution; this is projected to increase to more than 20 frames per second at 640 × 480 during 1994.

- SuperMAC has licensed its proprietary Cinepak CODEC scheme to eight other vendors including Microsoft, Apple, Creative Labs, Cirrus Logic and Weitek.
- Microsoft is shipping three CODECs with its Video for Windows software: Intel's Indeo, and Microsoft's Video1 and run-length encoding (RLE). It is adding a fourth format for motion-JPEG (agreed upon by 20 other vendors), where JPEG video files will be supported under Windows as audio/video-interleaved (AVI) files and JPEG still-image files will be supported under Microsoft Windows as device-independent bit-mapped (DIB) files.
- PC graphics chip vendors are working on new versions of their GUI accelerators to add hardware assistance to functions used by video, such as stretch-BLTs.
- Intel and ATI Technologies have announced a Shared Frame Buffer Interconnect (SFBI) specification, which defines a method for combining full-motion video, graphics, and other multimedia functionality into a single integrated multimedia subsystem.
- Intel continues to push its Indeo standard, which is focused on software-only decompression using standard PC architectures with accelerated VCA graphics.
- Intel recently demonstrated video device interface (VDI) software technology, an enhanced set of interface extensions for Windows. Vendors that have announced products supporting VDI include ATI Technologies, Brooktree, Matrox and Western Digital.
- VESA has announced that the VESA Advanced Feature Connector and the VESA Media Channel specifications have been released for technical review; these allow simple and inexpensive integration of digital video into the standard PC graphics environment.

Memory Opportunities

Dataquest has identified the following ongoing and new opportunities for memory devices in the EDP segments:

- DRAM, VRAM and fast/synchronous alternatives:
  - The demand for Windows, Windows NT, OS/2, and System 7 OS environments and their upgrades and future object-oriented versions will continue to push main memory configurations to larger sizes. Increased networking and use of multimedia capabilities and their huge file sizes (even with compression) will also drive up demand.
  - Most systems will double their main memory megabyte requirements from 1993 to 1998. Wider versions (×4, ×8, ×16) to reduce chip count and improve performance are becoming the norm, especially with space/power-conscious notebook designers. Demand will be strong for 16M and 64M DRAMs, but overall chip count per system

could stay the same or even decline as integration outstrips per-system requirements.

- Economically faster methods of accessing main memory are required for the new generation of faster systems, with CPU clocks heading to 100 MHz and for applications requiring speed for high-resolution video buffers. As video refresh rates head toward 80 Hz and resolution toward 1 million pixels with 24-bit color, the memory-mapped nature of display technology is beginning to slow down. There is also an opportunity to accelerate the performance of multitasking operating systems such as Windows NT and OS/2, where SRAM-based caching throughput can break down while the OS services several tasks requiring demand paging virtually simultaneously. With this in mind, several system memory accessing acceleration opportunities are being proposed, as follows:
  - Video RAM—Already a popular solution for video buffers found on the motherboard and graphics adapter cards, because it can effectively receive and transmit data simultaneously; however, designers are continually dissatisfied with the cost of VRAMs at twice that of DRAMs.
  - Synchronous DRAM—A JEDEC-proposed method for a clocked-synchronized DRAM; this solution is gaining support with suppliers and good awareness from designers.
  - Wide-word-width DRAM—Use of ×8 and ×16, among other configurations.
  - Rambus—A new licensed DRAM/logic bus interface from a company called Rambus and its signatories.
  - Enhanced DRAM and cache DRAM—From Ramtron and Mitsubishi respectively, and both involve a combination of DRAM and SRAM architectures.

- SRAM
  - SRAM will continue to be used predominantly in caches and main memory for some portable PCs. Cache sizes will continue to grow as system speed outstrips the main memory's ability to keep up. There will be a design-economic trade-off with the so-called fast DRAM alternatives for cache applications.
  - Access times will be needed for 10ns to 15ns for Pentium (66 MHz) and 5ns to 15ns for workstations, while 486-based systems are at 15ns to 20ns now. Pentium cache tag SRAM will require an 8ns access. For 100-MHz microprocessors, expect the access time requirements to be 50 to 100 percent faster.
  - Expect handheld PCs such as personal digital assistants (PDAs) and some subnotebooks to continue using SRAMs for main memory for power consumption reasons. Most notebooks have turned to wide DRAMs, which offer a compromise on power and cost between regular DRAMs and SRAMs.

- Nonvolatile
  - The principal applications will be for BIOS storage and program storage in portables and palmtops.
  - BIOS comes in two applications: main systems and graphics. The main system BIOS is rapidly trending towards 0.25MB (256K×8 or two 128K×8 configurations), as BIOS providers include more services to support features such as power management and PCMCIA. Graphics controller providers are using at least 32K×8 for VGA BIOS. As graphics board designers offer more nonstandard, customized modes for Windows acceleration and resolution, among other features, they will require larger configurations. To support line or field upgrading, BIOS designers are turning to flash anyway, from one-time programmable (OTP) and EPROM devices.
  - Palmtops, such as those from Hewlett-Packard and Apple, are embedding multiple megabytes of operating system and program storage. Modular Windows (ROM version OS), Lotus 1-2-3, and personal information management (PIM) functions round out the growing lists of uses for large nonvolatile arrays.
  - Printers will still demand nonvolatile memory for font storage, though Dataquest expects many producers to switch from ROM to flash when prices become competitive.
  - The rise of solid-state storage should proceed within the forecast period, though pricing per megabyte for solid state will still be far above that of magnetic media. However, the ruggedness and ease of use will make this technology popular for portable equipment producers, and the growth of PCMCIA cards for storage and other I/O functions will drive demand for nonvolatile (and other memories) throughout the next five years.
  - Smart cards will continue to use EEPROM devices for telephone card applications, though continued demand for higher encryption for security may increasingly push the memory devices to become further embedded in the processors.

Chapter 3
Semiconductor Demand in the European Communications Market

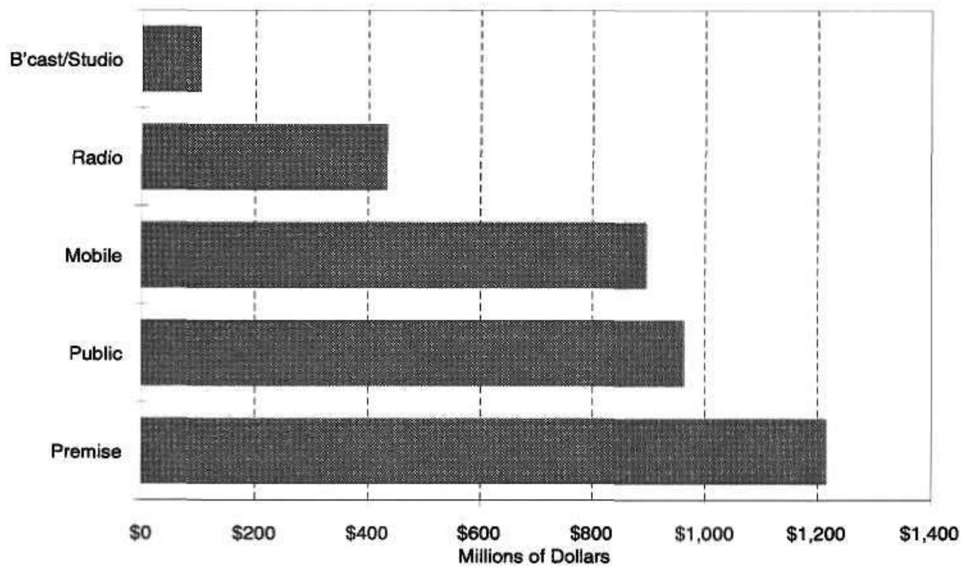
Market Overview

The semiconductor market from European telecommunications is estimated by Dataquest to be $3.6 billion in 1993. The premise telecoms segment is the largest market for semiconductors, estimated at more than $1.2 billion (Figure 3-1), but it exhibits a modest CAGR of 7.6 percent from 1993 to 1998, as shown in Figure 3-2.

This slowdown in growth rates is due to the ongoing liberalization of telephone companies' monopoly on the supply of PBX/key telephone systems and telephone handsets. This has caused greater competition in the market and a reduction in prices, which in some part have been passed on to semiconductor suppliers. This should be balanced by application areas showing exceptional growth such as desktop video teleconferencing, call processing equipment and cordless telephones.

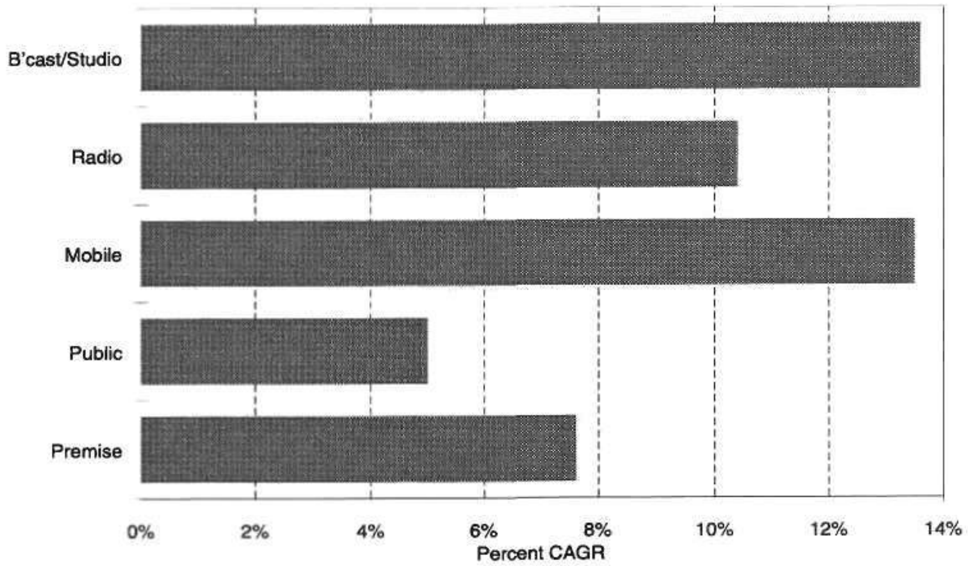
Although the public telecoms equipment segment is much larger (by value) than premise telecoms, the situation is reversed in the semiconductor market, with premise larger than public telecoms. The public telecoms semiconductor market was estimated to be $962 million in 1993; this segment is dominated by central office and transmission. This smaller semiconductor market is because of the much lower I/O ratios, especially for transmission systems.

Figure 3-1
European 1993 Communications Semiconductor Consumption by Segment



Source: Dataquest (June 1994 Estimates)

Figure 3-2
European Communications Semiconductor Consumption by Segment—Forecast CAGR 1993-1998



Source: Dataquest (June 1994 Estimates)

Figure 3-2 shows the growth rates of the semiconductor market in each of the communications segments. The two segments showing the highest growth rates are broadcast/studio and mobile communications. The growth rate in broadcast and studio semiconductor consumption is driven by the trend to digital video. The demand will be towards the end of the forecast period with the anticipated conversion and upgrading of studio and broadcasting equipment to meet the demands of digital and high-definition TV (HDTV), in all the video media sectors, cable, satellite and terrestrial TV.

The growth of the mobile segment is accounted for by the tremendous growth in unit demand for both cellular handsets and base stations, especially GSM. This is all the more remarkable when seen against the background of rapid price erosion of the GSM semiconductor content.

Telecommunications as a Technology Driver

The communications industry is a key semiconductor technology driver. Historically, it has driven improvements in levels of integration of application-specific integrated circuits (ASICs), and has pushed the development of certain technologies such as BiCMOS. Now, however, the communications industry is driving another technology with dramatic growth in mobile and cellular communications—low-cost, highly integrated radio frequency (RF) devices.

Table 3-1
Worldwide Top 10 Telecommunications Manufacturing Companies in 1992 (Billions of Dollars)

Rank	Company	1992 Sales	Country
1	Alcatel	15.32	France
2	Siemens	11.92	Germany
3	AT&T	10.81	USA
4	Northern Telecom	8.41	Canada
5	Motorola	7.81	USA
6	Ericsson	7.32	Sweden
7	NEC	6.84	Japan
8	Fujitsu	3.74	Japan
9	Bosch	3.49	Germany
10	Philips	2.57	Netherlands

Source: Dataquest (June 1994 Estimates)

Table 3-1 shows Dataquest's 1992 estimates of the world's top 10 telecoms equipment manufacturers, and ranks them using their reported 1992 telecoms equipment sales. Among the top 10 suppliers, 5 are European, indicating the continued dominance of Europe in this market.

In fact, the European companies seem to be getting stronger; of the top 20 companies in 1992, 10 were European. These companies' 1992 sales total more than $49 billion. This figure is greater than the total European communications market of $37.5 billion, demonstrating the importance of European companies' exports and operations outside their local markets.

Importance of Communications in the European Electronic Equipment Market

The 1993 total European electronic equipment production is estimated by Dataquest to be $147 billion. Dataquest believes that European communications is the second-largest equipment sector behind EDP. Although communications equipment production accounts for 25.5 percent of the total, it accounts for 23.3 percent of the European semiconductor market. This places communications as the second-largest user of semiconductors after EDP. European companies' growing domination of the world's communications equipment production underlines the importance of design wins for semiconductor vendors in Europe, as some production moves to local markets, particularly Asia.

European Communications Equipment Production Overview

The telecommunications equipment industry is broadly split into five main segments: public, premise, mobile, radio, and broadcast and studio. Total electronic equipment production in Europe is set to grow at a compound annual growth rate of 4.1 percent from 1993 to 1998. The value of European telecommunications equipment production will rise from $37.2 billion in 1993 to $45.5 billion in 1998, as shown in Figure 3-3. The percentage contribution of each segment varies little over the forecast period from 1993 to 1998 with the exception of mobile, where we expect equipment production to grow from $6.2 billion to $8.0 billion.

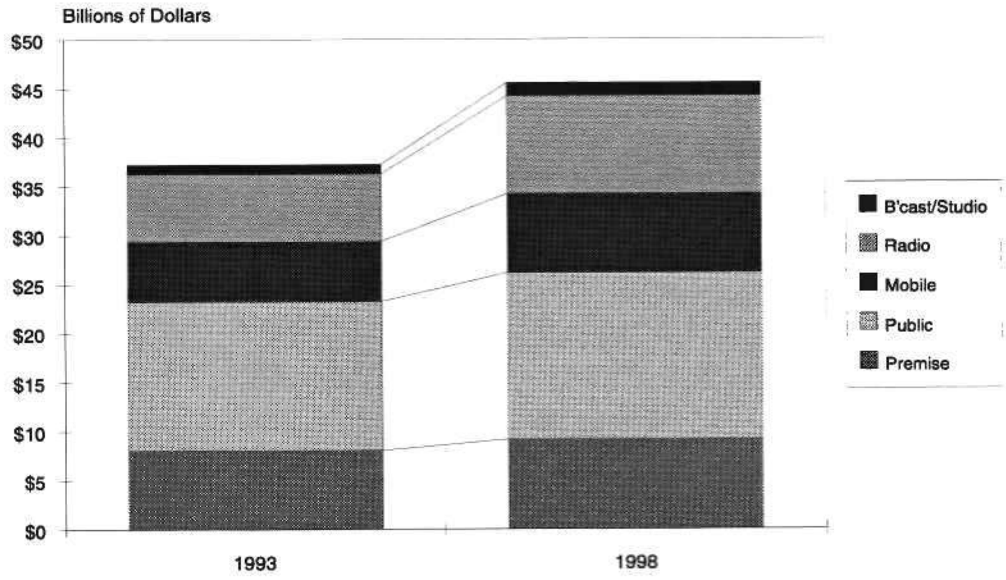
Public Telecoms Equipment

Figure 3-3 shows that the public telecoms equipment subsegment is one of the slowest-growing of all the communications sector, with a CAGR from 1993 to 1998 of 2.3 percent. The public telecoms subsegment comprises central office, transmission systems and access networks. This segment is dominated by central office and transmission systems; in 1993 they accounted for $15 billion of the $15.2 billion total.

Consolidation of the telecoms equipment sector continued in 1993, as seen in the following examples:

- Alcatel and Telettra
- AT&T and Amper
- Northern Telecom and STC

Figure 3-3
European Communications Equipment Growth by Segment, 1993-1998



Source: Dataquest (June 1994 Estimates)

Cable Transmission Systems

Throughout the latter half of the 1980s the market for cable transmission grew rapidly, reaching $2.4 billion in 1990. It is forecast to grow now only slowly for the rest of the forecast period. However, this small growth rate hides some dramatic changes in this market. There is now a very clear trend away from "old" technology to synchronous digital hierarchy (SDH)-based products.

The SDH market will grow very rapidly, exceeding $1 billion in 1995 and $2 billion in 1998. The market growth will be a result of increased volumes, which are to a certain extent balanced by falling prices. This growth has been driven by modernization programs and increasing levels of traffic from facsimile, mobile services and data services.

Central Office

The European central office market is mature: it peaked in 1991 and will decline steadily through the mid-1990s. The European public switched telephone network (PSTN) will continue to grow, exceeding 200 million local lines in use during 1996.

Access Networks

Sometimes called the local loop, this market includes equipment such as asynchronous digital subscriber loop (ADSL) and high bit rate digital subscriber loop (HDSL), fiber in the loop (FITL) systems, fixed radio access equipment and flexible multiplexers.

There are a series of interconnected, complex factors governing this market. New services, new technologies and liberalization encourage change, but on the other hand the current network adequately meets the demands of the largely residential market, and will be very expensive to upgrade. Any potential growth will be constrained by the availability of very adequate copper-based networks. Even the bandwidth requirements of video-on-demand to the home may now be met with the existing copper network, using the new technology ADSL.

Premise Telecoms Equipment

Figure 3-3 shows that the premise telecoms equipment subsegment is one of the slower-growing of the communications sector, with a CAGR from 1993 to 1998 of 2.7 percent. The premise telecoms subsegment primarily comprises terminal equipment, premise switching systems, data communications and image/text communications equipment.

Premise telecoms is the second largest subsegment, and is dominated by PBX/key telephone systems, accounting for 34 percent of this $8 billion equipment production market in 1993.

Other equipment categories in premise telecoms include facsimile, video teleconferencing, telex and videotex, and are all categorized as image and text communications equipment. The fastest-growing element of this is video teleconferencing, which will be dominated towards the end of the forecast period by desktop video teleconferencing.

Mobile Communications

The mobile segment CAGR of 5.5 percent hides some significant factors. This segment is split further into the following subsegments: cellular telephones; mobile radio base station equipment; and pagers and pager base station equipment. Cellular handset and infrastructure (base station) production is showing considerable unit equipment production growth over the forecast period. However, this subsegment is also witnessing the most aggressive price reduction pressure of any of the communications subsegments. Although unit production is increasing rapidly, price erosion is slowing the growth of the market value.

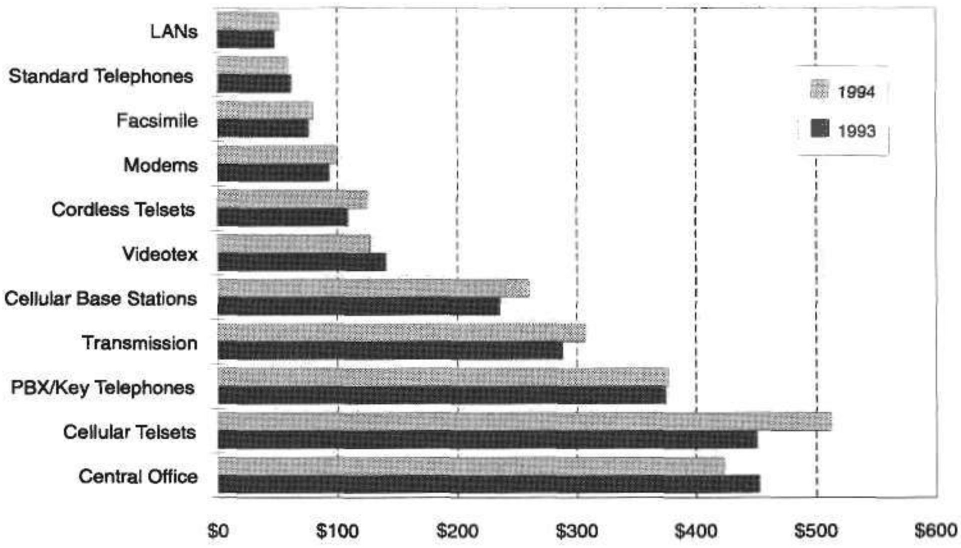
Semiconductor Demand by Equipment

Figure 3-4 shows the semiconductor demand of the major communications subsegments, the interesting factor is that the cellular telephone handsets proportion in 1993 is about the same size as central office. However, by 1994 we expect central office to contract and cellular handsets to power ahead, becoming the single largest market in the communications segment.

Key Enabling Semiconductor Technologies

Each of the telecoms segments has different demands on the semiconductor industry, in both growth rates and technology demands.

Figure 3-4
Top European 1993 Communications Markets for Semiconductors



Source: Dataquest (June 1994 Estimates)

As discussed earlier, Dataquest expects higher growth rates in the semiconductor market than in the equipment market, pointing to ever-increasing levels of semiconductor content in equipment; this is most evident in cellular handsets.

Compression technology, already implemented in voice telephony for digital cordless and digital cellular, will find higher-level applications in video decompression with the expected explosion in desktop video teleconferencing.

The enormous growth expected in cellular communications demand depends on the continued cost reduction of the semiconductor solution. This has opened up a major new challenge to the semiconductor industry to provide in high-volume, highly integrated, low-cost RF devices. This is especially true in RF power amplifiers, where there is a battle been fought between gallium arsenide (GaAs) and very high-speed bipolar solutions. A new entrant to this area could be silicon germanium (SiGe), which promises much but has yet to get real products to market.

Major Semiconductor Vendors in the Communications Segment

Table 3-2 shows Dataquest's 1993 estimates of the top 10 semiconductor vendors supplying the European communications sector. The communications segment is highly concentrated, with the top 10 vendors supplying 69 percent of the market. Also, the customer base for telecoms devices is highly concentrated upon the major equipment manufacturers such as Alcatel, Ericsson, Nokia and Siemens.

We estimate that Motorola continues to hold the top position in the telecoms sector, aided by its internal demand from cellular telephones and

Table 3-2
Top 10 Semiconductor Suppliers to Communications Segment 1992-1993
(Millions of Dollars)

1992 Rank	1993 Rank	Ranked Companies	1992 Sales	1993 Sales	1993/92 Growth
1	1	Motorola	283	428	51.2%
2	2	SGS-Thomson	260	310	19.2%
3	3	Siemens	182	252	38.5%
4	4	Philips Semiconductors	220	205	-6.8%
5	5	Texas Instruments	150	200	33.3%
9	6	AT&T	107	197	84.1%
7	7	AMD	135	181	34.1%
8	8	National Semiconductor	125	140	12.0%
6	9	Toshiba	113	139	23.0%
10	10	NEC	98	122	24.5%

Source: Dataquest (June 1994 Estimates)

infrastructure. The popularity of Motorola's range of microcontrollers and DSPs in telecoms further enhances its position.

SGS-Thomson Microelectronics has a wide-ranging portfolio of telecoms-specific, linear and discrete semiconductor products, and is the second-biggest supplier to the communications segment. Its strong long-term relationship with Alcatel, the largest telecoms equipment company in the world, has helped boost it to this position.

The company worthy of note is AT&T, with nearly all its sales into the communications section, in 1993 ranked in seventh position with $115 million of sales. This was nearly double its sales of 1992. AT&T has been particularly successful in supplying to Nokia.

Chapter 4
Semiconductor Demand in the European Consumer Market

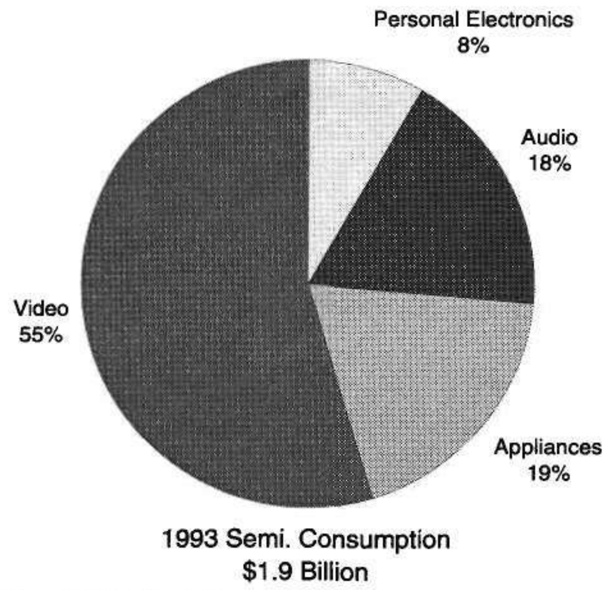
Market Overview

In terms of semiconductor markets, the largest single application market in consumer is television and videocassette recorders (VCRs). More than half of the European consumer segment semiconductor consumption is used in the manufacture and assembly of TVs and video recorders.

In terms of semiconductor consumption, European white goods production accounts for only 19 percent (Figure 4-1), while video equipment alone accounts for more than 54 percent of the consumer semiconductor total available market (TAM). Audio accounts for 18 percent of the consumer semiconductor market and the remaining 8 percent is personal electronics.

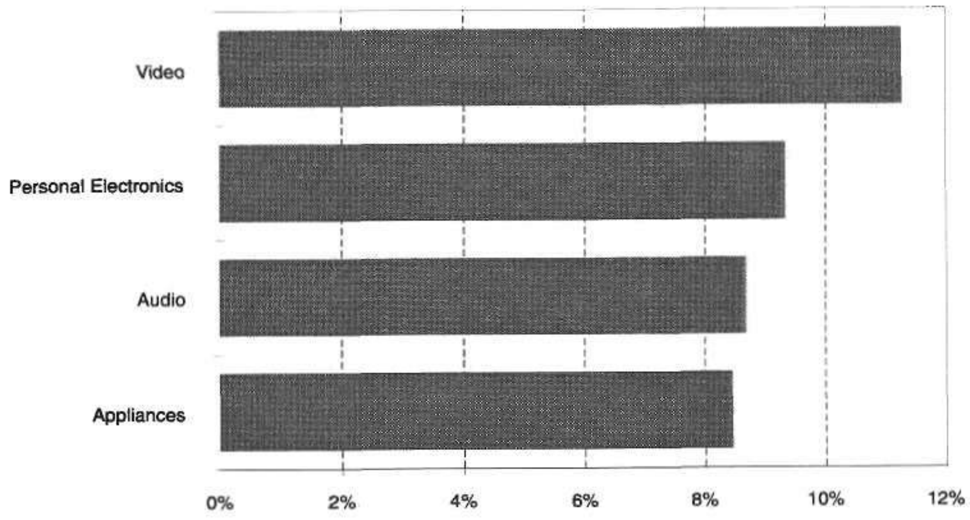
Video equipment production in Europe will continue to influence semiconductor market growth in the consumer electronics market. Combined TV and VCR semiconductor demand accounts for 55 percent of the TAM, with television alone accounting for 45 percent (Figure 4-2).

Figure 4-1
European 1993 Consumer Semiconductor Consumption by Segment



Source: Dataquest (June 1994 Estimates)

Figure 4-2
European Consumer Semiconductor Consumption by Segment—Forecast CAGR 1993-1998



Source: Dataquest (June 1994 Estimates)

Consumer as a Technology Driver

Consumer markets have lacked any new technology or innovation for many years. Existing products are serving mature markets where price and costs are established for homogeneous products. New technology in this market takes several years to catch on. High-definition television (HDTV) is an example of this, and the next new product will be digital TV. Digital television will be a semiconductor-rich application and will demand some of the most advanced technology that DSP and compression techniques have to offer.

Developments in digital technology are expected to lead to the development of digital television transmission and digital video for HDTV. Initially, HDTV was planned for an extension to the existing analog infrastructure in Europe implementing HD-MAC. Both HD-DIVINE and the ELG-DVB (European Launching Group for Digital Video Broadcast) propose to have digital television and HDTV ready by the end of 1996.

The reality in the television equipment market is that these products are serving mature markets where price and costs are established. It is therefore unlikely that the markets for these new-technology systems will take off in the initial years when prices of such systems are still high. New technology takes years to catch on in this volatile consumer market. As mentioned, HDTV is a good example of a technology which has not yet taken off, simply because of the high costs associated with these systems. Digital TV will be the next technology to be implemented for this market. Consumer markets offer volume production and will likely drive down costs when these systems are fully developed.

European Consumer Equipment Production Overview

Table 4-1 shows Fortune 500's 1992 estimates of the world's top 10 consumer equipment manufacturers and ranks them using their reported sales in 1992. Among the top 10 companies, 5 are Japanese, 3 are European, 1 US and 1 South Korean. The industry is therefore mostly dominated by the Japanese companies.

Importance of Consumer in European Electronics Equipment Production

The European consumer electronics market is estimated to contribute $17.4 billion (nearly 12 percent) to the total European electronic equipment production value of $147 billion. Dataquest places this segment among our six application market groupings as the fifth-largest segment by value, with the transportation segment being the smallest electronic equipment market.

The largest proportion of consumer equipment production is white goods (appliances such as microwave ovens, refrigerators and dishwashers), as shown in Figure 4-3, which account for nearly 71 percent ($12.0 billion) of the value of consumer electronic production in Europe. Video (accounting for 18 percent), personal electronics (6.4 percent) and audio (6.1 percent) are the next largest segments in that order.

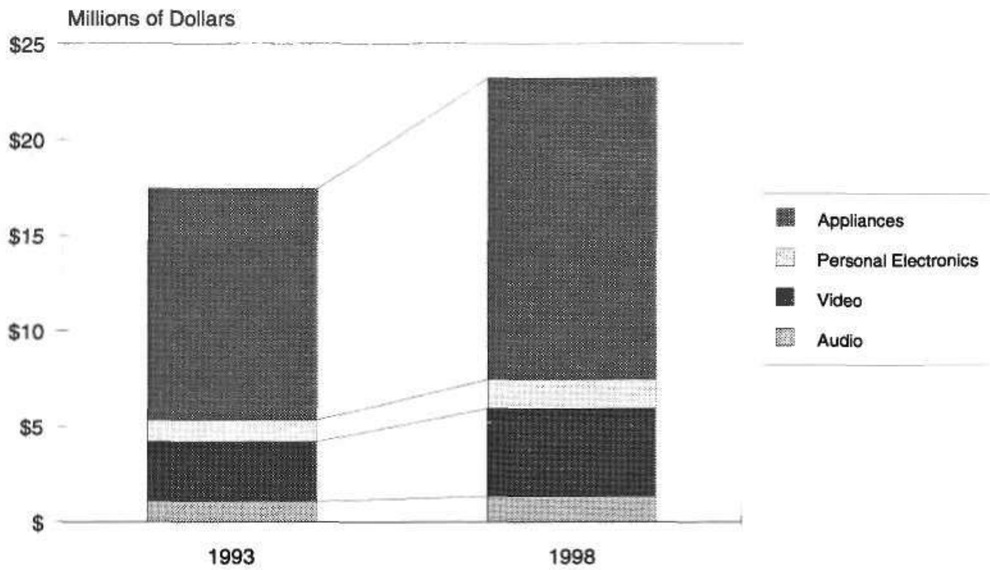
European consumer electronic equipment production is dominated by white goods electronics. Figure 4-3 shows the proportion that each of the consumer market segments account for the total. By far the largest segment by market value is appliances which, as mentioned,

Table 4-1
Worldwide Top 10 Consumer Manufacturing Companies in 1992 (Billions of Dollars)

Rank	Company	1992	Country
1	Matsushita	57.48	Japan
2	Samsung	49.56	South Korea
3	Toshiba	37.47	Japan
4	Philips	33.27	Netherlands
5	Sony	31.45	Japan
6	Mitsubishi	26.50	Japan
7	Electrolux	14.05	Sweden
8	Thomson	13.40	France
9	Sanyo	12.80	Japan
10	Westinghouse	12.10	USA

Source: *Fortune Magazine*

Figure 4-3
European Consumer Equipment Growth by Segment, 1993-1998



Source: Dataquest (June 1994 Estimates)

includes cookers, washers, dryers and other domestic equipment. This segment remains a potential market opportunity for the semiconductor industry as there is still a large opportunity for electronics penetration in many of these equipment.

Major Influences in Each Subsegment

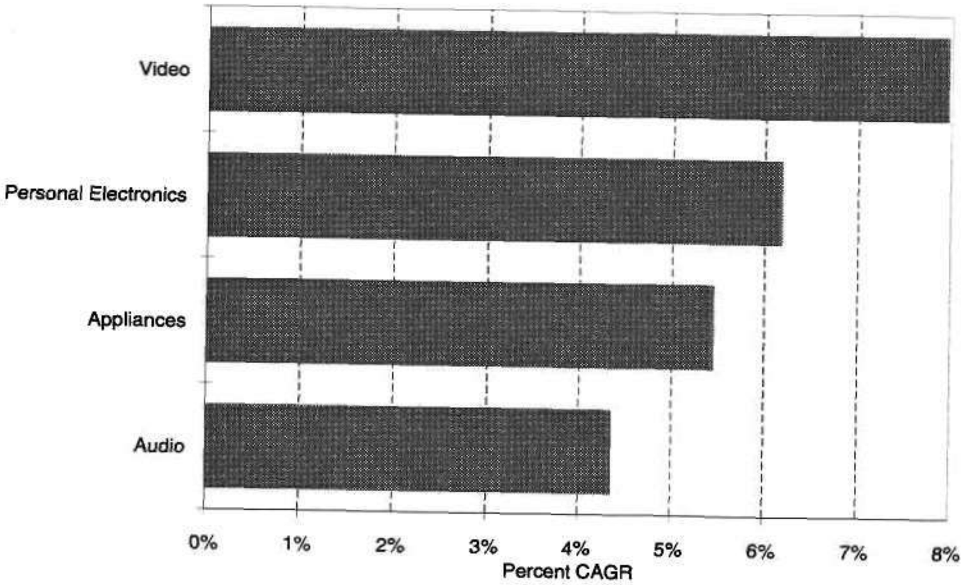
Although appliances account for the largest proportion of the consumer electronic production in Europe, it shows the second-lowest growth outlook towards 1998, as illustrated in Figure 4-4. This figure shows growth from video equipment leading the market segments, albeit from a low base in 1993 of $3.1 billion, compared with appliance equipment, which is growing from $12 billion in 1993. By 1998, video equipment will have reached only $4.5 billion, while appliance production in Europe will be worth $15.7 billion.

Market Share by Equipment Vendor in Each Segment

Refrigeration Appliances

Each of the equipment markets and manufacturers are very distinctly influenced by the channels of distribution of each product. In the last five years, many of the white goods manufacturers have been through a phase of consolidation through company acquisitions. In the refrigeration industry (Table 4-2), 61 percent of production is controlled by the top five players. The remainder is achieved by a large number of small to medium-size players which have established themselves as local players, especially in Italy.

Figure 4-4
European Consumer Equipment Production by Segment—Forecast CAGR 1993-1998



Source: Dataquest (June 1994 Estimates)

Table 4-2
1993 Top 5 Refrigeration* Appliance Manufacturers in Europe

Company	Percent Share in Units
Electrolux	20%
Whirlpool	16%
Bosch-Siemens Hausgerate	12%
Merloni	7%
Thomson	6%
Total in Units	17.5 million

* Refrigeration appliances include fridges, freezers and combinations
Source: Dataquest (June 1994 Estimates)

Cooking Appliances

The segment for cooking appliance equipment is slightly less consolidated than the refrigeration industry in Europe (Table 4-3). In this segment, 58 percent of production is controlled by the top 5 players and the remainder is accounted for by a wider number of players mostly specializing in niche market areas ranging from the high-tech, high-end sector to integrated coal/gas-fired domestic heating and water boiler/cooking appliances. For the vast proportion of

Table 4-3
1993 Top 5 Cooking* Appliance Manufacturers in Europe

Company	Percent Share in Units
Electrolux	27%
Bosch-Siemens Hausgerate	17%
Thomson	5%
AEG	5%
Whirlpool	4%
Total in Units	11.7 million

*Cooking appliances include grills, hobs, and ranges
Source: Dataquest (June 1994 Estimates)

this segment, Electrolux and Bosch-Siemens Hausgerate (BSHG) both control more than 40 percent of production.

Laundry Appliances

In laundry appliances, Whirlpool, the former Philips white goods company, is the market leader. In this segment, 64 percent of total production is controlled by the top five players. The remainder are mostly smaller national players and niche Scandinavian and Italian manufacturers which have established themselves in regions where climate exerts unique laundry requirements and customized equipment for these somewhat niche country markets.

Microwave Ovens

In the microwave oven segment (Table 4-5), the top 5 players control just over 50 percent of the market. Far Eastern and Japanese transplant assembly factories in Europe account largely for the remainder. Because this is a relatively new technology for the domestic market, and the technlogy leadership of these products lie within Japanese and Far Eastern countries, European players have concentrated mainly on assembly and less on product reasearch and development investment. Overall, the introduction of electronics to the white goods sector has met a very cautious reception from manufacturers which are operating in a highly cost-sensitive environment and cannot easily justify further investment expense for new product devlopment. Subsequently, few of these players buy directly from semiconductor vendors at the moment, preferring to subcontract modules and the necessary R&D required to subcontractors.

Dishwashers

Very few dishwashers are sold in Europe and subequently, few are made in Europe. Dishwasher ownership is still considered (in most parts of Europe) a luxury item and in unit terms accounts for the smallest proportion of the white goods market in Europe. The larger product diversified companies such as Electrolux, Whirpool and

Table 4-4
1993 Top 5 Laundry* Appliance Manufacturers in Europe

Company	Percent Share in Units
Whirlpool	17%
AEG	13%
Candy	12%
Merloni	11%
Thomson	10%
Total in Units	11.0 million

* Laundry appliances include washers, dryers and combinations
Source: Dataquest (June 1994 Estimates)

Table 4-5
1993 Top 5 Microwave Oven Manufacturers in Europe

Company	Percent Share in Units
Moulinex	15%
Electrolux	14%
Merloni	10%
Bosch-Siemens Hausgerate	8%
Whirlpool	7%
Total in Units	7.7 million

Source: Dataquest (June 1994 Estimates)

Table 4-6
1993 Top 5 Dishwasher Manufacturers in Europe

Company	Percent Share in Units
Electrolux	22%
Whirlpool	18%
Bosch-Siemens Hausgerate	14%
AEG	11%
Miele	10%
Total in Units	3.3 million

Source: Dataquest (June 1994 Estimates)

BSHG control more than 50 percent of production in Europe, but the market is still slowly developing.

Televisions and VCRs

Television production in Europe (Table 4-7) has become very competitive in the past few years as the market peaked at the end of the 1980s' economic boom. Coinciding with this was the ramping up of production by several large transplant operations in Europe such as Sony, which invested in both the United Kingdom and Spain to satisfy European market demands as well as to qualify for the "Made in Europe" labelling. (See also Table 4-8, which gives the top manufacturers for VCRs.)

This resulted in the exposure of the disadvantage of high labor costs in many European television manufacturing plants and made it more difficult for traditional European players to compete in this market. Subsequently, a proportion of production by some of the European companies, for example Thomson, has moved out of Europe into regions with low labor costs, such as Singapore.

Table 4-7
1993 Top 5 Television Set Manufacturers in Europe

Company	Percent Share in Units
Philips	16%
Sony	12%
Grundig	10%
Thomson	9%
Nokia	8%
Total in Units	19.0 million

Source: Dataquest (June 1994 Estimates)

Table 4-8
1993 Top 5 Videocassette Recorder Manufacturers in Europe

Company	Percent Share in Units
Philips	30%
Matsushita	16%
Grundig	11%
Sharp	10%
Hitachi	8%
Total in Units	6.0 million

Source: Dataquest (June 1994 Estimates)

Others have completely abandoned some of these factories and sold off to new players that are better positioned to utilize these plants. A good example of this is the acquisition by Gooding Electronics (which owns RACE, the UK subcontract house) of Grundig's TV factory in Creutzwald, France.

Dataquest predicts a consolidation of production by the major players at key European manufacturing locations. As technology advances, and barriers of national standards become less important, manufacturers will concentrate production activity at fewer locations in order to reduce costs. Smaller players will have to cope with pressures in the industry to cut costs. The development of digital technology in consumer applications will likely bring in some casualties and it will be the smaller players that will be the most vulnerable.

Future Product Trends

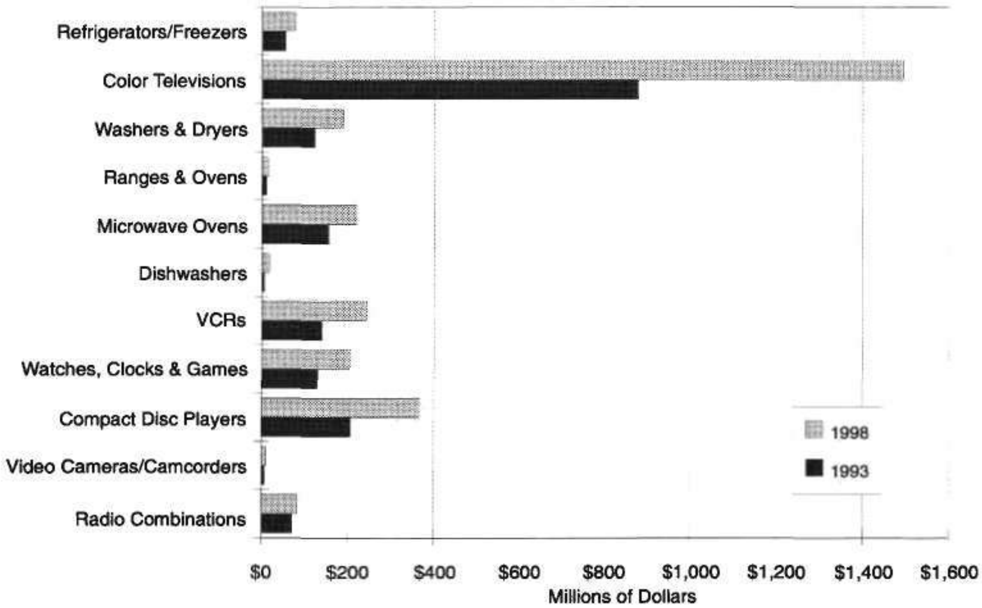
Dataquest forecasts certain consumer electronics markets to drive growth in the overall market, but this will also be partly offset by a shift in production by European manuacturers to specific low-labor-cost regions. The rapidly developing markets in certain countries of the Commonwealth of Independent States (CIS, the former USSR), and in China, Singapore and other Far Eastern countries, make it even more convenient to build up manufacturing capacity nearer these markets and at the same time benefit from the low costs that presently exist.

Semiconductor Demand Growth in Each Subsegment

The products in the consumer market which offer the fastest growth for semiconductors are shown in Figure 4-5. The fastest growth is coming from products with low volumes, while the lower rates of growth are on products that have reached market maturity.

Like the world markets, the European consumer electronics industry needs new products to stimulate future growth in this market segment. Dataquest believes that Europe will have its own digital TV service by the year 2000. We forecast that a digital television service in Europe will be accompanied by wide-screen HDTV. Digital television itself will also pave the way for other display technologies such as active matrix LCD. HDTV by itself is a semiconductor-rich technology and, combined with digital television, Dataquest forecasts growth in this area for semiconductor vendors.

Figure 4-5
Top European Electronic Equipment for Semiconductor Consumption, 1993-1998



Source: Dataquest (June 1994 Estimates)

Semiconductor Vendor Market Share in the Consumer Segment

Table 4-9 shows the top 10 semiconductor vendors' market shares for the European consumer segment. Philips ranks in first position, supplying 24 percent of the entire semiconductor requirement by European consumer electronics manufacturers. The next two vendors after Philips are SGS-Thomson and Motorola, which both account for 10.7 percent each of the consumer semiconductor TAM in Europe. Siemens has 8 percent share of the European consumer semiconductor TAM and ranks in fourth place. Toshiba is the first Japanese company to appear in the European consumer semiconductor market share ranking. The total sales of these top 5 players account for nearly 60 percent of the TAM.

The rest of the players in this market segment have less than 4 percent market share and therefore very little influence in this market.

There are some very niche players in the market share ranking that specialize in supplying television chip sets to the industry, and these players have experienced a similar growth in 1993, as did their major customers. Most semiconductor vendors in the ranking table showed some growth, although Mitsubishi showed the strongest growth in the top 10 ranking, with more than 50 percent.

Table 4-9
European 1993 Semiconductor Vendors to the Consumer Segment (Millions of Dollars)

1992 Rank	1993 Rank	Ranked Companies	1992 Sales	1993 Sales	1992/93 Growth
1	1	Philips Semiconductors	501	510	1.8%
2	2	SGS-Thomson	200	220	10.0%
3	3	Motorola	180	202	12.2%
4	4	Siemens	150	155	3.3%
5	5	Toshiba	91	104	14.3%
7	6	ITT	70	85	21.4%
NA	7	TEMIC*	NA	68	NA
6	8	NEC	73	60	-17.8%
11	9	National Semiconductor	40	40	0.0%
9	10	Mitsubishi	30	33	10.0%
		Total Market	1,718	1,889	10.0%

NA = not applicable
* This ranking includes, for the first time, TEMIC whose results were previously reported as the individual TEMIC companies—Telefunken, Matra MHS, Dialogue Semiconductors, Eurosil and Siliconix.
Source: Dataquest (June 1994 Estimates)

Chapter 5
Semiconductor Demand in the European Transportation Market

Market Overview

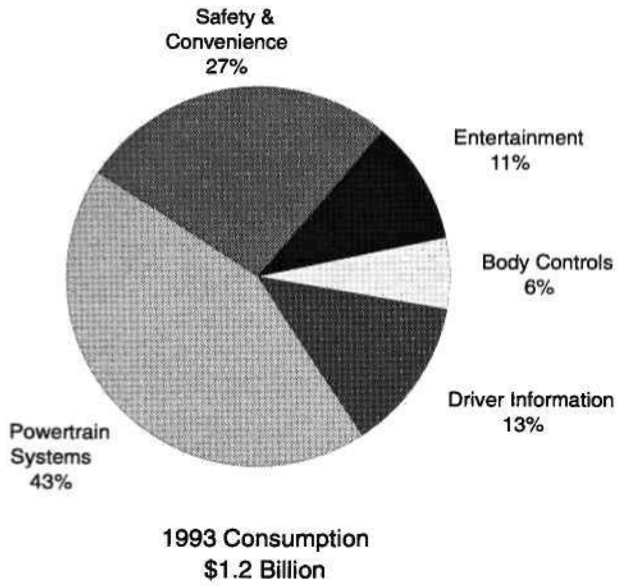
The semiconductor market from European transportation (automotive) is estimated by Dataquest to be $1.2 billion in 1993. The powertrain subsegment is the largest market for semiconductors, estimated at more than $500 million, as shown in Figure 5-1, but is forecast to grow at the slowest rate at 13 percent annually until 1998. This slowdown in growth is largely attributable to the maturity of engine/motor management systems in this segment, with nearly 100 percent penetration in cars produced in Europe, and very aggressive price pressure from car manufacturers. Most of the incremental growth in powertrain is forecast to come from spare parts, aftermarket and new powertrain applications.

Transportation Subsegment Semiconductor Consumption Growth

Total semiconductor demand for transportation applications is forecast to grow at 19.4 percent from 1993 to 1998. The growth drivers in this segment are body control electronics and safety and convenience electronics, as shown in Figure 5-2.

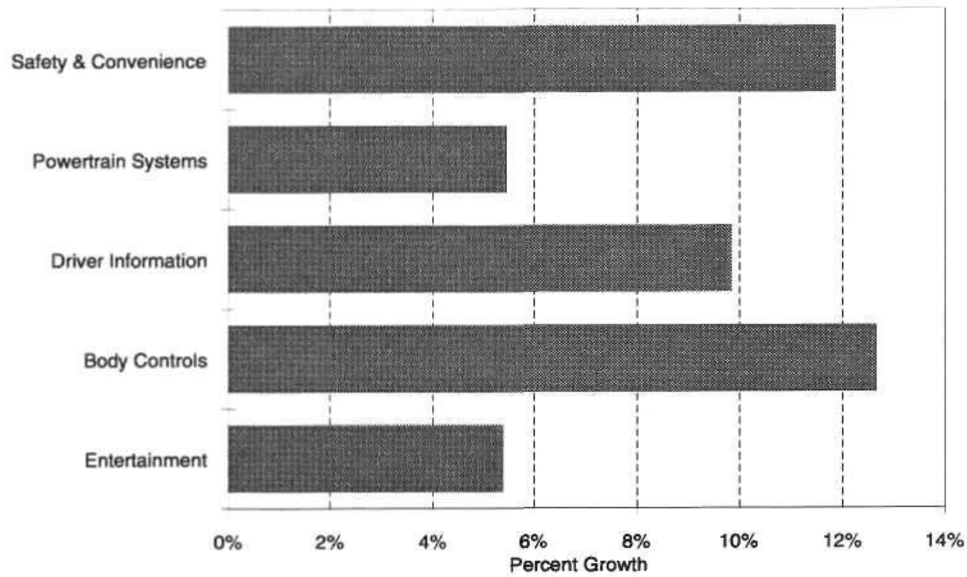
The fastest-growing market subsegment for transportation equipment is body control electronics, forecast to grow at an estimated 13 percent annually from 1993 to 1998. Antitheft devices and multiplexing

Figure 5-1
European 1993 Transportation Semiconductor Consumption by Segment



Source: Dataquest (June 1994 Estimates)

Figure 5-2
European Transportation Semiconductor Consumption by Segment 1993-1998



Source: Dataquest (June 1994 Estimates)

technology are both forecast to be key drivers of the demand for semiconductors in this segment.

The second fastest-growing subsegment, however, is safety and convenience applications at 11 percent from 1993 to 1998. Products in this category are yet to reach maturity. Airbag systems are forecast to grow fastest in this segment as dual front-passenger airbags begin to be introduced, and development for rear-passenger airbag systems also start to materialize. In terms of semiconductor demand, microchip consumption for safety and convenience applications will grow by an estimated 27 percent annually from $412 million in 1994. By 1998, Dataquest forecasts that semiconductor demand for this subsegment will approach $880 million by value.

The other subsegments in transportation (entertainment, driver information and powertrain electronics) are forecast to grow below the overall semiconductor TAM growth for the period from 1994 to 1998.

Semiconductor demand from in-car entertainment is forecast to show growth of nearly 17 percent until 1998, through increased semiconductor content for digital systems—digital technology for radio and tape/disc media systems. In contrast, in-car entertainment equipment production is forecast to grow at 5 percent annually until 1998. In-car CD players are now poised for growth, and with the introduction of in-car digital compact cassette (DCC) and Minidisc players imminent, the growth in semiconductor demand for this market segment is forecast to average 17 percent annually until 1998. Dataquest believes that developments in storage technology and global positioning will allow car navigation systems to merge into in-car entertainment systems. Many existing car radio manufacturers are expected to offer navigation equipment in the future.

Driver information systems including on-board computers, diagnostic systems, and dashboard electronics are expected to show a slower rate of growth in semiconductor demand, of 16 percent.

Powertrain electronic equipment is forecast to grow at 13 percent annually between 1993 and 1998. Dataquest believes that the semiconductor growth in engine control systems will come from tighter regulation on exhaust emissions.

Transportation as a Technology Driver

In the future generation of electronics infrastructure in cars, semiconductor technology advances in areas such as high-speed data transmission, wireless communication and video (multimedia) will play an increasingly important role.

In the data transmission area, we are already seeing the implementation of the controller area network (CAN) as a local area network (LAN) for engine management systems, and other types of data bus system for lower-speed applications. Several bus systems are being implemented in Europe, as most car manufacturers are using their own proprietary systems for data transmission at all data speeds.

Wireless communication systems and the infrastructure in place for GSM telephony is also providing a stimulus to car communication systems. Separately, developments in the wireless communication area and DSP are leading to the development of automatic tolling systems through the European Commission's DRIVE initiative and at national/local government level. An extension to these technologies is car identification systems that will help locate and identify vehicles.

Car identification systems opens up the possibilities for car security (antitheft), navigation, and positioning with the use of global positioning systems (GPS) technology. Car manufacturers are being faced with an unattractive proposition from insurance companies, which levy high premiums on motorists driving cars in the upper-middle- to high-end categories. To overcome these obstacles, manufacturers are developing systems that offer a solution to these problems. Electronic systems so far present the most viable solutions and are currently being considered by most European manufacturers for models in the 1994/1995 year. Dataquest believes that these systems will begin to spread across most car segments by the year 2000.

Major Transportation Electronic Equipment/Systems Manufacturing Companies in Europe

Table 5-1 shows the major transportation electronic equipment manufacturing companies in Europe and provides an estimate of the electronic systems production of these companies.

These company estimates are not intended as a ranking of the top automotive electronics companies in Europe, as they do not include revenues of specialist players such as, for example, electronic control modules manufacturers. Furthermore, some of these companies use subassembled modules from first- and second-tier suppliers to build a complete system.

Table 5-1
1993 Major Transportation Equipment Manufacturers in Europe (Millions of Dollars)

Company	1993 Production
Robert Bosch	$2,799
Siemens Automotive	$856
Ford Electronics	$679
Magneti-Marelli	$630
Valeo	$630
Telefunken Microsystems	$633
Mannesmann (VDO & Fichtel Sachs)	$532
Lucas	$550
Philips	$271
Hella	$187

Source: Dataquest (June 1994 Estimates)

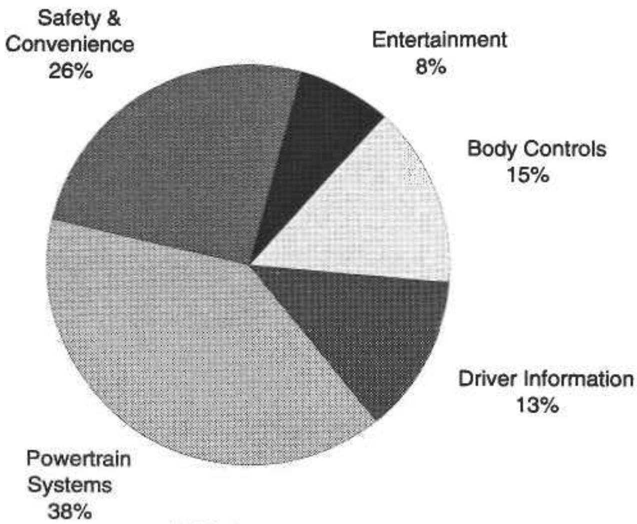
European Transportation Equipment Production Overview

Figure 5-3 shows an overview of electronic equipment production in the transportation segment. Powertrain systems dominate European electronic systems production for transportation applications. Legislation introduced in 1992 by the European Commission mandates the use of catalytic converters for petrol engine cars to reduce toxic pollutants, particularly carbon monoxide.

Catalytic converters rely on lambda sensors, which are controlled by an electronic control unit similar to engine management systems. It is more effective to use these control units as motor/engine management systems, hence almost all cars manufactured for sale in Europe are being fitted with electronic engine/fuel injection modules.

The legislation in 1992 has spurred growth of the powertrain segment to account for nearly 40 percent of electronic equipment production for the transportation segment.

Figure 5-3
European 1993 Transportation Electronic Equipment Production



Source: Dataquest (June 1994 Estimates)

Safety and convenience is the second-largest subsegment, followed by body control systems. The following highlights the key applications that are driving these segments:

- Transportation electronic equipment production in Europe is forecast to grow by nearly 9 percent annually until 1998. Body control electronics represents the fastest-growing market segment followed by safety and convenience electronics.
- Body control electronic equipment production is forecast to grow by an average of nearly 13 percent annually until 1998. Most of the growth in this market segment will be attributable to door, mirror and roof electronics and antitheft systems. Module-to-module communication electronics will also begin to take off from 1998 as multiplexed bus systems begin to gain entry into car applications.
- The safety and convenience segment is forecast to grow by nearly 12 percent annually throughout the forecast period ending 1998. Air bag systems, ABS and traction control electronics are among the fastest-growing systems contributing to this growth. Both airbag and ABS systems are finding their way into volume production car models, while traction control is being used for high-performance cars, and for heavy goods vehicles (HGVs) and trucks. Automatic locks (remote door-locking systems) and memory seat applications are also forecast to drive growth in this market segment.
- Other areas of growth will include climate control systems, advanced car entertainment systems, and car navigation systems. All of these systems represent a convergence of technology in the dashboard area.

Semiconductor Vendor Market Share in the Transportation Segment

Siemens has moved into joint number-one position with Motorola as the leading semiconductor vendors in this market segment. Siemens' rapid acceleration to gain market share in this segment is attributable to the success of the company's strategy to become a major player in automotive electronics. In the 1980s, Siemens established its automotive systems group and during 1988 acquired Bendix's engine control systems group. Siemens, a vertically integrated company, has also developed a successful alliance with Volkswagen, the leading German car manufacturer, which has helped Siemens grow its systems business.

SGS-Thomson ranks in third place with mostly specialized dedicated automotive ICs and in-car entertainment audio ICs. The depressed Italian and French car markets did not help, but the company managed to grow its business by 10 percent in this application segment.

Philips reached the $100 million mark in 1993 including sales to car entertainment equipment manufacturers, which is Philips' major strength in this segment. The rest of the players in this market segment had sales of less than $55 million. National Semiconductor declined slightly in 1993, while TEMIC is shown for the first time as a single player in this newly formed business group.

Texas Instruments effectively did not change its position in the market share rankings and remained in seventh position as a result of TEMIC (mostly the former Telefunken) and National Semiconductor maintaining their positions.

The first Japanese player to gain entry in the top 10 transportation segment market share rankings is NEC, which doubled its sales in this segment to reach tenth place from number 14 in the previous year.

Table 5-2
Preliminary Transportation Segment Semiconductor Market Share Ranking (Millions of Dollars)

1992 Rank	1993 Rank	Ranked Companies	1992 Sales	1993 Sales	1993/92 Growth
1	1	Motorola	129	151	18.0%
2	1	Siemens	128	151	17.1%
3	3	SGS-Thomson	110	125	13.6%
4	4	Philips Semiconductors	98	90	-8.2%
5	5	National Semiconductor	55	54	-1.8%
NA	5	TEMIC*	NA	54	NA
7	7	Texas Instruments	40	52	30.0%
9	8	Intel	34	51	50.0%
8	9	ITT	35	33	-5.7%
14	10	NEC	15	31	106.7%

NA = not applicable
* This ranking includes, for the first time, TEMIC whose results were previously reported as the individual TEMIC companies—Telefunken, Matra MHS, Dialogue Semiconductors, Eurosil and Siliconix.
Source: Dataquest (June 1994 Estimates)

Appendix A
Definitions and Methodology

This report contains detailed information on Dataquest's view of European electronic equipment production. Electronic equipment production is an important determinant of semiconductor market activity because semiconductor demand is derived, in part, from the underlying demand for the systems that use semiconductors. Therefore, the forecast of expected electronics systems production is an essential component to assessing future semiconductor market activity.

Changes in Definitions

Ex-factory revenue is used throughout this report, rather than end-user revenue. Ex-factory revenue measures the value of equipment as they are shipped out of a factory. End-user revenue takes into account retailing costs such as distribution costs, wholesale overhead costs, storage costs, and other additional costs that are not associated with the production side of equipment costing.

Segmentation

This section outlines the market segments specific to this report. Dataquest's objective is to provide data along the lines of segmentation that is logical and appropriate to the industry in question.

Dataquest defines the electronic equipment industry as the group of competing companies primarily engaged in manufacturing electronic goods. For the purposes of this report, important products of the electronics industry include data processing equipment, communications equipment, selected types of industrial equipment, consumer electronics, selected types of military and civil aerospace and defense-oriented electronics, and automotive electronics.

For forecasting purposes, Dataquest segments the electronics industry into six broad semiconductor application markets, desegregated into narrower electronic system groups, as follows (for detailed definitions of these segments, see later in this appendix):

- **Electronic data processing**
  - Computers
  - Data storage
  - Input/output devices
  - Dedicated systems
- **Communications**
  - Premise telecommunications
  - Public telecommunications

- Mobile/radio communications equipment
- Radio
- Broadcast and studio equipment

- **Industrial**
  - Security and energy management systems
  - Manufacturing and instrumentation systems
  - Robot systems
  - Medical equipment
  - Other industrial equipment
- **Consumer**
  - Audio
  - Video
  - Personal electronics
  - Appliances
- **Military/civil aerospace**
- **Transportation**

Exchange Rates

Dataquest uses an average annual exchange rate for each European country for converting revenue to US dollar values. When forecasting electronic equipment production, it is important to maintain consistency and continuity, thus we maintain exchange rates at constant 1993 calendar year. This prevents any inconsistencies in the conversion of growth projections and currency fluctuations. The 1993 exchange rate estimate uses actual average monthly exchange rates from January through December (data are gathered and supplied by the Dun & Bradstreet Corporation). The annual rate is estimated as the arithmetic mean of the 12 monthly rates. Exchange rates are provided in Table A-1 for your reference. Exchange rates for historical years are available on request.

Table A-1
1993 Exchange Rates

Country	Foreign Currency per US Dollar	US Dollar per Foreign Currency
Austria (Schilling)	11.65	0.08180
Belgium (Franc)	34.67	0.02778
Denmark (Krone)	6.4901	0.1478
ECU	0.858	1.11647
Finland (Markka)	5.7317	0.17671
France (Franc)	5.6717	0.16930
Germany (Mark)	1.6556	0.5752
Greece (Drachma)	229.33	0.004004
Hong Kong (Dollar)	7.7235	0.12945
Ireland (Punt)	0.6829	1.4266
Italy (Lira)	1,577.85	0.0005886
Netherlands (Gulden)	1.8583	0.5137
Norway (Krone)	7.1054	0.1334
Portugal (Escudo)	161.08	0.005687
Spain (Peseta)	127.87	0.007058
Sweden (Krona)	7.8217	0.1232
Switzerland (Franc)	1.4803	0.6785
United Kingdom (Pound)	0.6763	1.4917

Source: Dun & Bradstreet, Dataquest (June 1994)

Definitions

This section lists the definitions used by Dataquest to present the data in this document. For a detailed explanation and a complete listing of all definitions, please refer to the Dataquest publication, *Semiconductor Market Definitions,* SCND-WW-GU-9301 in your **Semiconductors Core** binder.

Application Definitions

Electronic systems groups comprise the following specific electronic equipment types:

- **Electronic Data Processing**
  - *Computer systems*: Includes supercomputers, mainframe computers, midrange computers, workstations, personal computers (including personal digital assistants, or PDAs)
  - *Data storage devices*: Includes fixed/rigid disk drives, flexible/removable disk drives, optical disk drives, tape drives (streamers), and solid-state storage devices (including PCMCIA memory cards)

- *Input/output devices* (including the previous categories, terminals and input/output devices): Includes alphanumeric terminals, graphics terminals, monitors, printers, media-to-media data conversion, magnetic ink character recognition, optical scanning equipment, plotters, mice, keyboards, digitizers, and other input/output devices
- *Dedicated systems*: Includes electronic copiers, electronic calculators and personal organizers, smart cards (IC cards), dictating/transcribing equipment, electronic typewriters and dedicated word processors, banking systems and funds transfer systems and terminals, point-of-sale terminals and electronic cash registers, and mailing/letter-handling/addressing equipment

- **Communications**
  - *Premise telecoms equipment*: (Sometimes referred to as "customer premise equipment") Includes:
    - Image and text communications, such as facsimile and facsimile cards, and video teleconferencing
    - Data communications equipment such as modems and modem cards, statistical multiplexers, T1 multiplexers, front-end processors, DSU/CSU, protocol converters, local area networks (LANs), internetworking, network management and packet data switching/wide area networks (WANs)
    - Premise switching equipment such as PBX telephone equipment and key telephone systems, interactive voice response systems, call accounting, and automatic call distributors (ACDs)
    - Desktop terminal equipment, such as telephone sets/pay telephones and cordless telephones, and teleprinters

    Please note: We have excluded cellular telephones from this category, as it is now included in the newly defined mobile/radio communications equipment segment.
  - *Public telecoms equipment*: Includes:
    - Transmission equipment such as multiplexers, carrier systems, microwave radio, laser and infrared transmission equipment, and satellite communications equipment
    - Central office switching equipment
  - *Mobile/radio communications equipment*: Includes cellular telephones (including microcellular telephones (for example, CT-2, DECT, GSM and PHP), mobile radios and mobile radio base station equipment; portable radio receivers and transmitters; radio checkout equipment; and other RF communications equipment, and pagers and accompanying base station equipment

- *Radio*: Includes airborne, marine, and ground systems sold as complete packages that include transceivers, power amplifiers, antennae, repeaters, transmitters, checkout (testing), monitoring, evaluation, and other equipment including terminal and broadcast equipment
- *Broadcast and studio equipment*: Includes audio equipment, video equipment, transmitters and RF power amplifiers, studio transmitter links, cable TV equipment, closed-circuit TV equipment, and other equipment such as studio and theatre equipment

■ **Industrial**

- *Energy/security management systems*: Includes alarm systems, such as intrusion detection and fire detection systems and energy management systems
- *Manufacturing and instrumentation systems*: Includes semiconductor production equipment, controllers and actuators, sensor systems, management systems, semiconductor-dedicated automatic test equipment (ATE), all other ATE, oscilloscopes and waveform analysers, nuclear instruments, and other test and measuring equipment
- *Robots*: Includes automated material handling, robot systems, robot-aided laser equipment, and robotic systems
- *Medical equipment*: Includes X-ray equipment, ultrasonic and scanning equipment, blood and body fluid analysers, patient monitoring equipment, and other diagnostic and therapeutic equipment
- *Other industrial equipment*: Includes power supplies, traffic control equipment, industrial and scientific research equipment, other industrial electronic equipment such as vending machines, laser systems, and teaching machines and aids

■ **Consumer**

- *Audio equipment*: Includes compact disc players, radio combinations, stereo hi-fi components, amplifiers, preamplifiers, tuners, cassette decks, graphic equalizers, turntables, speakers, equipment used in studio broadcast and home environments (equipment that interpret frequencies corresponding to audible sound waves), and musical instruments
- *Video equipment*: Includes video cameras and camcorders, videocassette recorders/videotape recorders, and color, monochrome and LCD televisions, and cable set-top and satellite set-top equipment (decoders)
- *Personal electronics*: Includes electronic game systems and cartridges, electronic toys, cameras, watches and clocks

- *Appliances*: Includes air conditioners, microwave ovens, washers and dryers, refrigerators/freezers, dishwashers, and ranges and ovens

- **Military and Civil Aerospace**
  - Includes *military electronics* such as radar and sonar, missiles and weapons, space-related electronics, communications and navigation equipment, electronic warfare, aircraft systems, military computer systems, simulation systems, and military electronics not elsewhere classified; and *civil aerospace* electronics such as radar, space-related electronics, communications and navigation equipment, flight systems, and simulation systems

- **Transportation (Automotive)**
  - Includes *in-car entertainment* systems such as AM/FM radio, cassette, compact disc players, and radio cassette combination systems; *body controls* (chassis) such as multiplex systems, lighting controls including automatic headlight systems, timers, reminders, and sequential signal controls, and other body controls including aerodynamic aid control and power window/roof controls; vehicle controls such as steering control, 2WD/4WD control, suspension control and traction control, active suspension, collision avoidance systems, collision warning systems, and cruise control; *driver information* systems such as dashboard/instrument clusters, analog or digital clusters, electronic analog/digital clocks and compasses, electronic thermometers, head-up displays, navigation and location systems, signal and warning lights, and trip computer; *powertrain systems* such as engine management systems, ignition control, fuel injection systems, and transmission control; and *safety and convenience* systems such as climate control systems, airbag control systems, automatic/interval wiper, keyless entry and door locks, security systems, memory seats, memory steering, memory mirrors, automatic seat belt systems, and antilock braking systems

Regional Definitions

- **Europe**: Western Europe includes Benelux (Belgium, Netherlands, Luxembourg), France, Italy, Germany (including the former East Germany), Scandinavia (Denmark, Finland, Norway, Sweden and Iceland) United Kingdom and Eire (Ireland), and the Rest of Western Europe (Austria, Gibraltar, Greece, Liechtenstein, Malta, Monaco, Portugal, San Marino, Spain, Switzerland, Turkey, Andorra and Vatican City, and Eastern Europe)
  - *Eastern Europe*: Includes Albania, Bulgaria, Czech Republic, Slovakia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Republics of former Yugoslavia, Ukraine, Belarus, Georgia, Russian Federation, Moldavia, Armenia, Azerbaijan, Kazakhstan, Uzbekistan, Tadjikistan, Kyrgyzstan, and Turkmenistan

Line Item Definitions

The objective of analysing electronic systems production is to estimate its important implications for semiconductor consumption.

The value of production is estimated as ex-factory revenue. Dataquest defines factory revenue as the money exchange value of the commodity transaction between the original equipment manufacturer and the point of entry into distribution. In the case of a direct sale that involves no distribution—as is the case with military systems—factory revenue is equal to the final user cost, net of sales taxes. For the purposes of this report, Dataquest defines ex-factory revenue as the derived production revenue from the factory value.

Data Sources

Production data have been consolidated from a variety of sources, each of which focuses on a specific part of the market. From time to time, we conduct production surveys for specific types of electronic equipment and the data gathered are also incorporated into the database. Our other sources include the following:

- Dataquest's estimates of systems manufacturers' end-user revenue
- Trade association data
- Various European Union and government agency statistics
- Japanese government and trade association (MITI, MOF, and EIAJ) intelligence
- Estimates presented by knowledgeable and reliable industry spokespersons
- Published product literature and prices
- Other Dataquest research groups (including Computer Systems and Peripherals, Telecommunications, and Document Management)

Unlike in Japan and the United States where government bodies supply regular production statistics, a Europe-wide statistic program is in its infancy; we believe that the estimates presented here are the most reliable and meaningful generally as applicable to the components manufacturers.

Forecast Methodology

Dataquest uses a variety of forecasting techniques (both qualitative and quantitative) that vary by technology area. Dataquest follows a three-step process to forecast electronic equipment production. First, current and expected future worldwide and European macroeconomic conditions are assessed and forecast. Dun & Bradstreet Corporation information is used to develop the macroeconomic forecasts for the world's major economies—the Group of Seven (G7) countries. This forecast identifies trends in the economic health of the world's leading consumers and producers of electronic equipment. Using this forecast in conjunction with input from other Dataquest industry sources (as identified earlier), Dataquest estimates the overall business climates in which the electronic systems market will operate.

Second, Dataquest analyses and forecasts the significant long-range trend and outlook in the various electronic system research groups (within Dataquest). This establishes a five-year trend growth path for electronic system production.

The final step in the forecast process is to reconcile expected fluctuations about market trends so that they do not inexplicably diverge. Dataquest anticipates that in the absence of shocks to the market, market fluctuations converge toward a long-term trend.

Because the time series data contained in this report comprise, in general, annual observations, and are sparse in terms of the number of observations, the data generally do not satisfy the requirements of quantitative empirical techniques such as econometric or statistical time series models. Therefore, in most cases, we have used judgmental models (that is, intuitive judgments, expert opinions, and subjective probabilities) or technological models (that is, curve fitting and the use of analogous data).

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SEMICONDUCTORS APPLICATION MARKETS EUROPE
Volume II

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Driver Information Becomes Multimedia-in-the-Car!
The development of in-car driver information systems was the first entry for semiconductor application into cars—car radios. As technology advances, more information could be received by the car to improve safety and security, aid route planning, reduce/control traffic, overall vehicle control, and for cars to cause less environmental harm. This *Dataquest Perspective* is a report on activities from the First World Congress on ATT and IVHS held in Paris, France from November 30 to December 3, 1994.
By Mike Williams

Driver Information Becomes Multimedia-in-the-Car!

Executive Summary

The main focus of the world's first congress for advanced transport telematics[1] (ATT) and intelligent vehicle highway systems (IVHS) was towards a global effort to reduce or eliminate road traffic congestion, and environmental pollution. Improved road safety and driver information also featured high on the agenda, to reduce road accidents and improve the flow of traffic and traffic information.

The congress, hosted by the French government, was organized by ERTICO (European Road Transport Telematics Implementation Coordination Organisation), ITS America (Intelligent Transport Systems), VERTIS (Vehicle Road and Traffic Intelligence Society of Japan), and the European Commission. A highlight of the congress (attended by more than 2,000 delegates) was an exhibition by more than 70 companies and organizations worldwide which have been involved in various research projects aimed at providing solutions for all the areas described above.

Seven demonstration cars were also available for delegates from the European Commission's PROMETHEUS (Programme for a European Traffic with Highest Efficiency and Unprecedented Safety) trial projects. This *Dataquest Perspective* presents an update of developments in this area planned for cars of the future—intelligent cars!

1. Telematics involves the combination of computing and telecommunications for driver and traffic information systems.

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Introduction

The entire area of road transport informatics (RTI) and its importance for car manufacturers is drawn from existing and future state-of-the-art technologies from the communications, computer and consumer electronics industries. RTI as a concept brings together these technologies into cars and on roads or along road networks.

Transport "telematics" is the term associated with computer and telecommunications applications for driver information systems. Telematics now covers multimedia applications involving the FM (analog) RDS (Radio Data Systems)/TMC (Traffic Message Channel), GSM (Global System for Mobile Communications) and global positioning systems (GPS), using satellites from the backbone of the future applications of electronics in cars and road transport management systems.

The three major worldwide producing regions (Europe, the United States and Japan) have been directed in their research and development for telematics and IVHS by leading regional/national level government administrations such as the European Commission's ERTICO in Europe, ITS America in the United States, and VERTIS in Japan.

In all three regions, smaller research groups have been formed to research special areas of the complete structure. The structures cover wide-ranging areas such as traffic information road signs, radio broadcast of traffic information, improved car safety, fuel efficiency (environment), road tolling, car identification, and in-car information systems. The entire concept of intelligent highways and smart cars is known as IVHS by the Americans, vehicle information communication systems (VICS) by the Japanese and road transport informatics (RTI) in Europe.

The emerging interface in cars that will display and relay traffic information is evolving around LCD car navigation systems using digital maps and car audio systems. Latest generations of car navigation and information systems include dynamic functions that allow for real-time traffic information processing and dynamic route guidance. Major setbacks in bringing products to the market revolve around political issues such as road tolling, and vehicle identification; and technical issues such as availability of digital road maps and data broadcast technologies/radio frequency allocation by national governments.

Common Objectives

The common objectives of the three major regions involve linking traffic information databases of the police, emergency services, automobile associations, radio stations and other sources such as roadside traffic monitoring systems to a central control office.

These data would then be made available to radio broadcasters or operators that would provide the data using radio (for example, RDS/TMC, and GSM) or satellite transmission. These broadcasts will provide real-time traffic information such as advance warning of road congestion, and other road conditions such as flooding, snow, ice, or oil spillage that could be used for dynamic route guidance.

Global research activities broaden to include roadside transponders, road sensors, beacons, and other infrastructural areas including road safety enhancements. These projects extend to cover service-oriented areas such as advanced car parking (reservations and parking management), restaurants, hotels, and "park-and-ride" public transport systems.

To reach this goal by the year 2000, some of the newest systems for cars in this area will soon include the following technologies:

- Smart cards—conditional access and prepayment facilitator
- LCDs for navigation systems—video/text information display, route guidance display
- Alphanumeric character modules for traffic information—low-cost text information display
- Ultraviolet/infrared head lamps for improved visibility—enhanced night vision
- Electronic mirrors using cameras—obstacle detection, cooperative driving
- Head-up displays (HUD)—driver warning information display
- Autonomous intelligent cruise control—safety and traffic flow control
- GSM—digital
- RDS/TMC—analog FM
- GPS (using satellite)—vehicle location and position

This *Dataquest Perspective* focuses on in-car applications of these research projects that are likely to impact automotive semiconductor markets.

In-Car Research Activities by Exhibitor

Research programs for the ATT and IVHS areas have been performed through a series of global activities. Participants of these research projects are mostly car manufacturers, telecommunications equipment manufacturers and service providers, radio manufacturers, car electronic systems manufacturers and some specialist suppliers to the military and civil aerospace industries.

This section provides an update of each company's or organization's latest products and development plans (as stated earlier, this *Dataquest Perspective* only covers those companies that are developing in-car electronic systems for ATT/IVHS applications):

AT/Comm Inc., USA: A microprocessor-based "smart transponder" read/write device, with configurable memory/storage. Multiple prepaid account balances can be maintained in a single device for road tolling, road pricing, automated parking, and so on. An LCD displays the account balance and a voice synthesizer warns of low funds prior to a road pricing zone.

CARMINAT, France: The CARMINAT project is a spin-off from the Eureka project, now part of the DRIVE-II project. CARMINAT (comprising Renault, TDF-TéléDiffusion de France, and the Lyonnaise des Eaux Dumez) has developed four types of driver information system based on RDS/TMC (using the Alert-C protocol):

- A traffic information system by speech synthesis using a memory card and RDS
- A traffic information system on color graphics screen providing route information, such as car parks, restaurants, hotels, petrol stations, and so on
- Graphical information system with GPS for positioning capability and "dead reckoning" incorporating all features in the first two systems
- Philips' Carin system incorporating all the above plus CD-ROM digital map source and dynamic route guidance

Sagem developed the first three systems above, and the fourth is based on Philips' Carin navigation system.

Defence Research Agency (DRA), United Kingdom: The DRA is a UK government agency established to coordinate research into the military/ defense areas and identify market opportunities for UK companies in this area. The DRA has recently set up a DRA transportation branch that is exploring areas where its expertise could be leveraged—areas such as head-up-display technology, infrared vision enhancement system, thermal image detection systems, and collision avoidance/intelligent cruise control systems.

Delco Electronics Corporation, USA: Delco is a subsidiary of General Motors, that designs and builds automotive electronic components. Delco presented a GPS-based/dead-reckoning, dynamic car navigation system (known as Telepath 100) with audio and real-time route guidance capability. The Telepath 100 system uses an 8-bit microprocessor.

Gilardini SpA, Italy: Gilardini is now a wholly owned subsidiary of Magneti-Marelli (the Fiat auto electronics company). Gilardini has developed an integrated color LCD route planner and GPS mobile navigation system for dynamic route guidance. The Gilardini system offers an RDS/TMC interface and uses a CD-ROM map that can provide synthesized voice guidance.

Motorola, USA: Motorola's Automotive and Industrial Electronics Group (AIEG) presented its latest GPS engines for ATT/IVHS applications. Motorola is also participating in the US ADVANCE (Advanced Driver and Vehicle Advisory Navigation Concept) project (1992 to 1997) for which the company has developed a dynamic GPS-based navigation and route guidance system, using high-speed data radiocommunications.

Nippondenso Co. Ltd., Japan: Nippondenso of Japan showed its new mobile information unit and terminal (MIUT), a GPS-based map navigation system which uses a PCMCIA format map and fits into a DIN slot. The MUIT uses a 32-bit RISC processor and has the ability to port to several types of communications device for dynamic navigation.

Philips Car Systems, Germany: Philips presented its masterpiece Carin navigation system. Carin is the only system to be sold in Europe by a car manufacturer (BMW). The Carin system is a dynamic route navigation and guidance system using CD-ROM maps, GPS, and RDS/TMC for real-time traffic information processing. It has a voice synthesizer which provides voice guidance.

PSA Peugeot Citroën, France: PSA participated in 13 separate PROMETHEUS pilot projects involving one concept car and 12 prototypes that demonstrated several research themes ranging from enhanced vision, lane-keeping support, collision avoidance, cooperative driving, intelligent cruise control, traffic information and route guidance systems.

Rockwell International Corporation, USA: Rockwell showed GPS modules for car navigation systems. The latest generation is a credit-card-sized GPS engine, and the company is believed to be working on a 60 percent form reduction for next-generation GPS modules.

Saab Scania Automobiles, Sweden: Through Saab and Sweden's involvement in the PROMETHEUS project, a head-up-display driver information system was developed with Delco for an intelligent cruise control. The Saab/Delco HUD uses a CAN bus for on-board communication, and a 5.8-GHz microwave link for short-range communication; and a laser-based optical sensor for collision avoidance measurements.

Siemens, Germany: Siemens displayed the latest generation of the Euro-Scout car navigation system. The system now allows for dynamic route guidance, and offers additional driver information through a smart card IC that provides access to traffic guidance information via beacons.

Sumitomo Electric Industries, Japan: Sumitomo Electric displayed a voice navigation system using an LCD and CD-ROM map already launched and offered on the Japanese market. The latest system offers dynamic route guidance and route calculation. Other products developed and manufactured by Sumitomo for ATT/IVHS include bus location systems, infrared vehicle detectors, number plate recognition systems and car parking space information systems.

Thomson-CSF, France: Thomson-CSF in conjunction with Renault and Sagem developed a collision avoidance system using millimetre wave technology. The company also demonstrated its capability with infrared technology for obstacle detection. The system is based on Sagem's military application expertise.

Toyota Motor Corporation, Japan: Toyota showed a fourth-generation proprietary "Multivision" navigation system that is fitted to the company's Lexus and Crown luxury cars. In addition to addresses, the "Celsior" navigation system uses telephone numbers to route destinations. Toyota has its own proprietary CD-ROM maps and offers total integration for FM multiplex, or other radio communications technology; it also has voice guidance. The system has a built-in TV, phonebook function, and audio/climate control functions.

Trafficmaster plc, United Kingdom: Trafficmaster offers a real-time (updated every three minutes) traffic information/map display system with a radio data receiver. It provides early warnings of congestion to help plan journeys. A second-generation system is planned for 1995 which will use a smart card for access to traffic/service information. Trafficmaster manufactures its units at its own facilities, but may begin to subcontract manufacture from 1995 to DDL in Ireland.

Trimble Navigation, USA: Trimble displayed its strengths and capabilities in global positioning systems. Like Rockwell, Trimble is offering a credit-card-sized GPS engine for automotive applications. Trimble also offers vehicle tracking systems using GPS technology for fleet control or emergency calling applications.

Volvo, Sweden: Dynaguide is the result of Volvo's involvement in PROMETHEUS. This product is a dynamic navigation and route guidance system that takes police, emergency services, radio and other public traffic information from the Swedish road administration via FM transmitters (RDS/TMC). The display unit is based on Philips' Carin navigation system. Volvo also has a system that allows interface to the GSM network as part of the SOCRATES project.

Dataquest Perspective

These car interface units (navigation, route guidance or traffic information systems, and so on) could also provide interfaces to public information systems and could be used for road tolling, identification, restricted access for traffic control, and park and ride services that could be useful at community level. These areas present sociopolitical issues and may present barriers to systems introduction at country level.

However, car navigation systems have now made highly visible entries into the OEM area as car manufacturers such as Honda, Mazda, Nissan, Toyota, BMW, and GM already have systems being installed in their top-of-the-range cars. Compared to Japan, Europe has a very small aftermarket for these systems, but the OEM market may be more significant as more players like Mercedes-Benz and Jaguar are soon to follow BMW's example. The benefits of these systems to drivers are safety, emergency calling, security, and advance knowledge of traffic conditions. Future systems will be even more dynamic, with very sophisticated multimedia functions for intelligent cruise control and intelligent braking using collision avoidance.

Dataquest believes that LCD units for car navigation systems will begin to appear in more car dashboards from the end of 1995 onwards as digital public communications infrastructure systems such as RDS/TMC become more widely available. Lower-cost solutions will use character display modules for text information displays only. These interactive driver information systems only just emerging hold the key to more semiconductor and electronic integration in the car and may present the first PC in the car! Dataquest will publish a Focus Report in April 1995 covering these emerging automotive electronic areas, looking at each of the new technologies and products in more detail.

By Mike Williams

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Dataquest Perspective

Semiconductors

Semiconductor Application Markets Europe

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- Philips' Carin system incorporating all the above plus CD-ROM digital map source and dynamic route guidance

Sagem developed the first three systems above, and the fourth is based on Philips' Carin navigation system.

Defence Research Agency (DRA), United Kingdom: The DRA is a UK government agency established to coordinate research into the military/defense areas and identify market opportunities for UK companies in this area. The DRA has recently set up a DRA transportation branch that is exploring areas where its expertise could be leveraged—areas such as head-up-display technology, infrared vision enhancement system, thermal image detection systems, and collision avoidance/intelligent cruise control systems.

Delco Electronics Corporation, USA: Delco is a subsidiary of General Motors, that designs and builds automotive electronic components. Delco presented a GPS-based/dead-reckoning, dynamic car navigation system (known as Telepath 100) with audio and real-time route guidance capability. The Telepath 100 system uses an 8-bit microprocessor.

Gilardini SpA, Italy: Gilardini is now a wholly owned subsidiary of Magneti-Marelli (the Fiat auto electronics company). Gilardini has developed an integrated color LCD route planner and GPS mobile navigation system for dynamic route guidance. The Gilardini system offers an RDS/TMC interface and uses a CD-ROM map that can provide synthesized voice guidance.

Motorola, USA: Motorola's Automotive and Industrial Electronics Group (AIEG) presented its latest GPS engines for ATT/IVHS applications. Motorola is also participating in the US ADVANCE (Advanced Driver and Vehicle Advisory Navigation Concept) project (1992 to 1997) for which the company has developed a dynamic GPS-based navigation and route guidance system, using high-speed data radiocommunications.

Nippondenso Co. Ltd., Japan: Nippondenso of Japan showed its new mobile information unit and terminal (MIUT), a GPS-based map navigation system which uses a PCMCIA format map and fits into a DIN slot. The MUIT uses a 32-bit RISC processor and has the ability to port to several types of communications device for dynamic navigation.

Philips Car Systems, Germany: Philips presented its masterpiece Carin navigation system. Carin is the only system to be sold in Europe by a car manufacturer (BMW). The Carin system is a dynamic route navigation and guidance system using CD-ROM maps, GPS, and RDS/TMC for real-time traffic information processing. It has a voice synthesizer which provides voice guidance.

PSA Peugeot Citroën, France: PSA participated in 13 separate PROMETHEUS pilot projects involving one concept car and 12 prototypes that demonstrated several research themes ranging from enhanced vision, lane-keeping support, collision avoidance, cooperative driving, intelligent cruise control, traffic information and route guidance systems.

Rockwell International Corporation, USA: Rockwell showed GPS modules for car navigation systems. The latest generation is a credit-card-sized GPS engine, and the company is believed to be working on a 60 percent form reduction for next-generation GPS modules.

Saab Scania Automobiles, Sweden: Through Saab and Sweden's involvement in the PROMETHEUS project, a head-up-display driver information system was developed with Delco for an intelligent cruise control. The Saab/Delco HUD uses a CAN bus for on-board communication, and a 5.8-GHz microwave link for short-range communication; and a laser-based optical sensor for collision avoidance measurements.

Siemens, Germany: Siemens displayed the latest generation of the Euro-Scout car navigation system. The system now allows for dynamic route guidance, and offers additional driver information through a smart card IC that provides access to traffic guidance information via beacons.

Sumitomo Electric Industries, Japan: Sumitomo Electric displayed a voice navigation system using an LCD and CD-ROM map already launched and offered on the Japanese market. The latest system offers dynamic route guidance and route calculation. Other products developed and manufactured by Sumitomo for ATT/IVHS include bus location systems, infrared vehicle detectors, number plate recognition systems and car parking space information systems.

Thomson-CSF, France: Thomson-CSF in conjunction with Renault and Sagem developed a collision avoidance system using millimetre wave technology. The company also demonstrated its capability with infrared technology for obstacle detection. The system is based on Sagem's military application expertise.

Toyota Motor Corporation, Japan: Toyota showed a fourth-generation proprietary "Multivision" navigation system that is fitted to the company's Lexus and Crown luxury cars. In addition to addresses, the "Celsior" navigation system uses telephone numbers to route destinations. Toyota has its own proprietary CD-ROM maps and offers total integration for FM multiplex, or other radio communications technology; it also has voice guidance. The system has a built-in TV, phonebook function, and audio/climate control functions.

Trafficmaster plc, United Kingdom: Trafficmaster offers a real-time (updated every three minutes) traffic information/map display system with a radio data receiver. It provides early warnings of congestion to help plan journeys. A second-generation system is planned for 1995 which will use a smart card for access to traffic/service information. Trafficmaster manufactures its units at its own facilities, but may begin to subcontract manufacture from 1995 to DDL in Ireland.

Trimble Navigation, USA: Trimble displayed its strengths and capabilities in global positioning systems. Like Rockwell, Trimble is offering a credit-card-sized GPS engine for automotive applications. Trimble also offers vehicle tracking systems using GPS technology for fleet control or emergency calling applications.

Volvo, Sweden: Dynaguide is the result of Volvo's involvement in PROMETHEUS. This product is a dynamic navigation and route guidance system that takes police, emergency services, radio and other public traffic information from the Swedish road administration via FM transmitters (RDS/TMC). The display unit is based on Philips' Carin navigation system. Volvo also has a system that allows interface to the GSM network as part of the SOCRATES project.

Dataquest Perspective

These car interface units (navigation, route guidance or traffic information systems, and so on) could also provide interfaces to public information systems and could be used for road tolling, identification, restricted access for traffic control, and park and ride services that could be useful at community level. These areas present sociopolitical issues and may present barriers to systems introduction at country level.

However, car navigation systems have now made highly visible entries into the OEM area as car manufacturers such as Honda, Mazda, Nissan, Toyota, BMW, and GM already have systems being installed in their top-of-the-range cars. Compared to Japan, Europe has a very small aftermarket for these systems, but the OEM market may be more significant as more players like Mercedes-Benz and Jaguar are soon to follow BMW's example. The benefits of these systems to drivers are safety, emergency calling, security, and advance knowledge of traffic conditions. Future systems will be even more dynamic, with very sophisticated multimedia functions for intelligent cruise control and intelligent braking using collision avoidance.

Dataquest believes that LCD units for car navigation systems will begin to appear in more car dashboards from the end of 1995 onwards as digital public communications infrastructure systems such as RDS/TMC become more widely available. Lower-cost solutions will use character display modules for text information displays only. These interactive driver information systems only just emerging hold the key to more semiconductor and electronic integration in the car and may present the first PC in the car! Dataquest will publish a Focus Report in April 1995 covering these emerging automotive electronic areas, looking at each of the new technologies and products in more detail.

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Dataquest Perspective

Semiconductors

Semiconductor Application Markets Europe

In This Issue

1993 European Printer Production

This *Dataquest Perspective* reviews European printer manufacturing, the production levels, locations, and capabilities of each manufacturer. It also addresses the issue of tariffs, and most importantly semiconductor trends in printers. The main topics in focus are as follows:

By Andrew Norwood

1993 European Printer Production

Summary

In 1993 printer production in Europe reached 4.26 million units, of which the bulk was matrix production. This drove a total semiconductor market for printers of $203 million. Dataquest estimates that the semiconductor market for printers will reach $366 million by 1998, driven by increasing printer production and rising semiconductor content. This *Dataquest Perspective*, researched in conjunction with the European Document Management Group, gives an analysis of European printer production in 1993 and beyond.

European Printer Market Overview

The European printer market continues to grow, with a compound annual growth rate (CAGR) for 1993 to 1998 of 6.1 percent. Within that rate, each of the different technologies are behaving differently; ink jet printers are growing at 13.8 percent while dot matrix printers are declining at 12.9 percent. The laser market is increasing at 8.5 percent, while others including thermal and line printers are moving upwards at 4.1 percent.

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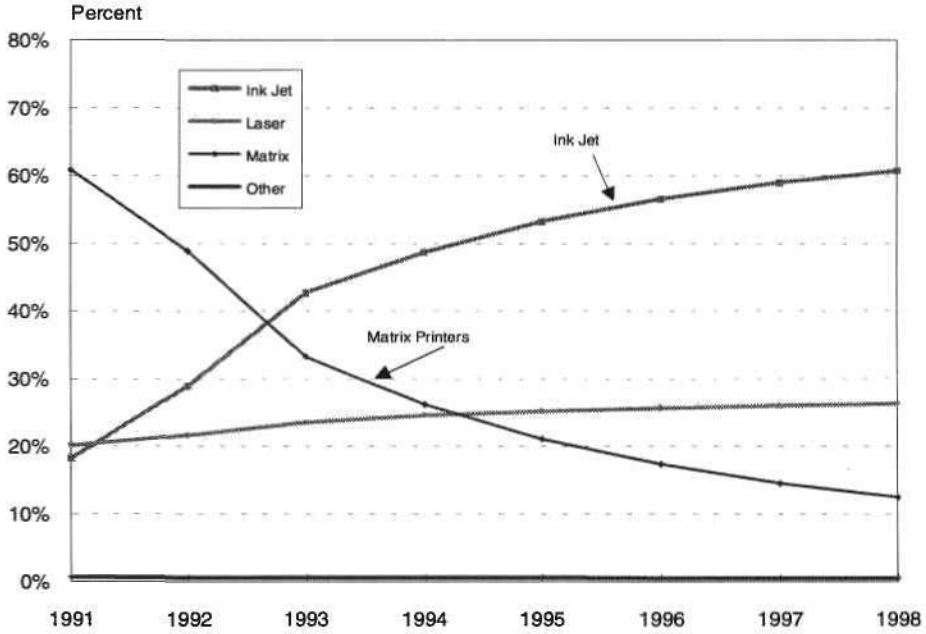
Figure 1 shows the market switchover between dot matrix printers and ink jet printers as the dominant technology. Some of the factors in the switchover are that dot matrix printers are still noisy, print quality has reached its upper limit and integrated sheet feeders came too late, while in contrast ink jet has none of these problems and has a smaller footprint. 1993 was the first year ink jet outperformed dot matrix printer shipments.

Table 1 shows Western European printer shipments by technology in 1993 and 1998. Ink jet technology can be seen to be the prevailing solution due to its many benefits, while laser technology grows slightly above market average.

Figure 1
European Printer Shipments by Technology 1991-1998



Source: Dataquest (July 1994 Estimates)

Table 1
European Printer Shipments 1993-1998

	Shipments Units (K)		Market Share (%)		CAGR(%)
Technology	1993	1998	1993	1998	1993/98
Ink Jet	3,620	6,923	42.6%	60.7%	13.8%
Laser	1,996	3003	23.5%	26.3%	8.5%
Dot Matrix	2,823	1,418	33.3%	12.4%	-12.9%
Other	50	61	0.6%	0.5%	4.2%
Total	8,489	11,405			6.1%

Source: Dataquest (July 1994 Estimates)

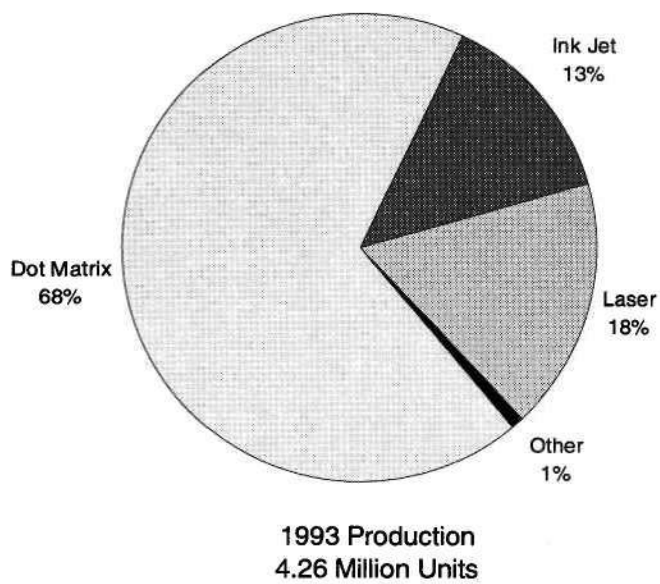
Analysis of Printer Production in Europe

Dataquest estimates that effective printer production was 4.26 million units in 1993. Effective production is where the printer controller boards are manufactured or production was subcontracted in Europe. Figure 2 shows European production of printers by technology. As can be seen from this chart, the overwhelming proportion is in the area of dot matrix printers, with 67 percent. However, as shown in Table 1, in terms of sales, matrix printers only accounted for 33 percent, the largest segment being ink jet printers with 43 percent.

Europe already has some limited ink jet production, with both Hewlett-Packard (HP) and Olivetti-Canon producing, and Epson starting production in 1994. If Europe is to supply an acceptable proportion of its printer needs, then we will have to see more ink jet production shifting to Europe in the next few years. Dataquest believes that this will happen, although there will be a time-lag between the uptake of ink jet technology and the shift of production to Europe, causing Europe's printer production to fall behind sales.

This is illustrated in Figure 3, which shows Dataquest estimates of ink jet production out to 1998, along with shipments for ink jet, and related semiconductor demand from ink jet. Production will fall further behind sales in the next few years due to the lack of ink jet production in Europe. However, as production moves to Europe in 1995 and onwards, we expect production to grow rapidly.

Figure 2
European Printer Production by Technology



Source: Dataquest (July 1994 Estimates)

Figure 4 shows that laser printers will continue a steady increase in shipments—an 8.5 percent CAGR between 1993 and 1998, with production growing faster. Increasing production will drive a semiconductor consumption with a CAGR of 9.8 percent over the same period.

The rapid decline of dot matrix printers is shown in Figure 5. At the moment Europe is in the strange position of producing more units than numbers shipped; this can be accounted for when Eastern European shipments are taken into account. Dataquest also understands that some large manufacturers have built up large inventories as production continues and shipments tail off. Over the next five years we expect to see production fall to approximately two-thirds of European shipments.

Figure 6 shows the overall view of printer production in Europe. The next few years are marked by slow production growth compared to shipments, but this picks up in 1996 mainly due to increasing ink jet production in Europe.

The semiconductor demand over these years continues to grow unaffected by the trend in ink jet and matrix production. This is because the semiconductor demand comes from laser printers, which show a steady unit production rise and increasing semiconductor demand. However, post-1995 ink jet consumption will drive the overall semiconductor market as laser consumption begins to slip. The key statistics are that total printer shipments show a CAGR of 6.1 percent between 1993 and 1998. Production has a CAGR of 12.7 percent and semiconductor consumption has a CAGR of 12.6 percent for the same time period.

Table 2 shows that, overall, Epson is the largest producer of printers in 1993, with production of 700,000 units; however, all of its production in the area of dot matrix printers. In 1994 Epson started to assemble ink jet printers in its factories in France and United Kingdom. Olivetti-Canon joint venture was the largest manufacturer of ink jet printers, with 396,000 units produced at its facility in Italy.

Table 3 shows European printer manufacturing locations and the technologies manufactured there. The table also gives an indication as to the type of production carried out at these locations; this is broken down into the following categories:

- **Full assembly** of the printer means that the controller board was manufactured by the company in Europe, although other subassemblies like the print engine may have been imported. This means in essence that the company was purchasing semiconductors in Europe and is therefore counted as effective production.
- **Subcontract assembly** applies were a company may contract out the manufacture of the controller printed circuit board to another company within Europe. Again, this means that the semiconductors are purchased in Europe, and this therefore counted as effective production.

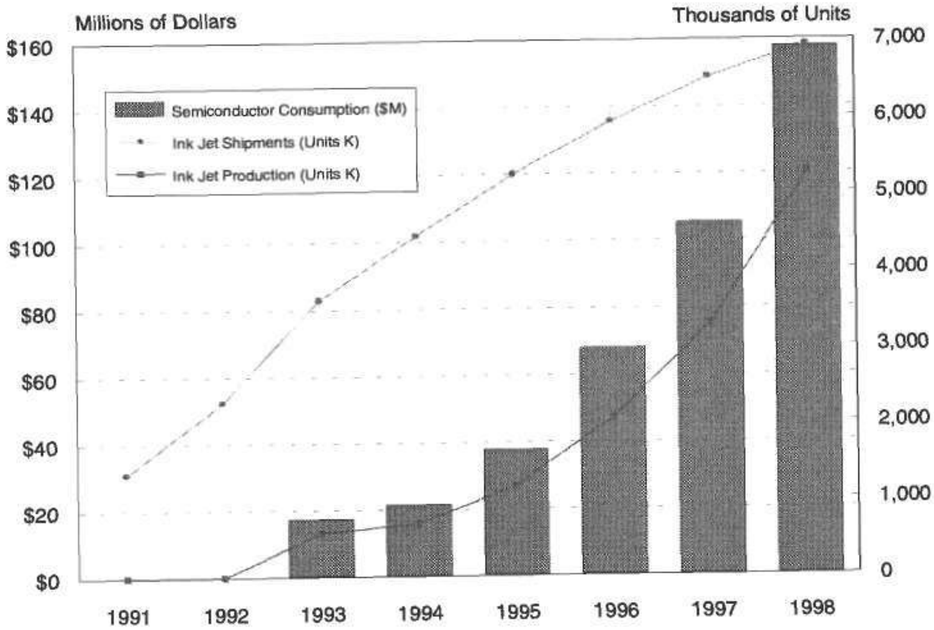
- **Final assembly** involves the assembly of printers from imported subassembled components, including the controller board which has been assembled outside of Europe with no local semiconductor purchase. This is therefore not counted as effective production.

Table 2
1993 European Printer Production Ranking by Manufacturer
(Thousands of Units)

Rank	Company	Dot Matrix	Ink Jet	Laser	Other	Total
1	Epson	700	-	-	-	700
2	Oki	654	-	-	-	654
3	Hewlett-Packard	-	180	228	-	408
4	Océ	-	-	400	-	400
5	Olivetti-Canon	-	396	-	-	396
6	Star	314	-	-	-	314
7	Olivetti	241	-	-	-	241
8	Citizen	220	-	-	-	220
9	Panasonic	190	-	-	-	190
10	NEC	150	-	-	-	150
11	Seikosha	150	-	-	-	150
12	Bull (Compuprint)	73	-	10	-	83
13	Mannesmann Tally	75	-	-	-	75
14	Fujitsu	73	-	-	-	73
15	Texas Instruments	0	-	55	-	55
16	Brother	44	-	-	-	44
17	Canon	-	-	30	-	30
	Others	17	-	32	24	73
	Total	2,901	576	755	24	4,256
	Split	68.2%	13.5%	17.7%	0.6%	100.0%

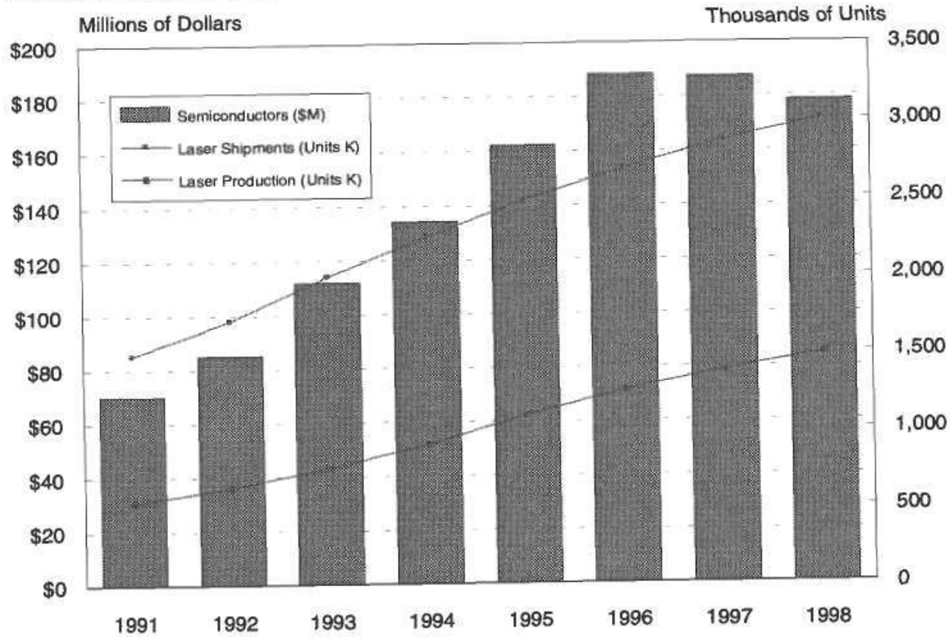
Source: Dataquest (July 1994 Estimates)

Figure 3
European Ink Jet Production and Related Semiconductor Demand 1991-1998



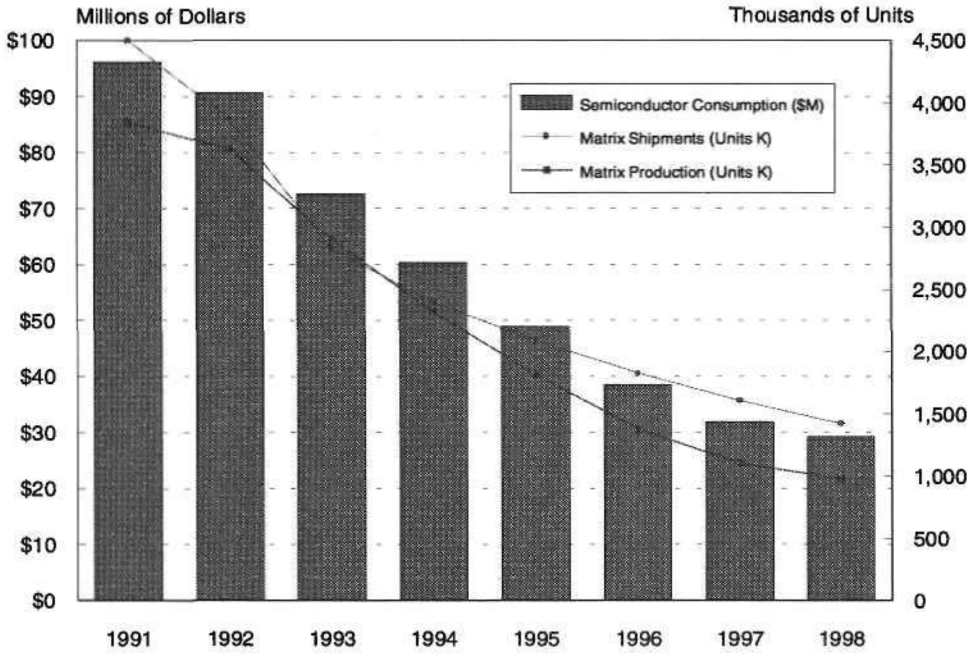
Source: Dataquest (July 1994 Estimates)

Figure 4
European Laser Production and Related Semiconductor Demand 1991-1998



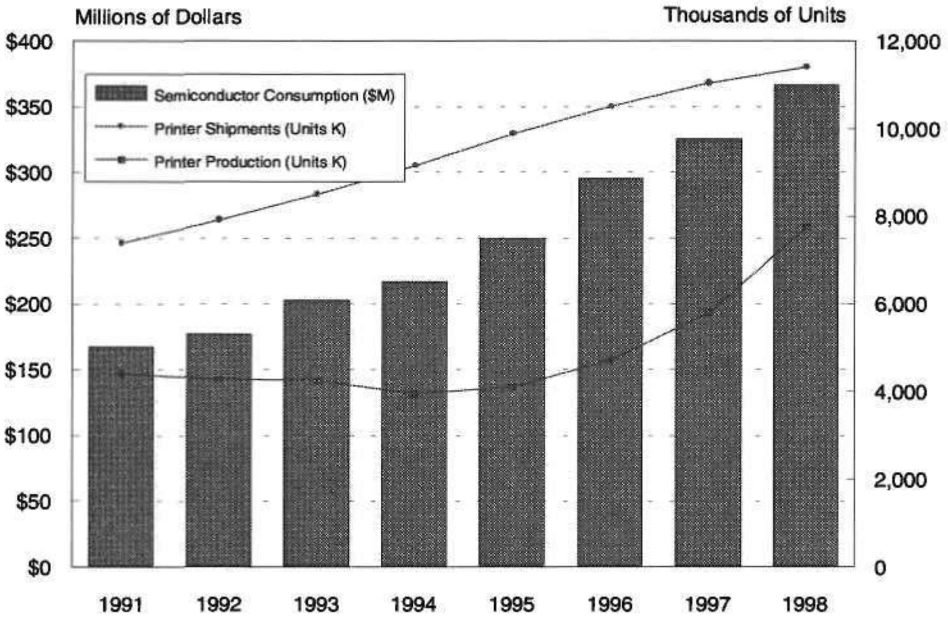
Source: Dataquest (July 1994 Estimates)

Figure 5
European Dot Matrix and Related Semiconductor Demand 1991-1993



Source: Dataquest (July 1994 Estimates)

Figure 6
European Total Printer Production and Related Semiconductor Demand 1991-1998



Source: Dataquest (July 1994 Estimates)

Table 3
European Printer Manufacturing and Design Locations.

Company	Town	Country	Final Assembly	Full Assembly	Sub-contract	Dot Matrix	Ink Jet	Thermal	Laser	Line	Other
Amstrad	Brentwood	UK			✔						
Brother	Wrexham	UK			✔	✔					
Bull (Compuprint)	Turin	Italy		✔		✔			✔		
Canon	Bretagne	France	✔						✔		
Citizen	Scunthorpe	UK	✔	✔		✔					
Dataproducts	Dublin	Ireland	✔		✔	✔			✔	✔	
Dataproducts	Amsterdam	Netherlands	✔			✔			✔	✔	
Epson	Creteil	France	✔		✔	✔	✔				
Epson	Telford	UK		✔		✔	✔				
Facit Partner	Atvidaberg	Sweden				✔			✔		✔
Ferrotec	Stillorgan	Ireland			✔						
Fujitsu	Málaga	Spain		✔		✔					
FKI Newbury Data	Staines	UK		✔	✔	✔					
Hewlet- Packard	Barcelona	Spain	✔	✔			✔				
Hewlett-Packard	Bergamo	Italy		✔					✔		
Hewlett-Packard	Amstelveen	Netherlands	✔						✔		
Järfälla	Järfälla	Sweden								✔	
Kyocera	Le Grand Quevilly	France	✔						✔		
Lexmark	Orleans	France		✔					✔		
Mannesmann Tally	Elchingen	Germany		✔		✔					
NEC	Telford	UK		✔		✔					
Nipson Printing Systems	Belfort	France			✔				✔		
Océ	Venlo	Netherlands			✔				✔		
Oki	Cumbernauld	UK		✔		✔					
Olivetti	Barcelona	Spain		✔		✔					

(continued)

Table 3 (Continued)
European Printer Manufacturing and Design Locations.

Company	Town	Country	Final Assembly	Full Assembly	Sub-contract	Dot Matrix	Ink Jet	Thermal	Laser	Line	Other
Olivetti-Canon	Agliè	Italy		✔			✔				
Olivetti	San Bernardo	Italy	✔			✔					
Olivetti	Scarmagno	Italy		✔		✔					
Panasonic	Duffryn	UK		✔		✔					
Printer Systems International	Siegan	Germany		✔		✔					
Rank Xerox	Venray	Netherlands	✔								
Rank Xerox	Neuville-en-Ferian	France	✔						✔		
Rank Xerox	Mitcheldean	UK		✔					✔		
Seikosha	Neumunster	Germany		✔		✔					
Siemens Nixdorf	Poing	Germany		✔					✔		
Star	Tredegar	UK		✔		✔					
Texas Instruments	Utrecht	Netherlands		✔					✔		

Source: Dataquest (July 1994)

Trade Issues and Dumping

When looking at the trends in printer manufacturing in Europe, it is important to remember that one of the main reason why so many Japanese printer manufacturers are present in Europe is tariffs. In the late 1970s and early 1980s, many European and US matrix printer manufacturers began to suffer from the effects of lower-cost products from Japan. This culminated in a complaint to the European Commission (EC) by the Committee of European Printer Manufacturers (Europrint) on behalf of companies such as Honeywell, Mannesmann Tally, Olivetti and Philips.

In 1988 the EC announced that it had upheld the complaints from the European printer manufacturers and imposed a definite antidumping duty on all imports of matrix printers originating in Japan. The level of these tariffs ranged from 4.8 percent for Tokyo Electric through to 47 percent for Fujitsu. The tariffs did not apply to matrix printers manufactured in Japanese-owned European plants, provided that these printers met the EC's "local content" requirements.

While Japanese matrix printer manufacturers saw the European market as full of potential for their products, they also realized that they could only achieve limited success by manufacturing all their printers in Japan. In the mid-1980s they changed their tactics from the traditional "Market Out" philosophy—everything made in Japan and shipped out to the market—to that of a "Market In" policy. The objective of this change was to bring the Japanese manufacturers closer to their European markets and to provide them with an ability to quickly react to customer demands and changes.

A combination of a change in marketing philosophy by Japanese printer manufacturers and the EC's antidumping legislation resulted in a number of Japanese matrix printer companies establishing full production facilities within the European Union. From an individual country viewpoint, the main beneficiary was the United Kingdom where a total of seven new or extended manufacturing plants were established.

When these changes occurred, the total European dot matrix printer market was estimated at 4.6 million units and rising. The total matrix market peaked in 1990 when both 9- and 24-pin printers were subjected to market pressure from ink jet machines. Dataquest estimates that by 1998 the total matrix market in Europe will have declined to about 1.4 million units, or just over 12 percent of the market. Although there has been a remarkable swing away from impact printers towards non-impact technology in Europe, manufacturing has seen little change.

The EC defines a product as dumped if its export price to member countries is less than the normal value of an equivalent product. The normal value is the price of the product in the country of origin of the product or exporter, whichever is more relevant.

The definition of local content by the EC was quoted as: "The value of the parts or materials used in the assembly or production and originating in the country of exportation of the product subject to the antidumping duty exceeding the value of all other parts or materials used by at least 50 percent." This condition was imposed to avoid subassemblies being shipped in from Japan and assembled using low-technology "screwdriver operation" in the local EC plant.

Printer Technology Trends

The main trends driving printer technology are as follows:

- Color printing
- Networking/groupware
- Multifunctional capabilities
- Host-based printing
- Software: multimedia

Briefly we will look at a couple of these areas that are effecting semiconductor trends in Europe.

Host-Based Printing

With the maturing of page printer languages, such as PCL and PostScript, and established positions of computer operating environments such as System 7 and Windows—Windows alone has an installed base close to 30 million users—Dataquest expects to see host-based printing solutions, such as QuickDraw and Windows printing, attempt a further impact on the market. QuickDraw page printer solutions have been penetrating the Apple market for a few years, and Windows printing solutions such as Microsoft's Windows Printing System is beginning to emerge. Host-based printers do not require the relatively expensive microprocessors but rely instead on the processing power of the host computer.

High-Resolution Printing

The trend to high resolution began in early 1990 with the introduction of Hewlett-Packard's LaserJet III printer. The printer featured Resolution Enhancement Technology, an edge-smoothing effect that gave the illusion of higher resolution. The next step in better print quality was when Hewlett-Packard announced its 600 × 600-dpi LaserJet 4 in late 1992, to be closely followed by other manufacturers. In terms of semiconductor requirements, high resolution requires more processing power and more memory.

Multifunctional Products

The large market for office equipment has, in many cases, been driven by supply/ push marketing from manufacturers. Manufacturers have often attempted to differentiate their products from their competitors by adding more and better features at competitive prices. Printer vendors, for example, have historically added fonts, emulations, and image-enhancement software as an improvement to the basic print engine. Copier companies have added zoom reduction and enlargement, and facsimile manufacturers have added automatic dialling and polling. As these markets have matured, manufacturers are running out of features to add to their products to differentiate themselves.

Now, in addition to adding features to their products, some manufacturers are attempting to add new functions to their engines. Facsimile manufacturers promote the copying function or printer emulations; copier companies have attempted to add printing and fax functionality; and several printer companies are offering fax and even scanning and copying capabilities to their print engines. Although in Europe at the moment multifunctional printers are not a significant factor, this may change with user demand.

Semiconductor Trends in Printers

The laser printer industry has two divergent trends in the area of semiconductors, one towards ever-increasing semiconductor content and the other towards dumb printers. Table 4 gives our estimates of average semiconductor content for the different printer technologies manufactured in Europe for 1993 and a forecast for 1998.

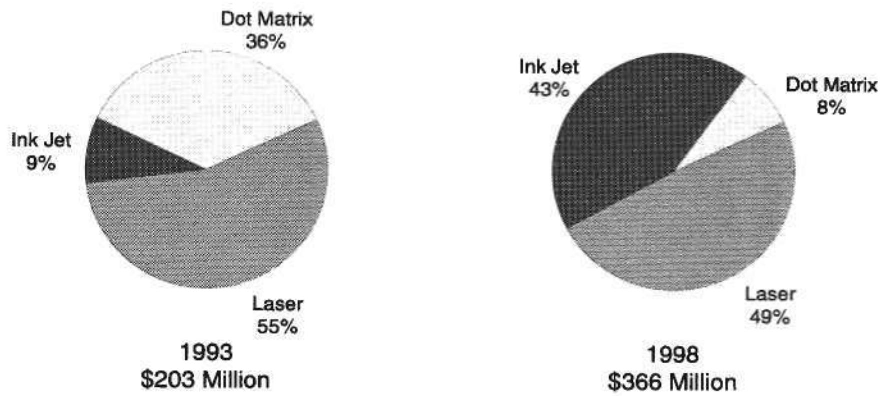
Although ink jet shipments are forecast at more than twice the number of laser printer shipments by 1998. Table 4 shows that laser printers have a higher semiconductor content as they are more advanced. This is borne out by Figure 7, which shows that in terms of semiconductor consumption, ink jet production consumes 43 percent of semiconductors compared with 49 percent for laser printer production.

Table 4
Semiconductor Content of Printers per Machine 1993 and 1998 (Dollars)

Technology	1993	1998	Percent CAGR
Ink Jet	$30	$30	0.0%
Laser	$148	$120	-4.1%
Dot Matrix	$25	$30	3.7%
Other	$39	$30	-5.1%

Source: Dataquest (July 1994 Estimates)

Figure 7
Total European Printer Semiconductor Consumption 1993 and 1998



Source: Dataquest (July 1994 Estimates)

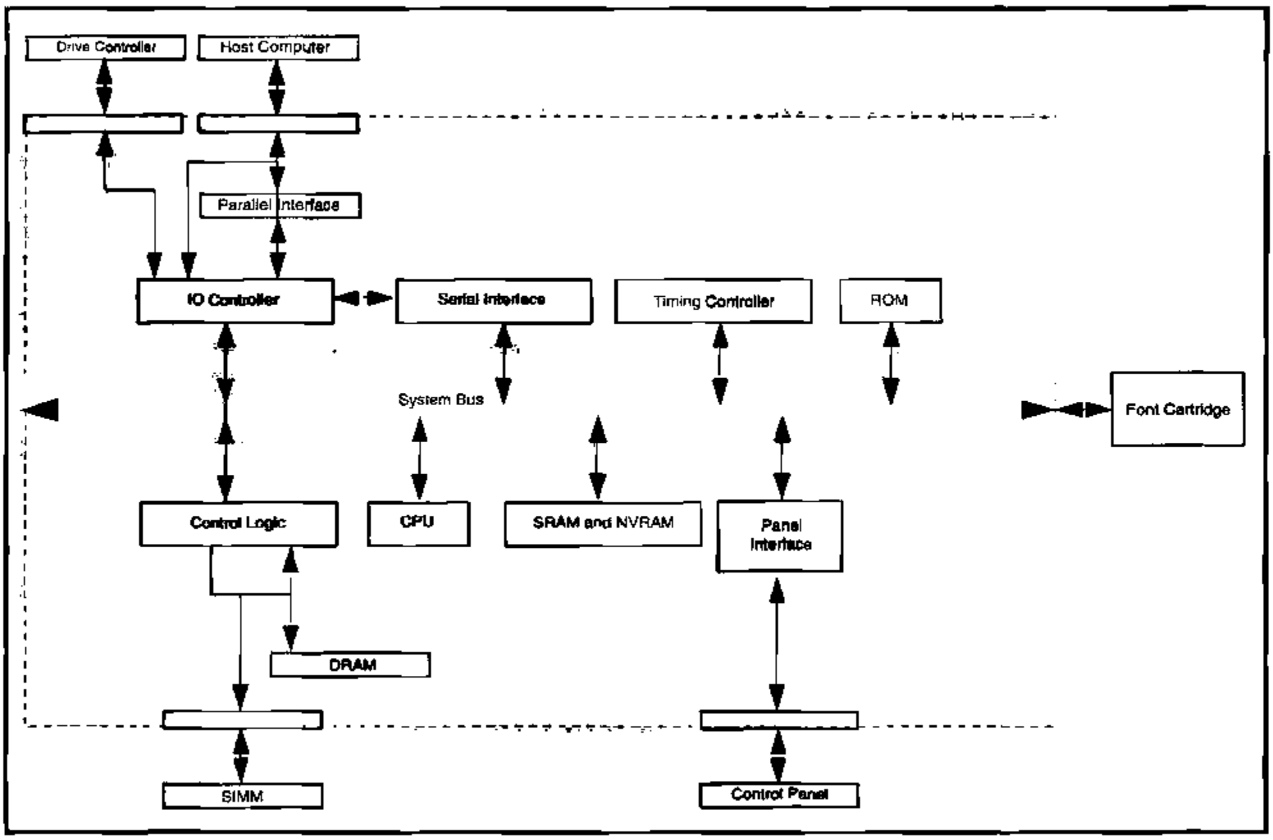
Laser Printers

Dataquest estimates that the 1993 semiconductor content of a laser printer was $148; of this, DRAM and microprocessor accounted for $117. The remainder of $31 came from all other devices.

Figure 8 is a block diagram of a typical laser printer. Table 5 shows semiconductor consumption for laser printers by device for 1993 and 1998.

SRAM and NVRAM devices hold the system settings; the panel interface drives the user control panel and would normally contain a 4-bit microcontroller. The ROM holds the system fonts, while control logic carries out memory addressing to the DRAM and arbitration of access to memory from CPU and I/O controller. The primary function of the drive circuitry controller is to interface to the laser, print drum, scanner motor, paper control mechanism, and so on.

Figure 8
Typical Laser Printer Controller Block Diagram



Source: Dataquest (July 1994)

Table 5
Total Laser Printer Semiconductor Consumption 1993 and 1998 (Millions of Dollars)

Semiconductor Device	1993	1998	Percent CAGR
Total Semiconductor	$111.9	$178.3	9.8%
IC	$111.9	$178.3	9.8%
Bipolar Digital	$0.4	$0.7	13.3%
Memory	$0.0	$0.0	-
Logic	$0.4	$0.7	13.3%
MOS Digital	$111.6	$177.6	9.7%
Memory	$64.2	$75.3	3.3%
Micro	$40.6	$89.6	17.1%
Logic	$6.8	$12.7	13.3%
Analog	$0.0	$0.0	-
Discrete	$0.0	$0.0	-

Source: Dataquest (July 1994 Estimates)

Processor Trends

The printer processor market was originally dominated by Motorola with its 68000 family, but laser printers have now given over to RISC processors as the preferred option for 600×600 dpi. The most popular processors used in Europe are as follows:

- Intel—i960
- Motorola—68000 and PowerPC
- AMD—29000
- MIPS—R3000
- Weitek— 8200
- Fujitsu—SPARC RISC

At the beginning of the year Canon announced an agreement with IBM regarding the PowerPC, whereby IBM will supply Canon with products based on the PowerPC microprocessor. One of the areas in which Canon first uses this microprocessor is likely to be in printers.

Printers other than laser will use low-performance microprocessors as processing is not important. An exception to this will be some high-end ink jet printers that use a page description language (PDL) and need the processing power.

Memory Trends

For laser printers, memory requirements fall into two categories: nonvolatile memories (typically ROM), which are used for code and font storage; and page memory, which is used to store the bit-mapped images of the page to be printed.

Nonvolatile applications are used to hold fonts and printer settings. As the number of standard fonts has increased—currently numbering some 32—nonvolatile memory has been rising to about 2MB for a normal printer.

Page memory applications need large amounts of memory capable of holding a complete page bit map because they are generally unable to process a page "on the fly" or in real time. Therefore, memory requirements for standard 300 × 300 dpi machines would be 1MB, or 4MB for a 600 × 600 dpi. Printers of 1,200 dpi will require a massive memory in excess of 16MB to store a bit map.

$$\text{Memory required for 1 page} = ((\text{papersize}^2 * \text{dpi}^2) \div 8 \div 1024) \div 1024$$

On top of this, the printer also requires additional memory for other tasks. Also, most printers are capable of handling quartile paper size, which is slightly larger than A4.

One technique used by some printer manufacturers to reduce memory content is "banding" or band buffering, in which only a fraction of a page is stored at a given time. Banding can reduce memory costs; however, there is a substantial speed trade-off.

Although the trend is for increasing memory in laser printers, we expect the value in dollar terms to peak in 1996. This is due to the fact that Dataquest expects a CAGR decline of about 30 percent in DRAM cost/megabyte between 1993 and 1998.

Ink Jet Printers

Although ink jet printers will never require the memory or processing power of laser printers and therefore the semiconductor content, the sheer volume of production by 1998 will mean that they will rival laser printers. This was shown earlier in Figure 7. Although some ink jet printers do have processors, many will contine without. A small amount of memory is common, but with the trend of downward memory prices this will amount to very little.

Dot Matrix and Others

Dot matrix printers, like ink jet, have low processing power needs and most are driven by simple 8-bit microprocessors; they also have limited memory, which can range from no memory whatsoever to 1MB. With shipments falling, local production is likely once again to move outside of Europe to the Far East, but this time to the newly industrialized economies (NIE) and not to expensive Japan.

Dataquest Perspective

European printer production will continue to grow at a CAGR of 12.7 percent between 1993 and 1998. Within that, each of the different technologies' production trends are different. Laser printers remain the most important in semiconductor terms, although ink jet becomes relatively more important. This is on the assumption that ink jet production will move to Europe, replacing the decline in dot matrix production.

Many European printer manufacturers will have a turbulent time in the next few years—especially matrix producers—as they have to decide whether to continue to manufacture in Europe, and swap to ink jet production, or alternatively to close plants. Several companies will still be sensitive to the issue of tariffs and dumping, although many indigenous European printer manufacturers of 10 years ago no longer exist.

The event to have the biggest effect on European printer semiconductor consumption will be Dataquest's forecast decline in DRAM price. Although the average DRAM cost for printers will decline from $71.5 in 1993 to $37.9 in 1998, memory content in megabytes will triple.

The trend towards ink jet printers for the home or small office, home office (SOHO) market seems unstoppable. However, laser printer manufacturers may try to win some of this business with cheap laser printers, especially using Windows-based printing.

Although multifunctional printers may also be a way of winning the SOHO market—combining fax, copier and printer into one item—if this happened it would seem unlikely that Europe would be able to hold onto production. This type of equipment would need to have a small form factor and require the skills usually witnessed in consumer goods and notebook computers—something Europe is not strong in.

Due to the make-up of printer manufacturers, most of the design tends to be done out of Japan or the United States, and that is where the European business needs to be won.

By Andrew Norwood

Appendix: Company Notes

A brief overview of those companies currently manufacturing or integrating printer products in Europe is given below.

Amstrad

Amstrad, based in Brentwood, England, is a new entrant into the printer industry. We believe that Amstrad-designed printer production will be subcontracted to Järfälla based in Sweden.

Brother

In 1987, Brother built its second manufacturing facility in Wales, at Wrexham, to produce 9-, 18- and 24-pin matrix printers. However, we now understand that Brother has stopped the production of printer products at this site. Research and development for Brother's matrix printers is carried out in Nagoya, Japan.

Bull

Bull's printer manufacturing plant, located just outside Turin, Italy, dates back to the 1960s when it was originally owned by Olivetti. In 1991, Bull took over the plant, which currently houses the printer design and manufacturing facilities. This 4,000 m^2 plant employs about 400 people producing the Bull range of medium- and high-speed matrix printers and the latest Bull range of 6- to 16-pages per minute (ppm) laser printers. Bull manufactures matrix printers for its own consumption in Europe, as well as carrying out assembly work production for OEM customers such as Digital Equipment, Unisys and Memorex Telex. This production is shown in our Bull estimates.

Canon

In 1983 Canon, chose Bretagne near Rennes, France to set up its second European manufacturing facility. Today this 27,000 m² facility provides employment for about 700 people, Canon makes a range of other equipment at this plant.

Citizen

In 1987 the Citizen Watch Company of Japan announced that it would build a 7,000 m² matrix printer manufacturing facility in Scunthorpe, England—the company's first computer printer factory outside Japan. The establishment of Citizen Manufacturing (UK) represented an initial investment by Citizen of nearly £6 million. This facility has the ability to produce some 300,000 9- and 24-pin dot matrix printers annually. The output from this site is targeted at the markets of Eastern and Western Europe, the Middle East and Africa. Research and development is carried out in Japan.

Dataproducts

Dataproducts, part of the Hitachi Group, has been established in Ireland since 1965 but did not start to manufacture printers until 1975. A major investment of between $15 million to $20 million in the company occurred in 1982, resulting in the construction of a new 20,438 m² purpose-built facility. This both services Dataproducts' European headquarters and houses the printer products and imaging supplies divisions of the company.

Dataproducts also carries out final assembly of laser printers at its plant in Amsterdam, the Netherlands. Research and development is carried out by Dataproducts in California.

Epson has two plants in Europe, one in France and the second in the United Kingdom. In 1985 Epson opened its first European printer manufacturing facility at Creteil, France. This 6,200 m² plant currently employs about 165 people who produce the 24-pin matrix printers. Although only final assembly takes place, we believe that board manufacture is subcontracted locally in Europe.

In a further commitment to the European printer market Epson opened its second manufacturing facility, in 1988, at Telford, England. This 16,000 m² plant has a 650-strong work force producing a range of matrix printers plus many associated printed circuit boards. In the early years, when the matrix printer market was more buoyant, this plant was targeted towards high-volume production with its associated long lead times. Over the last few years the market has declined and the need to be able to quickly react to customer orders has become more important. This has been achieved by changing the production method from mass to batch production, thus enabling the site to handle smaller production runs more effectively.

The Telford facility contains 10 production lines capable of producing up to 16 different matrix printer models. Recently production of the Epson Stylus 800 ink jet printer was undertaken at this site. Not only will this be the first nonimpact printer to be manufactured at this plant, but it also makes Epson the first Japanese manufacturer to initiate production of its ink jet printers in Europe. Generally, output from both these manufacturing facilities is sold to the Epson sales subsidiaries in Europe and Africa.

Research and development takes place at Seiko Epson Japan, in Hirooka-Nagano.

Ferrotec

Ferrotec has its headquarters in Ireland and sells a range of portable direct thermal transfer printers. The initial technical expertise was purchased from a small US company in 1988. Since then, more than £2 million has been invested in the development and introduction of the company's current range.

In 1992 Ferrotec signed an agreement with Serrib, a subsidiary of Group Bull, to manufacture its printer requirements; however, the design and development is handled in Ireland were a small amount of pre-production and prototypes are produced. Ferrotec's production is shown under its own name and not in Bull's production numbers.

Facit

Facit's production facility is located at Atvidaberg, Sweden. The work force at this location numbers about 500, currently producing a wide range of products for several OEM customers. These products include very specialized banking equipment as well as Facit's own Flexforce high-speed, 24-pin E950 and D960 matrix printers.

FKI Newbury Data

FKI Newbury Data's 9,300 m² manufacturing plant, located in Winsford, England, has been established for about 20 years. Newbury Data is involved in the production of specialist high-speed dot matrix printers; also, research and development is carried out at the plant. A small amount of production is subcontracted, but this is included within our estimates.

Fujitsu

Opened in 1973, Fujitsu's facility covers an area of 7,600 m² and produces a range of products including bank telling machines, money-counting equipment and the company's full range of 24-pin dot matrix printers, primarily sold into the European market. While the total plant employs about 750 people, only a small number are directly involved in the production of matrix printers.

Hewlett-Packard

Hewlett-Packard has three production locations in Europe, in the Netherlands, Spain and Italy.

Early in 1993 Hewlett-Packard announced that it would invest $17 million in its Amerfoort European Distribution Centre in the Netherlands, expanding its size by a further 10,000 m². This additional space can house up to five production lines, but initially only two lines will be operational. These lines are used to assemble and test the 4-ppm LaserJet 4 and 4ML range of printers for the European market. We believe that although this plant only carries out final assembly, production of the controller boards is carried out at HP's other production sites in Europe. We have therefore included these as effective production under HP estimates.

Hewlett-Packard initially started production at this site in San Cugat, Barcelona, Spain in 1985. Currently a range of large-format and desktop ink plotters are manufactured here, employing about 400 people. Over the next two years Hewlett-Packard plans to invest more than Pta 1,800 million ($15.3 million) in this facility by increasing the floor space by a further 8,000 m² and purchasing new equipment.

Hewlett-Packard plans to move the worldwide responsibility for the research, development, marketing and production of its entire range of large-format pen and ink jet plotters from San Diego, California, to Spain. Thus, within 18 months, all of the European markets' demand for ink jet printers will be manufactured at this location.

In 1990, Hewlett-Packard invested $6 million in a new manufacturing facility in Bergamo, near Milan, Italy. This site was originally planned for the manufacture of controller boards for the LaserJet series of printers and employed about 100 people. However, HP recently announced the decision to expand the scope of this plant by beginning the assembly/integration of all the 17-ppm LaserJet 4Si and 4SiMX printers for the European market at this location. This additional activity has resulted in an expansion of the work force to 350 people.

Järfälla

The original IBM manufacturing plant was established in 1971 at Jäfälla, Sweden. It was extended in 1982 to its present size of 60,385 m². This facility, has a mixed history of ownership; originally part of IBM manufacturing it was, for a short time, under the aegis of Pennant Systems, but in July 1993 it became part of IBM Sweden. Currently, Jäfälla as a company is changing its product line significantly and will not manufacture printers in large volumes as earlier.

Kyocera

In 1991 Kyocera purchased the French company AVX and formed Kyocera Manufacturing France. This company occupies approximately 3,000 m² of manufacturing space within the AVX plant, which is located in Le Grand Quevilly. The research and development is carried out in Yhoga, Japan and final assembly takes place in France. Therefore, no production estimates are shown in Table 2.

Mannesmann Tally

In 1979, Mannesmann Präzisiontechnik merged with Tally Corporation to become Mannesmann Tally, one of Europe's largest independent printer companies. The company is a supplier of a wide range of products, covering various technologies, but only the 9- and 24-pin range of dot matrix printers are manufactured in Europe, at Elchingen, Germany. Research and development is carried out by Mannesmann at Elchingen.

NEC Technologies

NEC opened a new 10,000 m² manufacturing site at Telford, England in 1987, which was initially planned to produce matrix printers, video recorders, facsimiles and mobile telephones. The total investment by NEC was reputed to be between £40 million and £50 million, of which approximately £15 million was invested in the printer factory. Since its original opening, a further 24,000 m² has been added to this complex and the output now includes monitors plus mobile telephones and 24-pin matrix printers. As matrix production has declined, the spare capacity has been taken up by mobile phones.

Nipson Printing Systems

Nipson is the high-speed printing division of Groupe Bull. This printer subsidiary manufactures the company's range of high-speed fanfold and cut-sheet magnetographic nonimpact printer range. These products are manufactured at the Belfort plant in France; this was established in the early 1980s. Belfort has a manufacturing work force of about 100 people, plus a further 100 people in the research and design departments. This plant has the capacity to produce about 300 printers per year. Although the company subcontracts board assembly because of the low volumes, we believe this work is carried out within Europe.

Océ

Océ specializes in the production of midrange (30- to 45-ppm) page printers which have been manufactured at the Venlo, Netherlands plant since 1988. This facility also produces photocopiers, photoconductors, silicon and belts. Most printers manufactured by Océ are sold into the European market.

Oki

In 1987 Oki Electric Industries invested £20 million to set up a 41,000 m² printer manufacturing site in Cumbernauld, Scotland. The operation was initially set up to produce dot matrix printers, and produced its one-millionth printer in 1991. Today, approximately 520 people are involved in the production of the Oki range of 9- and 24-pin matrix printers.

In mid-1993 Oki said that it would move production of low-end printers for the US market to its plant in Scotland. The high cost of the yen had forced Oki to look for a cheaper alternative to manufacturing in Japan. The plan was that Oki Cumbernauld would be "contracted" to build the machines and then ship them to the United States, and would then bill Oki Japan. Production started in October 1993, but in June 1994 Oki announced that it intends to expand its production base in Thailand, shifting the remaining Japanese printer production to its factory there.

Olivetti

Olivetti has four own-printer production plants in Europe, three in Italy and one in Spain; it also has a joint venture with Canon.

The Olivetti production facility at Scarmagno, near Ivrea, Italy has been established for many years. Medium- to high-speed 9- and 24-pin matrix printers, personal computers and automatic telling machines are manufactured here. Controller boards for the Olivetti lower-speed page printers are also manufactured at this location, where they are also integrated with low-end laser printer engines from Japan. The final quality inspection and test of the Olivetti 17-ppm page printer range is also undertaken at Scarmagno.

All the printheads fitted to the European-manufactured Olivetti range of matrix and ink jet printers are assembled and tested at the San Bernardo plant, which is also close to Ivrea. Research and development on the Olivetti range is carried out at Ivrea, Italy.

The Spanish plant in Barcelona produces the lower-speed 9- and 24-pin matrix printers in the Olivetti range. It employs about 150 people, covers an area of around 10,600 m^2 and has the ability to produce some 100,000 printers per year. However, with the decline in the 9-pin dot matrix market, it is doubtful if this level of output is required.

Olivetti-Canon

This production facility was created in 1987, when Olivetti and Canon signed a joint cooperation agreement that resulted in the formation of Olivetti-Canon Industriale (OCI), located in Agliè. Olivetti-Canon was originally founded to manufacture low-volume photocopiers for both the Canon and Olivetti badges, but a further agreement in April 1992 created a new bubble jet division. Under this agreement Olivetti manufactures ink jet printers for its own requirements plus those of other OEM customers such as Citizen, Fujitsu, Digital Equipment, NEC, Seikosha and Mannesmann Tally. Research and development is undertaken at Olivetti-Canon facilities in Yveroon, Switzerland.

PSi Printer Systems International

This company is the result of a buyout in July 1992 of the former Philips Kommunikations Industries AG printer manufacturing facilities at Seigen, Germany. Its 10,000 m^2 area is spilt 60–40 between manufacturing and administration. PSi currently produces a range of four heavy-duty, medium- to high-speed, 24-pin matrix printers. Research and development is carried out at Seigen.

Panasonic

In 1986, Kyushu Matsushita Electric opened a 9,600 m^2 manufacturing facility at Duffryn, near Newport, Wales to produce electronic typewriters and matrix printers.

Rank Xerox

Rank Xerox has three facilities throughout Europe in the Netherlands, the United Kingdom and Germany. The Rank Xerox manufacturing and assembly plant at Coslada, Spain was opened in 1975. Today, this site covers 18,580 m^2 and employs about 150 people in the manufacture and assembly of page printers.

The Rank Xerox site at Micheldean, England was originally opened in 1957. It currently covers 139,354 m^2 and employs more than 1,900 people, mainly for the assembly of page printers and low- to midvolume copiers.

Finally, the 120,774 m^2 plant at Venray, Netherlands employs 2,300 people producing copiers and most of the power supplies used in Rank Xerox copiers and printers. Remanufacture and refurbishment of some copiers is also undertaken at this plant.

Seikosha

The Seikosha matrix printer plant in Neumunster, Germany was opened in 1989 and currently manufactures all Seikosha's 9- and 24-pin dot matrix printers sold in Europe. In 1989 this 3,220 m^2 site represented an initial investment of DM 10 million. In line with many other manufacturers, all the nonimpact printers in the Seikosha range are imported into Europe.

Siemens Nixdorf Informationssysteme (SNI)

Although Siemens has historically designed and manufactured both matrix and ink jet printers, the company's activity today is primarily concentrated on high-speed electronic printing systems. These are produced at SNI's 35,000 m^2 manufacturing facility in Poing, Germany, opened in 1988. This site has a total work force of about 2,000 people, of which about 60 percent are directly involved in production.

Star

The 5,000 m^2 Star Micronics matrix printer facility in Wales was opened in April 1988, with financial aid from the Welsh Development Agency. Over the years the size of the facility has increased threefold and the output and number of employees has also grown. However, the decline in the demand for matrix printers has been reflected in the output of this plant. As with other Japanese companies, these were mainly sold via the company's own subsidiaries within Europe.

Texas Instruments

The Texas Instruments range of page printers is assembled at the company's European Logistics Distribution Centre in Utrecht, Netherlands. This operation employs between 15 and 20 people who combine the controller boards, made locally in Europe, with imported print engines.

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Dataquest Perspective

Semiconductors

Semiconductor Application Markets Europe

In This Issue

Final 1993 European PC Production

This *Dataquest Perspective* looks at European PC production in 1993. The main topics in focus are as follows:

By Andrew Norwood and Adrian Walker

Final 1993 European PC Production

Summary

As a proportion of overall semiconductor consumption in Europe, PC production accounted for over 20 percent of semiconductor sales during 1993, while Dataquest estimates that by 1998 this ratio will have increased to more than 30 percent. This makes the PC the single most important product for the European semiconductor industry. In 1993 PC production increased 32.7 percent over last year to reach 10.2 million units, with the United Kingdom and Ireland the largest producers, contributing 50.5 percent of all European production.

Dataquest published a *Dataquest Perspective*, SAMM-EU-DP-9309, in December 1993 announcing the preliminary results of 1993 PC production survey. We have now completed our review of 1993 and this *Dataquest Perspective* provides a in-depth summary of our research.

European PC Market Overview

The European PC market continued its growth in 1993 to reach 10.32 million units shipped in Western Europe (compared with 9.49 million in 1992), 8.7 percent over the previous year. However, in dollar terms the market contracted by 8.8 percent to $20.27 billion ($22.23 billion in 1992) despite the shift to high-end processors and more base memory. This demonstrates the intense price competition that has been raging between vendors in not only the European but also the worldwide PC market since mid-1992. This competition, added together with component supply problems, has meant a tough year for all but the largest manufacturers.

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Nearly all the top vendors have shown healthy growth of twice or more that of the market, with the exception of Commodore (minus 48.5 percent), Amstrad (minus 43.5 percent), ICL (5.4 percent), Toshiba (6.3 percent), and Vobis (12.7 percent). Commodore's decline of 48.5 percent, in fact, pulled the whole European PC market down, while Amstrad suffered as it closed its European operations. Toshiba failed to keep pace with the market as most growth in 1993 came from the desktop arena, in which Toshiba is not a player. Vobis is now finding it difficult to penetrate markets like Italy and France, while suffering from saturation in its home market.

The big gainers during the year were Escom (133.8 percent), Digital (124.5 percent), Hewlett-Packard (75.4 percent), and Dell (73.6 percent). All these vendors show healthy increases over the previous year.

Analysis of PC Production in Europe

Effective European PC production—that is, where at least memory and/or microprocessor were purchased in Europe—in 1993 showed a healthy 32.3 percent growth to 10.2 million units (7.7 million in 1992), ahead of shipments growth of 8.7 percent. One of the reasons why production grew above sales is that European manufacturing locations are being used to supply the new markets of Eastern Europe, the Middle East and Africa; for instance, both IBM and Compaq supply these markets from Europe. Also, companies are expanding their production sites in Europe, while others have announced plants; an outline of recent major developments follows.

In 1993 **AST Research** announced that it was to establish a manufacturing and distribution center in Limerick, Ireland. The 32,000 m^2 plant began production of desktop PCs in the first quarter of 1994 for the European, African and Middle Eastern markets. The initial plant capacity will be some 500,000 units per year. AST also announced an overhaul of its manufacturing operations worldwide; this includes the closure of its East Kilbride plant, which will close down in March 1994.

At the start of 1994 **Compaq Computer** announced that it is to equip its PC plant with two surface-mount lines at a cost of $10.5 million. This will enable the Erskine plant to build some of the PCBs which until now have been imported from Compaq's Houston, Texas and Singapore operations; local production of PCBs should account for 15 to 20 percent of total PCBs consumed in Erskine by 1995.

In 1994 **Dell Computer** announced expansion of its manufacturing operations involving a further investment of more than $12 million, which will increase employment by nearly 400 people within three years, bringing total employment in Dell's Irish operations to over 1,000 people. Currently Dell is believed to be carrying out partial assembly of PCs at the site, with locally procured microprocessor and memory being added. However, it is understood that Dell subcontracts the manufacture of PCBs locally in Ireland and the United Kingdom.

In 1993 **Gateway 2000** announced plans to start manufacturing in Clonshaugh Industrial Estate in Dublin, Ireland. Production was due to start at the beginning of 1994. An investment of $20 million will be made in buying and modifying the plant.

Dataquest believes that as much as 10 percent of European PC production could be destined for markets other than Western Europe, but this could prove to be a double-edged sword, as discussed later.

Production by Company

Table 1 shows Dataquest's estimates of effective PC production ranked by company in Europe (manufacturers producing more than 2,000 machines a month). Among the top players, little has changed in terms of ranking, and production growths do not differ greatly. The continued trend towards the major manufacturers is indicated by the fact that the top 15 companies show a combined growth of 43.3 percent, while the others only achieved a growth of 17.3 percent. Dataquest expects this to continue.

These companies have had the resources to compete in the market as well as fight for component resources, but further down the table smaller companies have suffered at the hands of both their competitors and the component suppliers.

The greatest number of availability problems were encountered in the memory area, especially some DRAM product types. The demand for DRAMs in 1991 and at the beginning of 1992 was slack, and semiconductor companies ramped back their investment in new production lines for the 4M DRAM. When the PC market exploded in the last quarter of 1992, suppliers were unable to match DRAM production levels with the huge rise in demand. These problems continued throughout 1993, with some lead times reaching 26 weeks or more. Within the 4M DRAM market, wider-word-width, low-voltage and thin small-outline packages (TSOP) devices were particularly difficult to source.

With the product shortages, prices were seen to rise across the 4M DRAM family. DRAM suppliers were able to raise prices in all accounts as customers struggled to source products. Dataquest estimates that pricing levels were as much as 30 percent above the DRAM reference prices that apply to Japanese-sourced DRAM devices.

The explosion and fire that occurred at the Sumitomo resin factory at the beginning of July 1993 had some short-term effects on the pricing of DRAMs as well. Prices on the "grey" market were seen to double for some key components within two weeks of the explosion, though the effects were relatively short-lived. Prices fell again, and within two months were back to a level slightly above the prices seen before the accident.

These shortages and price rises have had profound effects on many PC producers. In order to counter the long lead times, PC makers have had to accurately forecast their needs on their DRAM suppliers, and have

Table 1
Final 1993 Effective European PC Production Ranking
(Thousands of Units)

Rank	Manufacturer	Desktop	Laptop and Notebook	Subnotebook	1993 Total	1992 Total	1992/93 Growth
1	IBM	1,360.0	140.0	-	1,500.0	1,200.0	25.0%
2	Compaq	902.5	47.5	-	950.0	690.0	37.7%
3	Apple	750.0	50.0	-	800.0	658.6	21.5%
4	Olivetti	581.0	25.0	-	606.0	547.0	10.8%
5	Vobis	391.0	50.0	-	441.0	238.0	85.3%
6	Dell	400.0	-	-	400.0	251.0	59.4%
7	Siemens Nixdorf	290.0	-	-	290.0	130.0	123.1%
8	Hewlett-Packard	280.0	-	-	280.0	200.0	40.0%
9	Escom	250.0	20.0	-	270.0	150.0	80.0%
10	ICL (Nokia Data)	260.0	-	-	260.0	209.0	24.4%
11	Digital	210.0	-	-	210.0	NA	NA
12	Zenith Data Systems	200.0	-	-	200.0	100.0	100.0%
13	Actebis	180.0	-	-	180.0	106.0	69.8%
14	Peacock Computers	136.5	13.5	-	150.0	52.0	188.5%
15	Tulip Computers	130.8	10.1	2.9	143.7	130.0	10.6%
16	Packard Bell	140.0	-	-	140.0	62.3	124.7%
17	Psion	-	-	125.0	125.0	151.0	-17.2%
18	Aquarius Systems	110.0	1.5	-	111.5	106.0	5.2%
19	Intel	106.0	-	-	106.0	30.0	253.3%
20	Acer	95.0	-	-	95.0	24.0	295.8%
21	Elonex	87.5	-	-	87.5	72.0	21.6%
22	PC Warehouse	72.0	-	-	72.0	60.0	20.0%
23	AST Research	56.0	14.0	-	70.0	50.0	40.0%
24	Acorn	68.9	-	-	68.9	85.5	-19.5%
25	Toshiba	-	66.0	-	66.0	62.7	5.3%
26	Olidata	57.5	-	-	57.5	55.0	4.6%
27	Mitac	56.0	-	-	56.0	NA	NA
28	NCR	54.8	-	-	54.8	45.0	21.8%
29	Research Machines	45.6	-	-	45.6	60.0	-24.0%
30	Apricot	45.0	-	-	45.0	33.0	36.4%
31	Viglen	43.0	-	-	43.0	31.0	38.7%
32	Opus	28.9	-	-	28.9	47.0	-38.6%
33	Wortmann	26.7	-	-	26.7	17.8	50.0%
	Other	2,185.0	34.8	-	2,219.9	2,055.6	3.3%
	Total Units	9,599.7	472.4	127.9	10,200.0	7,709.5	32.3%
	Split by Format	94.1%	4.6%	1.3%	100.0%		

NA = not applicable

Source: Dataquest (May 1994 Estimates)

had to look to the higher-priced "grey" market for some product supply. Rising prices have put the already slim margins available to PC producers under further pressure, and some companies have been unable to survive in the tough conditions prevalent in 1993.

Certain companies, such as Magix of Germany, have disappeared off our list of manufacturers since last year. Magix, for instance, just found the business unprofitable and now concentrates on software.

Production by Platform Footprint

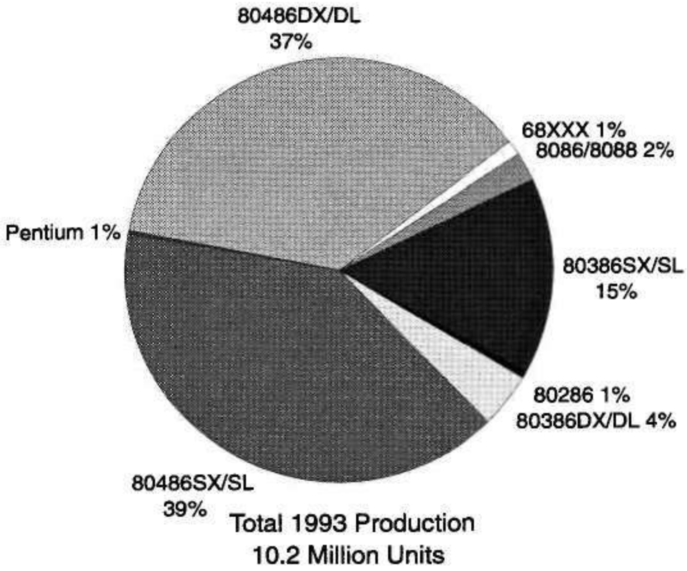
Europe's production of notebooks and subnotebooks still remains poor when compared with shipments in Europe. In 1993 it was desktop machines that drove the market, mainly due to a dramatic price/performance increase over an 18-month period.

The major players in the European notebook market (Compaq, Toshiba, Apple and IBM) all have manufacturing facilities in the Far East. As a general rule, notebooks are sourced from the Far East because economies of scale for local production are not as favorable as for desktops—for example, shipping costs, time-to-market, and so on. However, each of these companies does a limited amount of notebook assembly in Europe.

Production by Microprocessor

Dataquest believes that the 486DX2 and DX4 microprocessors will become the dominant microprocessors in 1994, but Intel is now accelerating its introduction of the Pentium microprocessor in the face of competition from AMD, SGS-Thomson, Texas Instruments (TI), Cyrix and IBM. Figure 1 shows the 1993 split of PC production by processor type, and Table 2 details production by manufacturer.

Figure 1
European PC Production by Microprocessor, 1993



Source: Dataquest (May 1994 Estimates)

Table 2
Final 1993 Effective European PC Production by Microprocessor
(Thousands of Units)

Manufacturer	8086/8088	80286	80386SX/SL	80386DX/DL	80486SX/S	80486DX/DL	Pentium	68XXX	Other	Total
IBM	-	-	229.5	7.5	786.0	474.0	3.0	-	-	1,500.0
Compaq	-	-	165.3	19.0	395.2	363.9	6.7	-	-	950.0
Apple	-	-	-	-	-	-	-	800.0	-	800.0
Olivetti	64.8	20.2	180.2	7.3	216.2	117.3	-	-	-	606.0
Vobis	1.1	0.8	24.5	83.0	115.2	215.0	1.4	-	0.1	441.0
Dell	-	-	35.2	0.8	153.6	208.4	2.0	-	-	400.0
Siemens Nixdorf	-	-	51.6	9.9	119.2	108.2	1.2	-	-	290.0
Hewlett-Packard	-	-	38.4	0.3	108.9	131.3	1.1	-	-	280.0
Escom	-	-	22.7	29.4	70.5	145.5	1.9	-	-	270.0
ICL (Nokia Data)	-	-	36.4	0.3	138.1	84.2	1.0	-	-	260.0
Digital	-	-	43.3	1.5	84.2	81.1	-	-	-	210.0
Zenith Data Systems	-	-	58.4	-	88.0	53.2	0.4	-	-	200.0
Actebis	-	-	10.3	18.5	62.3	88.9	-	-	-	180.0
Peacock Computers	-	1.8	10.2	18.0	26.4	93.6	-	-	-	150.0
Tulip Computers	-	-	16.7	28.8	62.4	35.9	-	-	-	143.7
Packard Bell	-	-	31.4	-	72.1	36.5	-	-	-	140.0
Psion	125.0	-	-	-	-	-	-	-	-	125.0
Aquarius Systems	-	-	3.2	2.2	49.9	55.0	1.2	-	-	111.5
Intel	-	-	4.0	6.0	38.0	58.0	-	-	-	106.0
Acer	-	0.5	23.0	1.0	37.1	33.5	-	-	-	95.0
Elonex	-	-	-	-	55.6	32.0	-	-	-	87.5
PC Warehouse	-	-	6.8	1.0	36.4	27.5	0.3	-	-	72.0
AST Research	-	-	7.0	-	49.0	14.0	-	-	-	70.0
Acorn	-	-	-	-	-	-	-	-	68.9	68.9
Toshiba	-	-	29.1	-	32.9	4.0	-	-	-	66.0
Olidata	-	-	13.3	8.3	6.6	28.6	0.7	-	-	57.5

(Continued)

Table 2 (Continued)
Final 1993 Effective European PC Production by Microprocessor
(Thousands of Units)

Manufacturer	8086/8088	80286	80386SX/SL	80386DX/DL	80486SX/S	80486DX/DL	Pentium	68XXX	Other	Total
Mitac	-	0.1	8.6	1.0	28.8	17.5	-	-	-	56.0
NCR	-	-	10.6	-	20.8	23.5	-	-	-	54.8
Research Machines	-	-	9.1	-	29.6	6.8	-	-	-	45.6
Apricot	-	-	9.0	9.0	18.0	9.0	-	-	-	45.0
Viglen	-	-	1.7	1.7	18.1	21.5	-	-	-	43.0
Opus	-	-	6.1	0.2	11.1	11.5	-	-	-	28.9
Wortmann	-	-	-	8.0	8.0	10.7	-	-	-	26.7
Other	5.3	8.8	389.8	147.0	749.2	917.2	2.6	-	-	2,219.9
Total Units	196.2	32.1	1,475.3	409.5	3,687.3	3,507.3	23.4	800.0	68.9	10,200.0
Split by Format	1.9%	0.3%	14.5%	4.0%	36.2%	34.4%	0.2%	7.8%	0.7%	100.0%

Source: Dataquest (May 1994 Estimates)

During 1993 the 68xxx was used only by Apple—previously, Commodore had manufactured its Amiga in Europe which used the 68xxx. At the start of 1994 Apple began switching its product line to the PowerPC, but some 68xxx production is likely to continue until mid-1995 as old products lines are phased out. The PowerPC is guaranteed to have limited success, at least with Apple alone, but other take-up depends on purchasers making a positive decision to buy a PowerPC machine. A number of manufacturers like Vobis, Aquarius Systems and Peacock have already announced PowerPC machines, but they are also supporting Pentium and, in some instances, Digital's Alpha.

Production and Design by Country

It is no surprise that, once again, the United Kingdom and Ireland dominate the rest of Europe in terms of PC production, as the top three manufacturers are all located there. The regional development agencies for Ireland and Scotland have worked very hard to attract the PC manufacturers and their associated industry in the last eight years, and continue to have success, with the United Kingdom and Ireland being the first choice. Ireland had a good year in 1993; previously, it had suffered the loss of Digital to Scotland, but it attracted AST Computer to Ireland, along with Gateway 2000.

Table 3 lists the European manufacturing locations. The table also gives some indication as to the type of work carried out there, as follows:

- **Full stuffing** of the motherboard means where all semiconductors are loaded onto a printed circuit board, while **part stuffing** of the motherboard refers to when some components (usually memory or microprocessors) are loaded onto a PCB.
- **Subcontract assembly** applies to the manufacture of partially stuffed PC motherboards that are contracted to an outside company within Europe.
- **Screwdriver assembly** involves the assembly of PCs from brought-in, subassembled components; companies involved in only this type of manufacture are not shown in Table 3.
- The design location of the PC motherboard is also indicated in the last column. **OEM** means that the motherboard comes in from the Far East and is sourced from one of the numerous motherboard manufacturers.

As can be seen from Table 3, one area where Europe lags behind other world regions is in the design of PC motherboards. Dataquest estimates that for 1993, just over 45 percent of PC manufactured in Europe have motherboards designed in Europe or with a European design influence. For semiconductor manufacturers wishing to sell products other than microprocessors and memory, the European design influence is important. Figure 2 shows the country split of PC production in 1993.

Table 3
European PC Manufacturing and Design Locations

Company	City	Country	Full Stuffing	Part Stuffing	Subcontract	Screwdriver	PCB Design Location
Acer	Ahrensburg	Germany		✓		✓	Lungtan,Taiwan and San Jose, USA
Acer	Eindhoven	Netherlands		✓		✓	Lungtan,Taiwan and San Jose, USA
Acorn	Cambridge	England			✓		Cambridge, England
Actebis	Soest	Germany		✓			OEM
Add-X-Normerel	Granville	France	✓	✓			Hauts de Buc, France
ADL Computers	Madrid	Spain		✓		✓	OEM
Amstrad	Shoeburyness	England		✓	✓		Brentwood, UK
Apple	Cork	Ireland	✓				Apple US and European input
Apricot	Glenrothes	Scotland	✓		✓	✓	Birmingham, UK and OEM
Aquarius Systems	Bad Homburg	Germany		✓			Aquarius Taiwan
ASEM	Buia	Italy		✓		✓	Buia, Italy
AST Europe [1]	East Kilbride	Scotland		✓			Irvine, USA
AST Europe [2]	Limerick	Ireland		✓			Irvine, USA
Batavia	Tiefenbach	Germany		✓			OEM
CDC	Fornacette	Italy		✓			OEM
Cinet	Oslo	Norway		✓		✓	Oslo, Norway
Compaq	Erskine	Scotland	✓	✓			Houston, USA
CompuAdd	Bristol	England		✓			Austin, USA
Dell	Limerick	Ireland		✓			Austin, USA
Digital	Ayr	Scotland	✓	✓			Taiwan and USA
Elonex	London	England		✓			Oakleigh Systems, USA
Elonex (Cordata)	Cumbernauld	Scotland	✓	✓			Oakleigh Systems, USA
Escom	Dresden	Germany		✓			OEM
Escom	Irvine	Scotland		✓			OEM
Gateway 2000 [2]	Dublin	Ireland		✓			North Sioux City, USA

[1] Closed during 1993 or after
[2] Due to start in 1994 or after

(Continued)

Table 3 (Continued)
European PC Manufacturing and Design Locations

Company	City	Country	Full Stuffing	Part Stuffing	Subcontract	Screwdriver	PCB Design Location
Hewlett-Packard	Ile d'Abeau (Lyon)	France		✓	✓		Grenoble, France
IBM	Greenock	Scotland	✓	✓	✓		Boca Raton, US with Greenock inputs
ICL (Nokia Data)	Ashton-Under-Lyne	England		✓			Kidsgrove, UK
ICL (Nokia Data)	Helsinki	Finland	✓	✓			Linkoping, Sweden
ICL (Nokia Data)	Kidsgrove	England	✓				Kidsgrove, UK
Intel	Leixlip, Co. Kildare	Ireland	✓				Oregon, USA
Microsys	Perugia	Italy		✓			OEM
Mitac	Telford	England		✓			Mitac Taiwan
NCR	Augsburg	Germany	✓				USA
Olidata	Cesena	Italy		✓			OEM
Olivetti	Marcianise	Italy	✓				Ivrea, Italy and Cupertino, US
Olivetti	Scarmagno	Italy	✓				Ivrea, Italy and Cupertino, US
Opus	Redhill	England		✓		✓	OEM
Packard Bell	Wijchen	Netherlands		✓			N/A
Packard Bell [2]	Angers	France	✓				N/A
PC Warehouse	Val-de-Reuil	France		✓			Taiwan
Peacock Computers	Wunnenberg-Haaren	Germany		✓	✓		Wünnenberg, Germany and OEM
Psion	London	England	✓	✓			London, UK
Research Machines	Oxford	England		✓		✓	OEM
SHR	Ravenna	Italy		✓			OEM
Siemens Nixdorf	Augsburg	Germany	✓			✓	Augsburg, Germany and OEM
Siemens Nixdorf	Dresden	Germany	✓				Augsburg, Germany and OEM
Siemens Nixdorf	Fürth	Germany	✓				Augsburg, Germany and OEM
Siemens Nixdorf	Haubourdin	France	✓				Augsburg, Germany and OEM

[1] Closed during 1993 or after
[2] Due to start in 1994 or after
N/A = not available

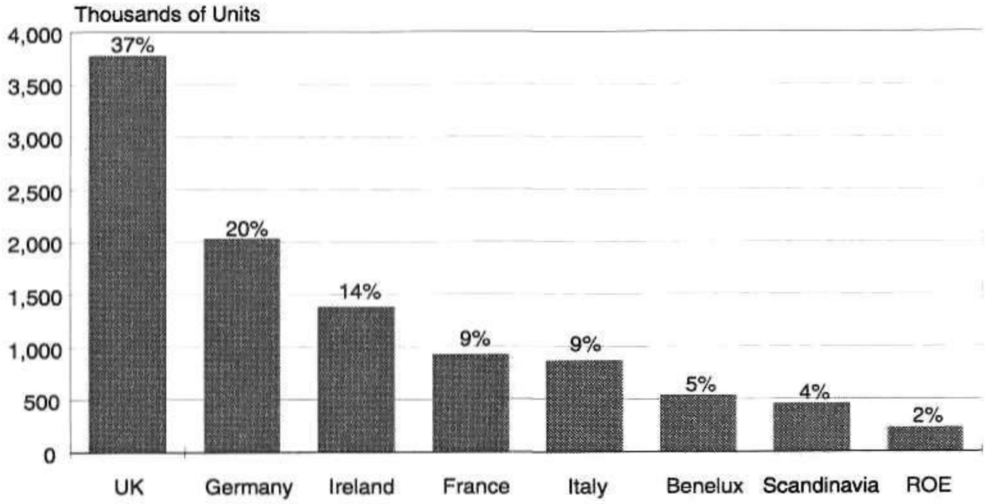
(Continued)

Table 3 (Continued)
European PC Manufacturing and Design Locations

Company	City	Country	Full Stuffing	Part Stuffing	Subcontract	Screwdriver	PCB Design Location
Soecoma Computers	Veldhoven	Netherlands		✓			OEM
Tiki Data	Oslo	Norway		✓	✓		Oslo, Norway
Toshiba	Regensberg	Germany	✓				Japan
Tulip Computers	Hertogenbosch	Netherlands	✓	✓			Hertogenbosch, Netherlands
Unisys	Barentin	France		✓			San Jose, USA
Viglen	Alperton	England		✓	✓		Alperton, UK and OEM
Vobis	Aachen	Germany		✓		✓	OEM
Vobis	Würselen	Germany		✓			OEM
Vobis	Siegen	Germany		✓			OEM
Vobis	Eupen	Belgium		✓			OEM
Vobis	Vienna	Austria		✓			OEM
Wortmann Computer	Hullhorst	Germany		✓		✓	OEM
ZDS	Angers	France	✓				N/A

[1] Closed during 1993 or after
[2] Due to start in 1994 or after
N/A = not available
Source: Dataquest (May 1994)

Figure 2
European PC Production by Country, 1993



Source: Dataquest (May 1994 Estimates)

Dataquest Perspective

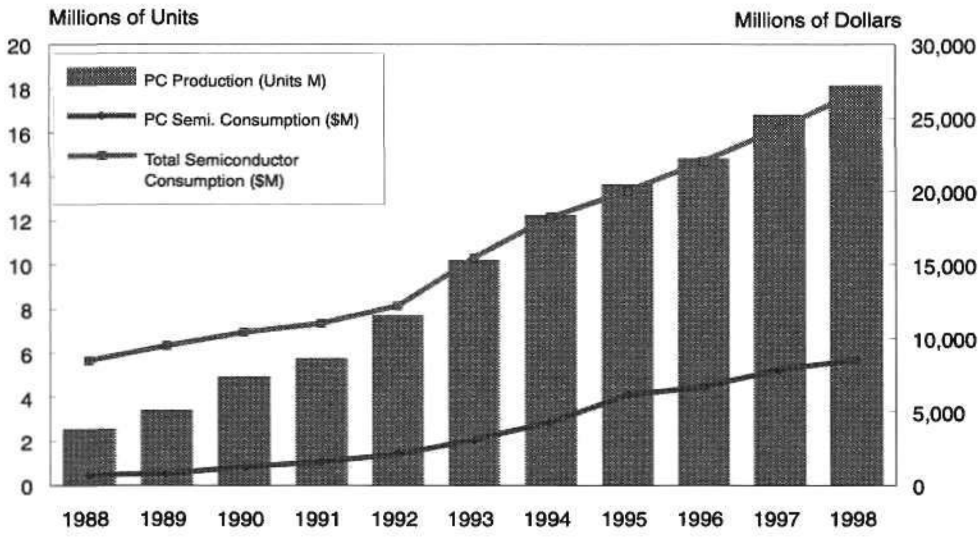
Dataquest's estimates show that the PC manufacturing industry in Europe accounts for approximately 20 percent of the total semiconductor market, rising to more than 30 percent in 1998, as shown in Figure 3.

With major manufacturers expanding or setting up production plants, Dataquest forecasts PC production in Europe to rise by 20 percent to 12.2 million units in 1994. The 486 microprocessor will almost certainly remain the dominant platform, with the high-end 486DX2 and DX4 likely to be the most popular variants, as users continue to demand greater computing power.

During 1994, however, we will start to see a change in microprocessor usage as Intel will be pushing the Pentium. Intel is predicting that the Pentium will account for 25 percent of PC shipments worldwide by the end of 1994. Further still, Intel will be facing competition from the PowerPC grouping of IBM, Apple and Motorola.

The rise in the importance of the PC for the semiconductor market is driven by the ever-increasing number of units produced. Also at the same time, machines are moving to ever higher-value microprocessors whose prices are also relatively more expensive than the previous generation. Memory prices are falling but machines are shipping with ever-increasing memory content, which will more than offset the fall in prices. By 1996 we expect to see the start of the trend towards dual-microprocessor machines; this again will have the effect of increasing the

Figure 3
European Semiconductor Consumption and PC Semiconductor Consumption



Source: Dataquest (May 1994 Estimates)

average semiconductor content per machine. Dataquest will be analysing and reporting these trends through its new series of reports entitled *Dataquest Inside the New PCs* (see the end of this *Dataquest Perspective* for more information).

Shortages

The market conditions for memory experienced in 1993 are continuing in the early months of 1994. Dataquest has seen no evidence of any slowdown in demand for memory and other key components from the PC producers; many are being extremely aggressive with increases in manufacturing plans for 1994. Also, Dataquest is expecting the amount of memory per PC to increase substantially this year, creating further demand for memory, especially DRAM devices.

If the PC market remains strong, DRAM demand will still lead supply for the majority of the year. This means another difficult year for PC producers as they search for the best pricing and delivery deals to keep their end equipment competitive in the market.

DRAM producers are increasing production levels and Dataquest believes that some devices should reach demand-and-supply balance during the second quarter of this year. However, other devices will remain in shortage, provided that current demand levels continue throughout the year. One challenge for DRAM suppliers is to match their production mix plans to their customers' needs. With more than 250 different types of 4M DRAM, this becomes a difficult task.

Finally, how long can the PC industry almost single-handedly drive the semiconductor industry? And what could cause the end of the semiconductor PC boom, or PC manufacturing in Europe to falter? Some factors:

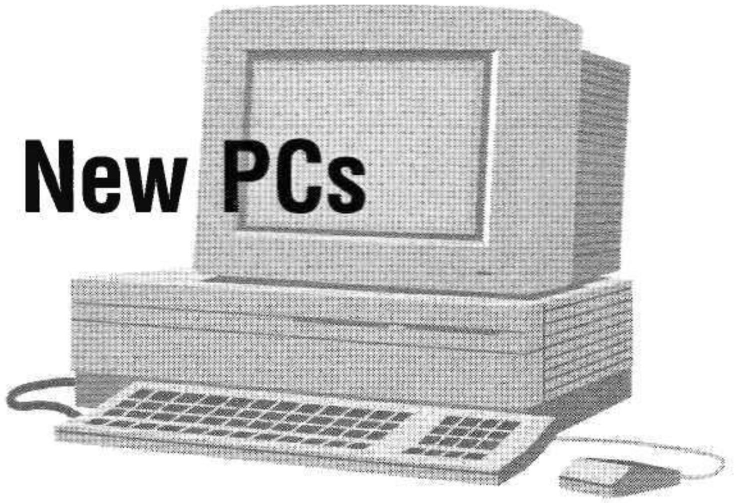
- At some point the European PC market will radically change from being a growth market to a replacement market; at the moment, Dataquest expects this to happen after 1998.
- As the Eastern European PC market increases, some manufacturers may decide to relocate their plants nearer to that region, enabling them to supply both Germany and Central and Eastern Europe, while benefiting from less expensive labor costs and from generous grants.
- Changes to the European tariff structure could alter the economies of manufacturing in Europe, or alternatively other countries changing their tariff can affect manufacturing here (for example the US active-matrix display tariffs).
- Component costs rising in Europe against the worldwide average.
- A DRAM crisis brought about by a conflict between North and South Korea or another Sumitomo-type disaster, for instance, could have a disastrous effect both in Europe and worldwide.

In summary, we expect PC production to reach 12.2 million units in 1994 and forecast production activity to increase at a compound annual growth rate of 12.6 percent between 1993 and 1998, reaching 18.15 million units. The emergence of multimedia and teleworking should help to prolong the PC boom for the time being. Dataquest will continue to monitor trends in the European manufacturing industry and related issues, publishing a preliminary estimate of 1994 PC production in January 1995.

By Andrew Norwood
Adrian Walker

New from **Dataquest**

Inside the New PCs



A series of reports analysing the manufacturing costs and bill-of-materials of the latest PC and workstations.

"Dataquest Inside the New PCs"

Dataquest is launching a new PC teardown analysis service on June 1, 1994. Dataquest has developed a new product offering that will be indispensable to you as a manufacturer, supplier or OEM of PCs and workstation products.

Every month, Dataquest acquires four to six of the newest PCs or workstations on the market and performs a full teardown analysis of each new model. Dataquest analysts produce a series of detailed reports containing a complete bill-of-materials and further analysis in design and manufacturing trade-offs, with opinion on pros and cons.

These new reports go beyond semiconductor contents to include mechanical and cabling elements, connectors, casing materials, packaging, PCBs, power supplies, flat panel displays, keyboards and storage subsystems.

The new *Dataquest Inside the New PCs* reports offer an independent one-source database of PC bill-of-materials, pricing of these materials and a pricing forecast of PC components; the database is also available on floppy disk.

For further information about these PC teardown analyses, please contact Mike Williams on +44 (0) 494 422722 or send him a fax on +44 (0) 494 422742.

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Dataquest Perspective

Semiconductors

Semiconductor Application Markets Europe

In This Issue

Consumer TV and Video Production in Europe

Digital TV is set to become a reality in Europe by the year 2000, in tandem with high-definition TV. However, European manufacturers need to gear themselves up to take advantage of the next consumer boom, in both Western and Eastern Europe. These are some of the trends identified by a major survery that Dataquest has carried out of consumer electronics production. The market for this equipment is set to grow to $2 billion in 1994, up slightly on 1993, although still comprising only 11 percent of the total semiconductor market. This *Dataquest Perspective* shows estimates for the unit production of the major manufacturers in Europe, and estimates the percentage of those products which contain European-sourced semiconductors. The main topics in focus are as follows:

By Mike Williams

Consumer TV and Video Production in Europe

Summary

As a proportion of overall semiconductor consumption in Europe, consumer electronic equipment production (including white goods) accounted for 12 percent of all semiconductor sales during 1993. Dataquest forecasts that in 1994, this market segment will grow from $1.9 billion to $2.0 billion, but will only account for 11 percent of semiconductor market this year.

Combined television and videocassette recorder production in Europe accounted for nearly 60 percent of the consumer electronics industry semiconductor total available market (TAM) during 1993. Television alone accounts for 45 percent of the total video equipment manufactured in Europe. The largest volume of TV production is in the United Kingdom, but Germany is the largest volume producer of consumer video equipment, contributing nearly 22 percent of all European video equipment production.

This *Dataquest Perspective* is a summary of the results from an extensive survey of consumer electronics production in Europe conducted by

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Product Code: SAMM-EU-DP-9401
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Dataquest early this year. It shows estimates for the unit production of the major manufacturers in Europe, and estimates the percentage of those products which contain European-sourced semiconductors.

European Video Market Overview

Consumer video equipment is defined as television (TV), videocassette recorders (VCR) and camcorders. During 1993, the market for video equipment in Europe remained flat at 36.5 million units. In 1994, the video markets are forecast to reach 39.5 million units, with most of the growth in 1994 forecast to come from television sets. Dataquest believes that depressed economic conditions have delayed many prospective purchases of television. Some initial indications of a slow recovery in the economic situation in Europe, plus the effect of the World Cup (although the 1992 Olympics failed to prove this theory) could stimulate market growth this year.

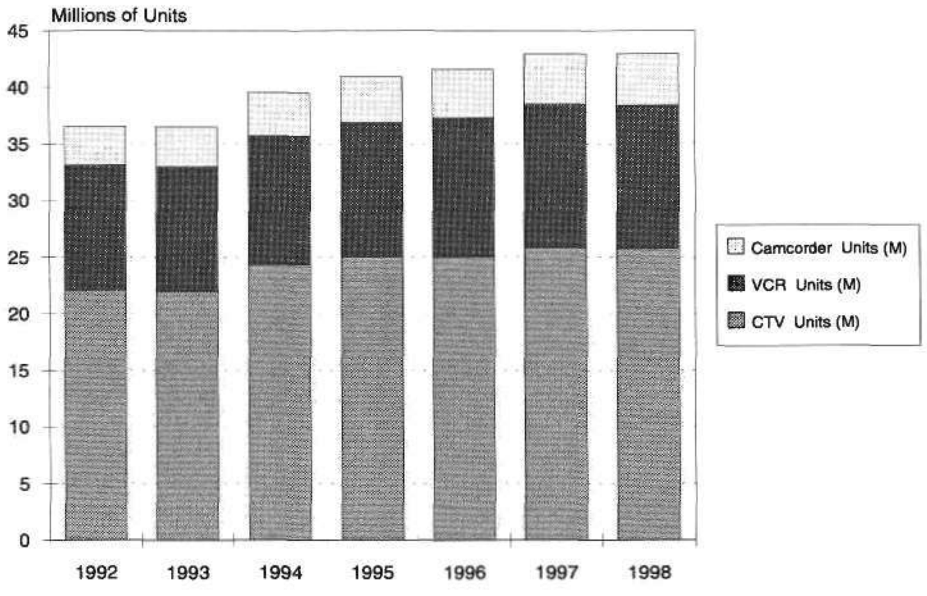
Market Trends

Figure 1 shows the market trends for consumer video equipment. By 1998, the European video market is expected to reach 43 million units. In volume terms, the largest market is television which, having reached a plateau in the late 1980s, is now being stimulated by growth in the expanded European market. The fastest-growing market segment is video camcorder equipment. VCR equipment is now reaching maturity as satellite and cable television systems take off.

Key Players in Europe

By far the most significant players in Europe are those with TV manufacturing capability locally. The leading players are Philips, Thomson

Figure 1
Video Equipment Markets in Europe



Source: Dataquest (March 1994 Estimates)

Consumer Electronics, Nokia and Grundig. Sony, too, is a key player, although the strong value of the Japanese currency and a shift in corporate strategy towards focusing on emerging markets for minidisc/multimedia technologies has had some effect on the company's ability to pour more investment in this region. VCR accounts for a smaller proportion (33 percent) of the consumer video equipment market as most VCR production worldwide still comes from Japan and the Far East.

Video Equipment Markets Growth Factors

In many consumer markets of this nature, new growth comes mostly from the addition of new features to enhance an aging product. This industry as a whole is now lacking new technology and new features, but all this is soon to change. The introduction of digital television will bring a new impetus to the world of television and its peripheral markets. For the time being, this industry has been sustained by replacement equipment markets and second-time buyers.

Dataquest believes that only 5 percent of color televisions bought were "first-time" purchases. Of the rest, 40 percent were replacements and 60 percent were additional sets for the home. In VCR equipment markets, we believe about 40 percent were first-time purchases, and of the remainder nearly 90 percent were replacement purchases and 10 percent accounted for additional sets.

Analysis of Video Equipment Production in Europe

Overview

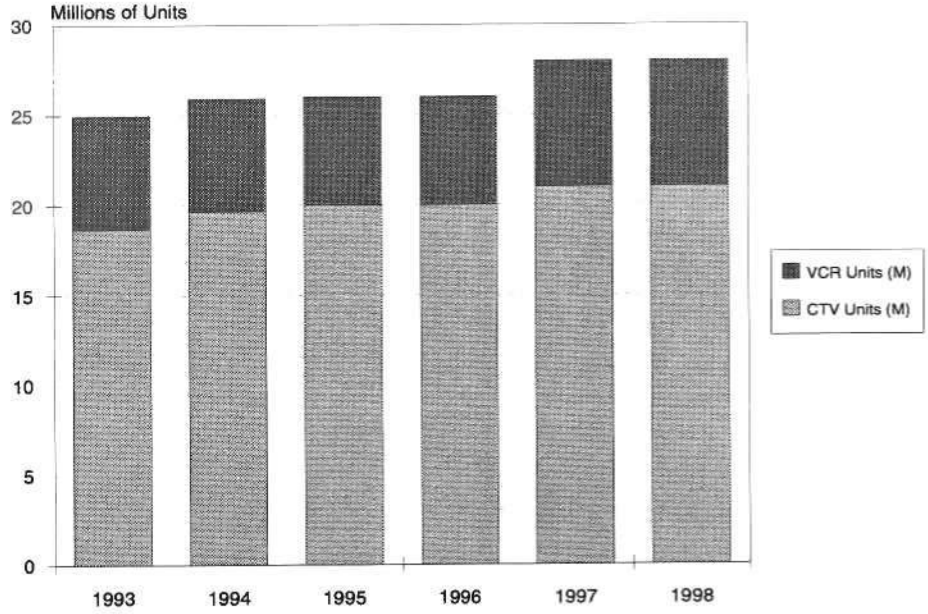
Overall, European unit production of TV and VCR is nearly 26 million units. Compared with the European market, local production (excluding screwdriver activity) accounts for 70 percent of the total European market for combined TV and VCR sales.

Television production accounts for the largest proportion of all video equipment manufactured in Europe. In unit terms, television production during 1993 amounted to approximately 75 percent of all video equipment built in Europe. VCR decks represent nearly 24 percent and the remainder is Sony's camcorder production at its Ribeauville plant in France. Figure 2 shows the production forecast of TV and VCR equipment trends in Europe. We have excluded camcorder production forecasts in this *Dataquest Perspective* (presently only Sony is a local manufacturer). In later sections of this report, we look at the European TV and VCR semiconductor markets separately.

Video Equipment Production Country Splits

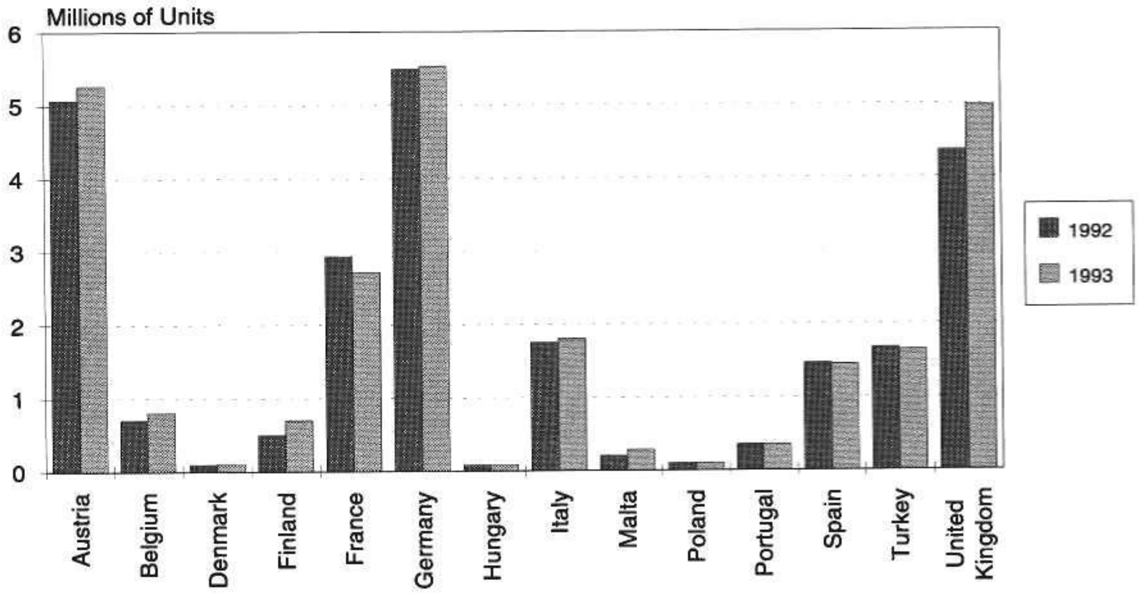
By country, the largest single manufacturing base for video equipment is Germany. During 1993, Dataquest estimates German manufacture of video equipment at 2.8 million TVs and 2.24 million VCRs. Germany has a total of 12 TV and VCR manufacturing plants including Nokia, Thomson and Grundig as the major manufacturers in this country. Other companies active in Germany include Loewe Opta, Matsushita, RFT, Sony, and Toshiba.

Figure 2
European Consumer Video Equipment Production Forecast (TV and VCR Only)



Source: Dataquest (March 1994 Estimates)

Figure 3
Consumer Video Equipment Production in Europe (TV and VCR Only)



Source: Dataquest (March 1994 Estimates)

The second most important country for video equipment production is the United Kingdom, which has gained its strength from successfully attracting Japanese and Far Eastern electronic equipment companies into the country. Other major producing countries are Austria, which has shown a relatively stable production volume, and France and Italy. Figure 3 shows country video equipment production in Europe.

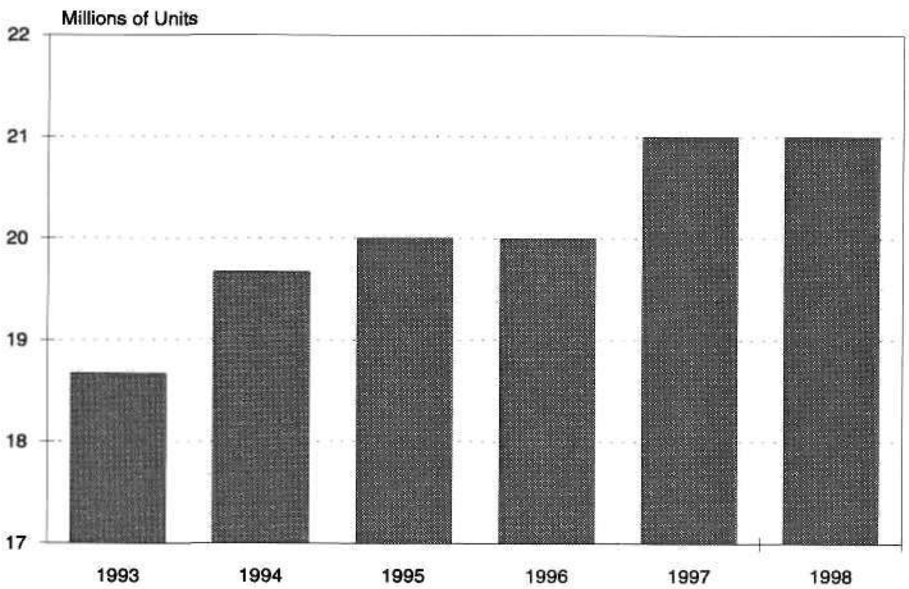
European TV Manufacturing Overview

European TV manufacturing industry has suffered from the general recession that ushered in the 1990s. During this period, the consumer markets were first to suffer as so-called "luxury goods" became less critical as a result of weakened consumer confidence and spending limitations due to higher unemployment. Cheaper televisions imported from Korea and other Far Eastern countries made it difficult for European players to trade.

Consequently, many companies had to reconsider their manufacturing activity in Europe: Thomson moved its Ferguson manufacturing activity at Gosport in England to Singapore during 1992; Thomson also closed its Berlin factory in 1993 and shifted production there to a factory in Singapore; Grundig closed down its factory at Creutzwald in France at the end of 1993, and is planning further job cuts at its German factories for 1994.

Figure 4 shows the television production forecast for Europe. While the market in Europe is poised for expansion from the expanding Eastern European market, production of high-end televisions is expected to

Figure 4
Television Production Forecast



Source: Dataquest (March 1994 Estimates)

continue to service the requirements of most of Western Europe, while cheaper imports from the Far East are more likely to fulfill the demand from most of Eastern Europe.

Country Television Production Trends

Figure 5 shows country television production in Europe from 1992 to 1993. TV production in the United Kingdom alone represents 19.5 percent of total Europe. The combined production of Austria, France, Germany, Italy and the United Kingdom represents the bulk of European TV production, estimated to be 75 percent. Most TV production in these countries are high-end TVs mainly for satisfying demand from Western European markets.

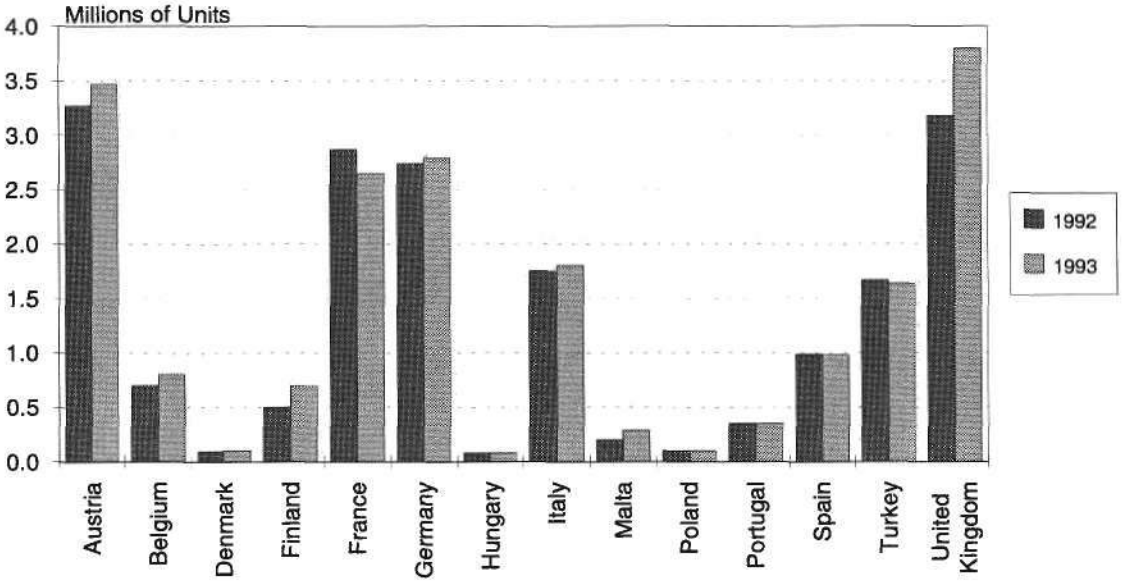
Major Television Equipment Manufacturers

As mentioned earlier, Philips, Thomson, Sony, Nokia and Grundig are the leading manufacturers of televisions in Europe. Altogether, these five companies account for nearly 50 percent of total European TV production. With the exception of the Japanese and Far Eastern players, the rest of the players are present in particular national markets, for example: in Italy, Mivar and Seleco; in France, Thomson (although Thomson has several brand names for the rest of Europe); and in Germany, Loewe and Metz. Figure 6 shows the major television manufacturers' production in Europe.

CRT (Picture Tube) Manufacturers in Europe

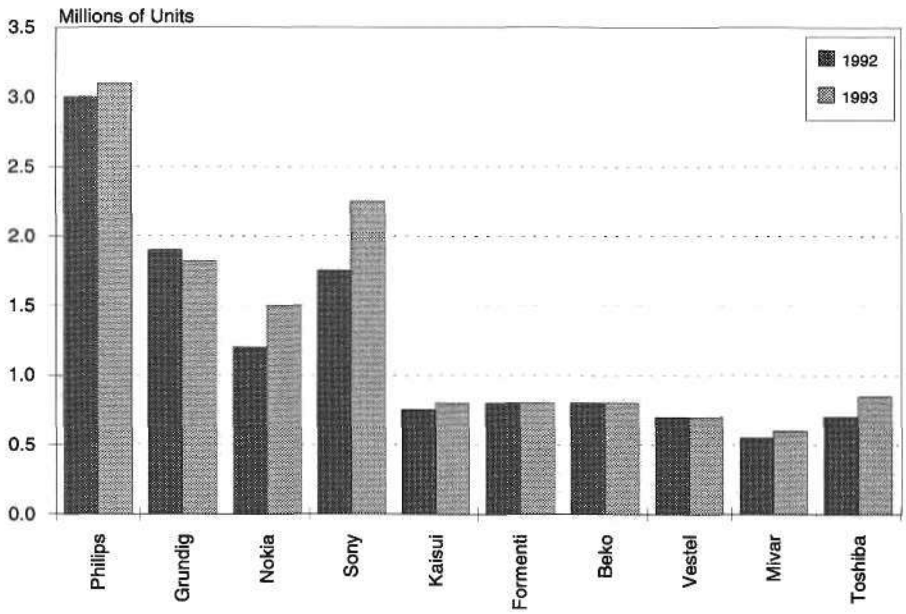
Until now, all the major TV manufacturers have had their own in-house cathode-ray tube (CRT) manufacturing. In the earlier days of television,

Figure 5
TV Production by Country



Source: Dataquest (March 1994 Estimates)

Figure 6
Leading TV Manufacturers in Europe



Source: Dataquest (March 1994 Estimates)

in-house CRT manufacturing capability was viewed as a strategic strength. Nowadays, advances in technology make the business of manufacturing picture tubes less critical as their applications have expanded beyond television into other areas such as computing, communications and other industrial applications.

Philips manufactures CRTs for color televisions and computer systems at Durham in England. Philips has commenced expansion work on a $28 million investment to achieve capacity of 2.3 million units annually.

Last year, Nokia spent $35 million modernizing its picture tube factory at Esslingen, Germany in an attempt to find a partner or buyer, but the company has so far failed to find any suitable investor. In March 1994, Nokia announced plans to stop producing tubes at Esslingen but will continue making televisions buying picture tubes from outside suppliers, possibly Hitachi. Sony and Thomson also make their own picture tubes in Europe.

Recent difficult market conditions after the mini-boom following unification of the former east Germany into the new federal republic have meant that CRT manufacturers in Europe that were anticipating a consumer boom during the Barcelona Olympics experienced a decline in their markets as European TV markets/production stagnated. In an attempt to maintain productivity, many CRT manufacturers are addressing other markets such as the computer monitor markets.

Technology Trends and Growth Factors

The key trends affecting the television segment are all digital: the move from analog technology to digital technology. Digital technology for television provides a superior platform for vastly enhanced sound, picture and broadcasting transmission quality. The most publicized plan for this is high-definition television (HDTV).

Like all consumer markets, growth in a mature product segment usually comes from new developments in technology, features, and design. Expanding the markets also helps boost volumes, but only for a short while as the television market in particular is essentially a replacement market with a relatively small proportion of first-time buyers annually.

Large-screen television is already becoming popular in Europe and the next trend will be toward wide-screen viewing. Digital television is more likely to deliver HDTV in Europe. In its very early days, teletext was a set-top peripheral before it became integrated into television sets. Other features like built-in cable television receivers (CATV) and satellite receivers are also likely to follow the same route. It may be too early to forecast built-in CATV/satellite receivers for television sets, as some standards still need clarification—especially in relation to digital television. The potential volume markets in Eastern Europe remain to be reaped although this may still be many years to come.

Wide-Screen and HDTV Plans in Europe

The future of television is widely acknowledged to move toward wide-screen 16:9 aspect ratio format, helping television to compete with cinemas. In Europe all the major TV manufacturers are providing wide-screen television sets as part of their product range.

Presently, only a very small proportion of consumers (mainly early adopters) have wide-screen TVs as the market price of these sets averages three times that of ordinary large-screen television sets. There is a trend in Europe for wide-screen TV but the picture-tube depths required for wide-screen TV makes it less attractive for most Europeans. LCD technology, or ceiling-to-screen projection TV, may likely offer a solution for reducing the depth of wide-screen TVs in Europe.

Although HDTV may be a number of years away for Europe, the European TV industry is certain to have wide-screen TVs before digital HDTV. The European Commission (EC) established D2-MAC (Multiplexed Analog Component) as a mandatory standard for all television broadcasting satellites as the first steps towards HD-MAC. British Sky Broadcasting (BSB) found a loophole in this regulation and started transmitting television broadcasts over telecommunications satellites. This action by satellite television broadcasters completely discarded the initiative but paved the way for wide-screen television.

After more than a year of uncertainty, the European Commission finally agreed on a plan for wide-screen TV. The four-year $265 million plan is to promote wide-screen TV services within the European Union (EU).

The subsidies are available only to broadcasters and program producers. This plan is expected to stimulate market growth for wide-screen televisions across Europe from 1997 onwards.

The European Commission will distribute $185 million to broadcasters between June 1993 and June 1997 to help upgrade equipment to wide-screen technology, convert existing programs and produce new ones in the wide-screen format. Industry and public institutions will have to match the EC funding. A further $80 million will then be made available in 1995 for those smaller countries which have less well-developed media industries.

The European Commission and the French and Dutch governments hope that this plan could lead to development of an HDTV standard for Europe. The United Kingdom's government, in agreeing, won guarantees that Japanese TV manufacturers based in the United Kingdom—such as Sony—would be eligible for future research projects and standards discussions.

Meanwhile, in the United States the contenders in the digital HDTV race have formed a "Grand Alliance." The Federal Communications Commission (FCC) has approved the consolidation of the major contenders into an alliance to come up with the final standard. The companies/universities involved include the following:

- Massachusetts Institute of Technology (MIT)
- General Instrument
- AT&T
- Zenith
- Advanced Television Research Consortium
  - Philips Consumer
  - Thomson Consumer
  - David Sarnoff Research Center
  - Compression Labs Inc.
  - NBC

The FCC is coordinating the US version of HDTV. The alliance has already finalized details of the US HDTV standards, which will now have the specification shown in Table 1.

This specification has been presented to the FCC and it is expected to be approved within the next six months. Already the FCC has approved the VSB transmission mode for HDTV. By the winter consumer electronics show in 1995, the US market should have seen early HDTV production models. Now that the Japanese Ministry of Post and Telecommunications has announced plans to review current Japanese policy on HDTV, the "Grand Alliance" lead is a significant breakthrough as it may form the basis of a global digital HDTV standard.

Table 1
US HDTV Specifications

Specification	Recommendation
Video Compression	MPEG 2 HDTV profile with "B" frames
Audio Compression	Dolby AC-3 six channel-CD, Musicam (in testing)
Scanning Mode	Both progressive and interlaced
Video Resolution	1920 × 1080 (active in interlaced 1280 × 720 (active) initially for progressive
Screen Aspect Ratio	16:9
Transmission Mode	Vestigial sideband (VSB-16) or quadrature amplitude modulation (QAM-32)
Transport Structure	Packetized based on MPEG-2 specification

Source: Grand Alliance

Europe's Route to HDTV

Over the years, the European market has maintained its individual country market characteristics until the formation of a common European market which has led towards harmonization. The first steps toward harmonizing European television markets were announced in 1986 when EUREKA (the European Commission project) put together recommendations and a proposal for a new television format as an intermediate step between analog broadcasting and a digital television broadcasting standard in Europe.

High-definition television in Europe was proposed and a standard defined as HD-MAC. This was presented by the EC through EUREKA to European governments, TV manufacturers and terrestrial broadcasting authorities. HD-MAC would be compatible with the family of existing European Broadcast Union MAC standards. D2-MAC was developed as a cable and satellite standard by the Comité Consultatif International de Télégraphie et Téléphonie (CCITT) in France and later also supported by the Deutsche Bundespost. Both HD-MAC and D2-MAC offered some advantages over PAL (Phase Alternating Line) and SECAM (Sequentiel Couleur Avec Memoire: sequential color with memory) in terms of improved sound, greater picture resolution and an optional 16:9 wide-picture aspect ratio.

However, the cost of ownership of a HD-MAC standard as an intermediate step toward reaching full digital broadcast makes it unattractive to both consumers and broadcasters as both parties strive endlessly to attain realistic market prices for HDTV wide-screen sets. The European industry has now discarded the HD-MAC route; the most likely way forward is for Europe to go for a fully digital HDTV and broadcasting standard.

To date, an interim solution to wide-screen (16:9), but not high-definition, has been put forward, PALplus. PALplus (a program involving Nokia, Philips, Thomson and major PAL broadcasting authorities in

Europe) allows programs to be broadcast in the 16:9 wide-screen format using existing PAL delivery systems, and be received on either 16:9 or existing 4:3 receivers. The establishment and formation of PALplus is focused around the consensus that future television standards will be wide-screen with 16:9 aspect ratio.

Nordic efforts towards reaching terrestrial digital HDTV have resulted in the formation of a project known as HD-DIVINE (*Di*gital *Vi*deo *N*arrow-band *E*mission). HD-DIVINE aims to develop a digital HDTV/TV system which can be introduced in Europe before the year 2000.

The company HD-DIVINE was established April 1, 1993. It is owned by Teracom/Svensk Rundradio, formerly Swedish Telecom Radio, (40 percent); Telia of Sweden (30 percent), Sveriges Television (10 percent), Telecom Danmark (10 percent) and Telecom Finland (10 percent). HD-DIVINE demonstrated the basic concept of digital terrestrial HDTV in 1992 at the IBC in Amsterdam and has reached an agreement with Nokia to develop receivers for the consumer market based on the system specification provided by HD-DIVINE. HD-DIVINE plans to present this as a basis for a European standard of digital broadcasting to the European Telecommunications Standards Institute (ETSI). The plan is to present the complete system in Berlin at the 1995 International Funkausstellung (IFA); although the pending acceptance of Finland and Sweden into the European Union could completely alter these plans.

Parallel to this is the establishment of a consortium known as the European Launching Group for Digital Video Broadcasting (ELG-DVB). So far, some 120 institutions (including satellite and network operators, equipment manufacturers, program providers and administrations) from 12 European countries have signed the Memorandum of Understanding (MoU) on the European "digital television" project to provide a European digital television and place it on the market as from 1995. The MoU aims at the following:

- Preparing proposals on European standards for the transmission of digital television via cable and satellite and on terrestrial transmission, the former planned to be available by the end of 1993.
- Shaping, in cooperation with all those involved, the technical development, influencing the regulatory prerequisites and preparing the introduction of digital television in Europe.

All three groups (PALplus, HD-DIVINE, and the ELG-DVB) plan to have fully operational systems ready for demonstration and launch in 1995 for terrestrial, cable and satellite transmission.

Members of the European Parliament were given a live demonstration of HDTV transmission by satellite using equipment and techniques developed by Thomson-CSF, the BBC and other European organizations. The demonstration was based on coding equipment developed at Thomson's Laboratories Electroniques de Rennes (LER) using an algorithm close to the MPEG II standard.

LCD TVs

Liquid crystal display (LCD) TV in Europe is still very "nichey" and currently applies only to the handheld portable TV market segments. Current analog technology used in Europe for broadcasting makes handheld portable TV difficult to use, with multipath interference and poor picture quality. Digital broadcasting will eliminate these difficulties and promises to make LCD TV more usable. Advances in the development of LCD technology will also make LCD an attractive long-term option for wide-screen HDTV in Europe.

Philips, Thomson-CSF and Sagem have been given the all clear by the European Commission to set up a joint venture to make active matrix LCDs. The EC has given the Flat Panel Display joint-venture company an exemption from its ban on anti-competitive joint ventures because of the company's "strategic importance" to the EU. Philips will have an 80 percent share, with Thomson and Sagem having 10 percent each. The company hopes to start manufacturing this year.

Video-on-Demand

In September 1993, Philips Consumer Electronics announced a compact digital set-top decoder for video-on-demand (VOD) applications over the public switched telephone network (PSTN). Designated "The Home Interactive Multimedia Terminal," the prototype converts 1.5 Mbit/s digital TV signals into NTSC or PAL analog signals for display on standard television sets. Video dial-tone (VDT) in the United States will probably be the first application. The system allows VCR-like control of remoter source material. The unit combines a standard E1/T1 communications interface, and an MPEG-1 decoder as well. The phone is still usable while watching TV. Philips says this is the first of a series of terminals which will include versions suitable for use in asynchronous digital subscriber loop (ADSL) and broadband fiber networks as well as for applications using satellite, cable, terrestrial broadcast and other media.

Video Plus/ShowView

California-based Gemstar Inc. has developed a video programming technology trade-marketed as both "VideoPlus" and "ShowView" in Europe. VideoPlus (as it is known in the United Kingdom and ShowView on continental Europe) makes programming video (VCR/VTR) recordings easier by coding both time information and television channel information.

Teletext

In its early days, teletext was offered as a set-top box. The teletext facility allows the display of alphanumeric data on a TV screen. Teletext information is transmitted within the PAL broadcast as digital data in the top lines of the 625-line transmission which are not normally viewable. The user-selected page of information is decoded from the teletext transmission and viewed on the TV screen. Normal teletext decoders allow the user to select a page by number and view the desired page when the data are transmitted.

Newer additions to the general teletext facility, include a memory within the TV set to allow multiple pages of teletext data to be stored and viewed on demand. This facility, for instance, allows instant viewing of predetermined pages rather than waiting for a particular page of data to be broadcast; this capability is generally known as "fastext." The key semiconductor devices used for teletext applications include DRAM memory and, in more advanced variations, microprocessors.

Dolby Surround pro-Logic

The sound quality of most home television entertainment systems is no comparison to that of large cinema auditoriums. Dolby Surround pro-Logic brings the cinema effect to the home. It uses 4-channel high-performance amplifiers and a special decoder to double up the stereo signal received into four signals, which are fed through five loud-speakers (two of which are backward facing) to create a sound that fills the room and yet has a source from the TV set picture. The use of digital signal processors (DSP) permits precise user control surround modes that use time alignment technology to present a neutral balanced soundstage.

European VCR Manufacturing Overview

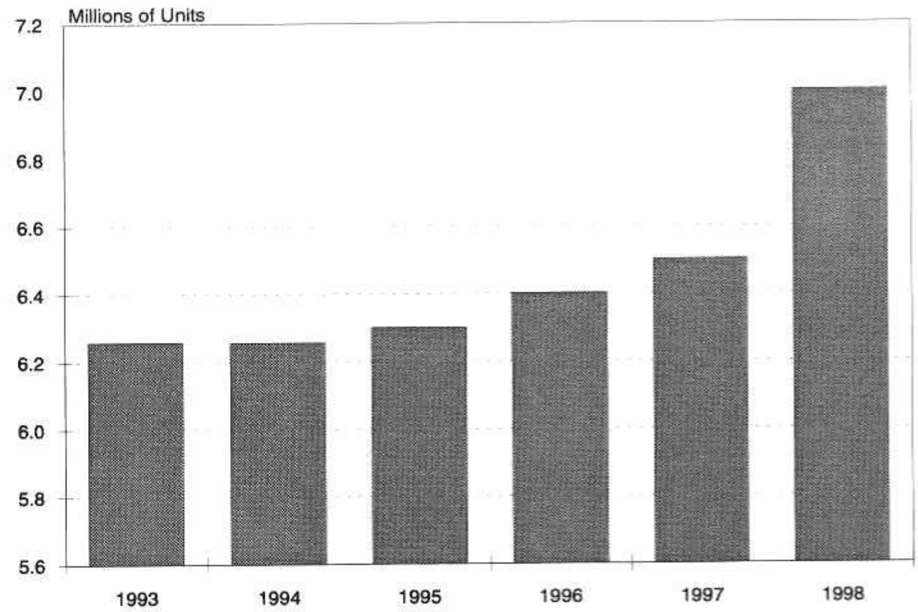
With the exception of Philips, VCR production activity in Europe has been dominated by Japanese and Far Eastern manufacturers. The level of semiconductor procurement is still quite low as most components are procured as subassembled modules from subcontract manufacturers and other suppliers outside of Europe.

European VCR production is approximately 60 percent of the market. Most high-end VCRs are imported into Europe from Japan and the Far East. Market trends for VCR are largely dependent on developments in television technology. It is still not clear whether other peripherals like cable and satellite receiver equipment and set-top boxes may replace the functionality of VCRs; or whether they will become integrated systems with satellite/cable receivers built-in. It is still too early to predict which way the market will evolve.

Figure 7 shows the trend for VCR manufacturing in Europe. During 1993, Thomson ceased VCR production at its Berlin plant (this production has now been moved to Singapore). Europe is losing VCR manufacturing capacity as companies like Thomson have moved all their VCR production away from Europe to other such Far Eastern countries.

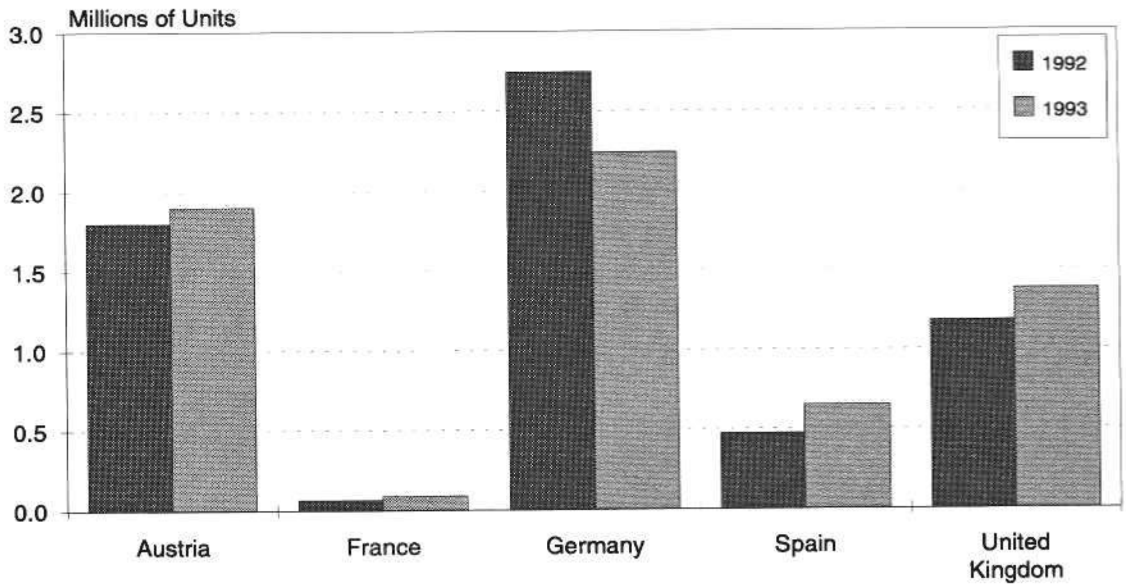
Figure 8 shows European VCR manufacturing profile by country. Only five countries in Europe have VCR manufacturing activity. Germany is the largest VCR manufacturing country in Europe. In 1993, German VCR production declined slightly as a result of the Thomson factory closure. Austria is the next single most important country for VCR production in Europe, but almost all of this is attributed to Philips. German VCR manufacturers are mostly Japanese and Far Eastern; these include Matsushita, Hitachi, Goldstar and Sanyo. Grundig and Thomson are the only European companies manufacturing VCRs in Germany.

Figure 7
European VCR Production Forecast



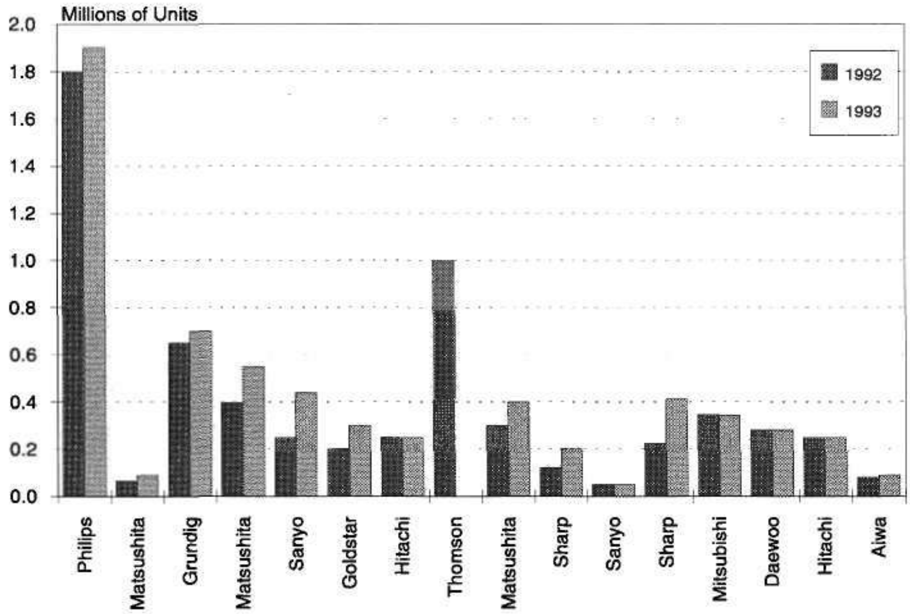
Source: Dataquest (March 1994 Estimates)

Figure 8
VCR Production by Country



Source: Dataquest (March 1994 Estimates)

Figure 9
VCR Production by Major Manufacturer



Source: Dataquest (March 1994 Estimates)

VCR manufacturing activity in Europe is shown in Figure 9. Philips is the largest manufacturer in Europe contributing nearly a third of all European VCR manufacturing.

Growth Factors

HDTV will bring growth in digital VCRs. Currently, digital VCRs are being developed in the United States and Japan. The Korean government formed an alliance at the beginning of 1994 to release funds for the development of digital video products.

Conventional home VCRs use analog recording systems to record such analog signals as the FM-modulated image signals. In contrast, digital recording systems convert the image signals to digital formats. Digital recording methods surpass analog ones in image and sound quality as they exhibit little or no deterioration in image quality even during dubbing. Today's high-band, home-use VCRs are the Super VHS and Hi8 systems which deliver excellent image quality, even with long-play cassettes. The challenge facing VCR manufacturers is adding digital recording mechanisms to home-use VCRs. The next stage after digital VCRs will be HDTV VCRs, but this will only become commercially viable after standards for HDTV have been fully completed.

Video Equipment Semiconductor Consumption Forecast

Semiconductor consumption by television and VCR equipment manufacturers in Europe reached $1.15 billion in 1993. This year, the semiconductor market in Europe for these same applications is forecast to reach nearly $1.2 billion, representing a 4 percent annual growth rate.

Semiconductor Forecast Model

Table 2 shows European television production and provides a semiconductor market forecast. The semiconductor forecast is driven by the specification of television sets manufactured in Europe.

Ordinary TVs are typically of 14- to 20-inch screen sizes. High-end TVs comprise mostly television sets above 20-inch screen size. The television semiconductor consumption forecast (Table 2) shows that in 1993, an estimated 60 percent of TVs were of the high-end specification. In 1993, the semiconductor content of high-end TVs is estimated to be $45; this drives a semiconductor consumption of $504 million.

To avoid double counting, other features added onto basic television functions are listed separately as a percentage of total TV production in Europe. For example, auto-tune is a feature which allows the TV to automatically tune in to local TV stations and locks onto a station, making it easy for the user to program into a channel. During 1993, the auto-tune function on chip is estimated to be worth approximately $2. We have further estimated the IC content for features including teletext/fastext, program delivery control (PDC) and remote controls; NICAM; Dolby Surround pro-Logic; and cable/satellite. From 1996, we have included our initial estimates of digital TV functions, which include all the compression functions and decoder processes. A similar methodology is used for our VCR semiconductor forecast.

Thus, semiconductor content of an ordinary television set is estimated to be worth $44. At the very high end, semiconductor content could reach $80. Digital television semiconductor content today is worth at least $350 (depending on functionality). Television semiconductor demand in Europe is estimated at $828 million in 1993 and is forecast to exceed $1.0 billion by 1998 (nearly the same size as the market for combined TV and VCR during 1993).

The average semiconductor content is estimated as the total semiconductor market apportioned to the total number of television sets manufactured in Europe. This presents a useful indicator to the level of video equipment specification built in Europe. Dataquest forecasts that by 1998, the introduction of digital HDTV will begin to ramp up the demand for semiconductors in this market.

Table 3 presents our VCR semiconductor consumption forecast for Europe. Semiconductor consumption for VCR applications in Europe reached $329 million in 1993 and is forecast to remain fairly flat until 1998, when digital television in Europe should begin to take off. VCR semiconductor content is much higher than the average for television as the functions required are more complex. Dataquest estimates the complete VCR assembly semiconductor content at nearly $90 per set. Our survey revealed that not all semiconductors required for complete VCR system assembly are procured in Europe. Most of the local semiconductor purchases supplement subassembled modules imported into Europe for VCR production.

Table 2
Television Semiconductor Consumption Forecast
(Millions of Units and Millions of Dollars)

	1993	1994	1995	1996	1997	1998
TV Production (Units M)	19	20	20	20	21	21
Percentage of TV						
Ordinary	40%	35%	30%	30%	25%	20%
High-End	60%	65%	70%	70%	75%	80%
Auto-Tune	10%	16%	22%	35%	40%	60%
Features	60%	65%	70%	70%	80%	90%
NICAM	40%	50%	60%	70%	75%	80%
Dolby	20%	20%	25%	25%	30%	30%
Integrated Cable/Satellite	2%	2%	3%	4%	5%	10%
Digital	0%	0%	0%	1%	2%	4%
Semiconductor Cost						
Ordinary	$28.00	$26.00	$25.00	$24.00	$23.00	$23.00
High-End	$45.00	$42.00	$40.00	$38.00	$35.00	$35.00
Auto-Tune	$2.00	$2.00	$1.75	$1.50	$1.30	$1.00
Features	$4.00	$4.00	$4.00	$3.50	$3.50	$3.00
NICAM	$5.00	$4.00	$3.50	$3.00	$2.50	$2.00
Dolby	$6.00	$6.00	$5.00	$5.00	$4.50	$4.00
Cable/Satellite	$18.00	$17.00	$15.00	$13.00	$13.00	$12.00
Digital	$0.00	$0.00	$0.00	$300.00	$250.00	$200.00
Semiconductor Market ($M)						
Ordinary	$209	$179	$150	$144	$121	$97
High-End	$504	$537	$560	$532	$551	$588
Auto-Tune	$4	$6	$8	$11	$11	$13
Features	$45	$51	$56	$49	$59	$57
NICAM	$37	$39	$42	$42	$39	$34
Dolby	$22	$24	$25	$25	$28	$25
Cable/Satellite	$7	$7	$9	$10	$14	$25
Digital	$0	$0	$0	$60	$105	$168
Total TV TAM	$828	$843	$850	$873	$928	$1,006
Average Semiconductor Content	$44	$43	$42	$44	$44	$48

Features = teletext/fastext, PDC, remote control

High-end TVs have a nominal higher semiconductor content; their additional cost is increased by other capabilities, such as auto-tune.

Source: Dataquest (March 1994 Estimates)

Table 3
VCR Semiconductor Consumption Forecast
(Millions of Units and Millions of Dollars)

	1993	1994	1995	1996	1997	1998
VCR Production (Units M)	6	6	6	6	7	7
Percentage of VCR						
Ordinary	80%	65%	45%	35%	35%	30%
High-End	20%	35%	55%	65%	65%	70%
Auto-Tune	10%	20%	40%	60%	80%	90%
Features	1%	2%	3%	4%	4%	5%
NICAM	60%	60%	80%	70%	75%	80%
Dolby	6%	8%	20%	18%	25%	30%
Integrated Cable/Satellite	0%	0%	0%	0%	0%	0%
Digital	0%	0%	0%	0%	1%	1%
Semiconductor Cost						
Ordinary	$45.00	$42.00	$40.00	$35.00	$35.00	$35.00
High-End	$65.00	$65.00	$60.00	$60.00	$55.00	$55.00
Auto-Tune	$2.00	$2.00	$1.75	$1.50	$1.30	$1.00
Features	$4.00	$4.00	$3.50	$3.50	$3.00	$3.00
NICAM	$5.00	$4.00	$3.50	$3.00	$2.50	$2.00
Dolby	$6.00	$6.00	$5.00	$5.00	$4.50	$4.00
Cable/Satellite	$18.00	$17.00	$15.00	$13.00	$13.00	$12.00
Digital	$0.00	$0.00	$0.00	$300.00	$250.00	$200.00
Semiconductor Market ($M)						
Ordinary	$225	$171	$113	$78	$80	$74
High-End	$81	$142	$208	$250	$232	$270
Auto-Tune	$1	$3	$4	$6	$7	$6
Features	$0	$1	$1	$1	$1	$1
NICAM	$19	$15	$18	$13	$12	$11
Dolby	$2	$3	$6	$6	$7	$8
Cable/Satellite	$0	$0	$0	$0	$0	$0
Digital	$0	$0	$0	$0	$8	$18
Total VCR TAM	$329	$334	$350	$354	$347	$387
Average Semiconductor Content	$53	$53	$56	$55	$53	$55

Features = teletext/fastext, PDC, remote control

High-end TVs have a nominal higher semiconductor content; their additional cost is increased by other capabilities, such as auto-tune.

Source: Dataquest (March 1994 Estimates)

There is very little consumer video camcorder production in Europe. Our research shows that Sony is the only camcorder equipment manufacturer in Europe. We estimate that Sony assembled nearly 800,000 units of video camcorder equipment during 1993 at its Ribeauville factory in France. The Sony facility in France also has an SMT assembly line for camcorder equipment. It is believed that Sony produces camcorder equipment on an OEM basis for some European vendors at this factory.

Dataquest forecasts that the semiconductor market for consumer VCR will remain flat until 1997. The introduction of digital television technology will also show an effect on the semiconductor demand for VCR equipment in Europe.

Dataquest Perspective

Dataquest believes that Europe will have its own digital TV service by the year 2000. However, we believe that a digital television service in Europe will be accompanied by wide-screen HDTV, which will permit the introduction of very high-quality television sets. Digital television itself will also pave the way for other display technologies like active matrix LCD. HDTV by itself is a semiconductor-rich technology and, combined with digital television, Dataquest forecasts growth in this area for semiconductor vendors.

Other related factors facing the industry today are likely to have an impact on the potential for semiconductors in this area. Manufacturing activity is shifting away from Europe into the Far East, and some key suppliers to the television industry are already making decisions that provide a signal for future manufacturing strategy. Nokia, for example, has announced that it is pulling out of the CRT (television picture tube) business. Dataquest believes that there is not enough volume business for Nokia's CRT business to survive. Philips has also expressed concerns about its partly owned subsidiary Grundig. Grundig has responded by announcing further job cuts at its German plant. We believe that there is a potential threat for most key manufacturers to shut factories in Europe and move away to lower-cost manufacturing areas.

Dataquest predicts a consolidation of production by the major players at key European manufacturing locations. As technology advances, and the national television standards barriers become less important, manufacturers will concentrate production activity at fewer locations in order to reduce costs. Sony's factory at Bridgend in Wales is an example, where most of the volume from the Barcelona plant is being transferred to Bridgend. Many other smaller players will have to cope with pressures in the industry to cut costs. The development of digital television itself will likely bring in some casualties, and it will be the smaller players that will be most vulnerable.

Manufacturing activity in a price-sensitive market such as consumer video equipment creates many cost constraints. Europe could still remain a very competitive region in the manufacture of televisions and videocassette recorder equipment if the manufacturing processes were less labor-intensive and more automated. Nokia is demonstrating this by moving the production of portable televisions in Europe to its highly automated factory in Bochum, Germany. This demonstrates how competitive Europe could be. The most price-sensitive televisions are the small-screen sets which have little margin for absorbing further costs.

As Eastern European markets begin to develop, the "Eastern promise" could become a reality. This could potentially begin to add a further 2 million to 3 million units to television production in Europe and a similar number of units to VCR manufacturing in Europe. The question on everybody's lips is: "When will the consumer boom happen again?" The answer to that question is another question: "When will Europe get its act together for digital television?"

By Mike Williams

Appendix: Company Profiles

Aiwa

Aiwa has one TV manufacturing plant in Wales which opened in 1990. Products manufactured here are mainly TVs and VCRs. Aiwa also has an assembly plant for hi-fi audio products at the same location. Aiwa is a subsidiary of Sony, which has a majority shareholding. Aiwa plans to expand its factory at Penyfan Industrial Estate in Wales with the creation of 480 new jobs. The Welsh Development Agency will build an 11,000 m^2 extension to its factory which it leases to Aiwa. The extension will be used to expand VCR production at the plant where hi-fi equipment, CDs and VCRs are already manufactured.

Bang & Olufsen

Bang & Olufsen manufactures high-end hi-fi audio components, satellite receivers, and color televisions at its main plant in Struer, Denmark. During 1993, Bang & Olufsen reduced its shareholding in a 50–50 telecommunications joint venture with L.M. Ericsson to 25 percent. A strategic decision to concentrate on its primary business led to an equity reduction in the joint-venture company, DIAX Telecommunications A/S, as well as a divestiture of wire manufacturing, shopfitting and transformer manufacturing subsidiaries.

Bekoteknik (A. Koc Company)

Bekoteknik is a subsidiary of the Turkey-based Koc family-owned business, The Koc Group. The Koc Group was founded in 1926 and now supplies automotive components through a number of subsidiary companies (including a joint venture with Fiat), as well as textiles, food processing, white goods, retailing, finance, construction materials, computer systems, mining and energy products among several other activities. Bekoteknik manufactures televisions and audio equipment at its factory in Istanbul, Turkey and is one of the country's leading manufacturers. The company badges its TV and audio equipment as Beko.

Blaupunkt

Blaupunkt is a subsidiary of the Robert Bosch company specializing in radio and communications equipment. Grundig is believed to be an OEM for Blaupunkt.

Daewoo

Daewoo is one of the leading Korean conglomerates, others being Hyundai, Lucky-Goldstar and Samsung. Daewoo manufactures VCRs at its factory in Antrim, Northern Ireland (since June 1988), and procures semiconductors "made in Europe" for its products. Daewoo's Antrim plant has capacity for 600,000 units of VCRs per year. Daewoo has recently announced plans to invest $5 million in a television plant at Pruszkow near Warsaw, Poland to produce 250,000 TVs a year from March 1994. Daewoo's president Soonhoon Bae said that as much as $20 million could be invested in the plant to bring production up to 600,000 sets a year.

Elbit/Fraba

Elbit is one of Israel's largest manufacturers of defense and civilian electronics products and systems. Elbit owns a subsidiary (and brand name), Fraba Technology, which manufactures audio, TV, video and hi-fi equipment. Fraba TVs (with built-in video entry-phones) are assembled in Israel and Germany from locally purchased components. The company also manufactures defense and medical products.

Formenti

Formenti is a major Italian manufacturer of television, built-in satellite and/or cable television sets, VCRs, and CRT monitors, with two major plants in Sessa Aurunca and Concorezzo, Italy. All televisions are manufactured at Sessa Aurunca and the rest of the products are made in Concorezzo. Formenti badges its color TV and video products as Phoenix and White-Westinghouse.

Galaxis

Galaxis manufactures and assembles color TVs, integrated color TVs and VCR combination systems, satellite receivers, CD players, audio hi-fi equipment, VCRs and camcorders in Italy.

Goldstar

Goldstar is a Korean company manufacturing color TVs and VCRs in Worms, Germany (since November 1987). The company also manufacture video drums and decks in Germany and procures all CRTs for TV production from within Europe. All board assemblies for TV and VCR products are imported.

Gooding Consumer Electronics

Gooding Consumer Electronics is a subsidiary of Gooding Holdings, which also owns RACE Electronics, the subcontract manufacturing company in Wales. Gooding acquired Grundig's television plant in Creutzwald, France during 1993 and is now one of the major television manufacturers in France.

Grundig

Following the divestiture of Grundig's French plant, Grundig now has four television plants in the European region: Turkey, Spain, Germany and Austria. All of the plants have television manufacturing and the German plant also makes VCRs and car radios.

Hitachi

Hitachi has two consumer electronics plants in Europe: Hirwuan (near Cardiff) in Wales (color TVs and VCRs); and Landsberg in Germany (VCRs). Hitachi procures all semiconductors for its TV products and part of its semiconductor requirement for VCR production in Europe.

Imperial

Imperial is an Italian manufacturer of television sets in Europe. The company manufactures TVs and built-in satellite receiver TVs in Milan, Italy and procures almost all its TV semiconductor and component requirement from within Europe.

JVC (Japan Victor Company)

JVC has two consumer electronics plants in Europe: Villers la Montagne in France; and East Kilbride in Scotland. The Scottish plant manufactures color TVs only, while the French factory manufactures audio hi-fi components and stereo car radio/cassette players. JVC procures most semiconductors for its production in Europe. JVC is a subsidiary of the Matsushita Corporation.

Kaisui (Great Wall France)

Kaisui assembles TVs in two manufacturing plants at Sable-sur-Sarthe in France (the first opened in 1989 and the second in 1992). During 1992, Kaisui also established a subsidiary company, Universal Electronics Tunisia in Tunisia for PCB assembly. All TV PCBs are now supplied by the fully automated Tunisian subsidiary factory. The company also has an electrical appliance subsidiary Sodistream, which has a plant in France. Sodistream manufactures domestic appliances such as mixers, food processors, blenders and liquidizers. A separate design and audio equipment subsidiary is also located in Hong Kong.

Loewe Opta

Loewe Opta manufactures high-end color TVs in Germany. Loewe Opta is a subsidiary of Matsushita.

Luxor

Part of the Nokia Consumer Electronics Group headquartered in Geneva, Luxor's color TV plant is in Sweden.

Matsushita

Matsushita trades under the JVC, Loewe Opta, Panasonic, Technics and National brand names. It has three consumer electronics plants in Europe. The plant in the United Kingdom manufactures color televisions only; the plant in Germany makes audio equipment, CD players and VCRs. The plant in Germany (Piene, near Hannover) is one of only a few in Europe manufacturing camcorders. The company also has plants in Longwy, France (VCR subassemblies, audio amplifiers and tuners/receivers); and also in Gerona, Spain (VCR subassemblies, audio products, loudspeakers and vacuum cleaners).

The company has held close links with Philips for many decades and Philips has a 20 percent share.

Metz

Metz is a German radio and television receiver manufacturer. The key manufacturing plant is in Furth, Germany where the company manufactures televisions, video and camcorders. Metz procures some of its semiconductor requirement in Europe and imports subassemblies and most camcorder components.

Mitsubishi

Mitsubishi has two plants in Scotland for color TV and VCR manufacturing. A facility also exists in Germany which makes CD players. We believe this to be the largest manufacturing plant of CD players in Europe. Mitsubishi has also built a plant in France to make mobile phones.

Mivar

Mivar has one plant in Milan, Italy for manufacturing color television sets. All of Mivar's TVs are equipped with CATV receivers. We estimate that Mivar makes more than 60 percent of Italy's color television production. Probably, as a result of the poor state of the consumer electronics market in Europe, Mivar's plan to build a new factory in 1994 has been postponed. Mivar now plans to open a new factory for color televisions in Abbiategrasso, Milan, Italy in 1996.

Nokia

Nokia is Finland's largest manufacturer of consumer goods, having three factories in Europe. It also owns Luxor and Salora. The plant at Turku in Finland makes color televisions. Nokia also makes satellite receivers and pay TV equipment at Motala in Sweden. In 1993, Nokia's French factory Oceanic was closed, with all the production having been transferred to Salo, Finland and Bochum, Germany. Most of Nokia's television production comes from its factory at Bochum in Germany.

Orion

Orion assembles color televisions at the factory in the United Kingdom. The annual output by this facility is estimated to be about 100,000 units. Orion is believed to be a screwdriver operation with no semiconductor procurement in Europe (we have excluded this from the production estimates in Table 2).

Ortadogo

See Samsung.

Philips

Following the announcement of the closure of its Spanish plant, Philips will have three TV manufacturing plants in Europe: Dreux in France, Bruges in Belgium, and a plant at Monza, Italy. Philips plans to launch color monitor tube production at its factory in Lebring, Austria in the fourth quarter of 1994. Philips also has a VCR factory in Vienna, Austria. For the UK CRT factory, Philips has announced plans to invest $28 million to expand monitor tube production. During 1993, Philips sold its 35 percent stake in a joint venture with Matsushita to Matsushita in a deal estimated to be worth about $1.6 billion. The joint venture began in 1952, and covered semiconductors, cathode-ray tubes and lamps. Philips has a 35 percent shareholding in Grundig, the German television company.

Radiomarelli

Radiomarelli is a subsidiary company of the Fiat group that manufactures color televisions in Torino, Italy. Radiomarelli buys CRTs from Europe for its TV manufacturing and also does some partial stuffing of PCBs, procuring some semiconductors from Europe.

Rundfunk Fernseh Telekommunikation (RFT)

RFT was founded in 1920 marketing radio receivers. The company started manufacturing TVs in 1957. In 1969, RFT started building its first volume transistor TVs. Since 1992 RFT has been building color portable TVs under the SIESTA brand name. RFT also manufactures satellite receivers in Stassfurt, Germany.

Samsung

Samsung has four factories in Europe making color televisions and video recorders. The company established a TV plant in Portugal in 1982. It added to its European portfolio, a color TV, VCR and microwave oven plant in the United Kingdom during 1987. In 1989, a new color TV and VCR plant was set up in Spain. In addition to these is a joint venture with Ortadogo in Turkey, in which Samsung has an 80 percent stake.

Sanyo

Sanyo has four consumer electronics factories in Europe: Sanyo Industries, Nordlingen, Germany (VCRs); Sanyo España SA, Tudela, Spain (color TVs); Sanyo Electric Manufacturing, Newton Aycliffe, United Kingdom (microwave ovens); and Sanyo Industries, Lowestoft, United Kingdom (color TVs). Sanyo procures most of its components and semiconductor requirement for its TV manufacturing locally in Europe.

Scanel-Nesco

Scandinavian Electronics Manufacturing (Scanel)–Nesco started its activities in Reykjavik, Iceland in 1968. The company has been involved in manufacturing, importing and distribution of consumer electronics systems and components since then. The Nesco brand offers built-in satellite TVs and VCRs among its audio/video equipment range of products. TVs are designed in Denmark with production in Denmark and the Far East. The company is headquartered in Hamburg, Germany.

Schneider

Schneider manufactures color TVs and hi-fi audio equipment at its factory in Turkheim, Germany.

Seleco

Seleco has six plants in Europe: Turin, Italy (car alarm system production); Milan, Italy (CTV final assembly); Udine, Italy (VTR and OEM products, including pay-TV decoders and video projectors); Pordenone, Italy (CTV and professional products); Malta (small CTV production); and Barcelona, Spain (small CTV production). Seleco procures most of its semiconductor and component requirement for color TV and video projector manufacturing locally in Europe.

Sharp

Sharp has two consumer electronics manufacturing plants in Europe. In Wrexham in Wales, Sharp has a VCR and CD player plant for which the company procures semiconductor components locally. Sharp plans to commence manufacturing of computer equipment at Wrexham in August 1994. A second factory in Barcelona, Spain which makes color TVs has been closed down for refurbishment. Production of color TVs in Spain will start again in August 1994. In Alsace, France, Sharp plans to commence facsimile and photocopier equipment manufacturing from August 1994.

Siemens

Siemens has three consumer electronics plants in Europe: France (color TVs), Germany (color TVs, and plans to make S-VHS VCRs), and Austria (color TVs and VCRs).

Sony

Sony has three TV manufacturing plants in Europe: Bridgend, Wales; Fellbach (near Stuttgart), Germany; and Barcelona, Spain. The factory at Bridgend is the single largest Japanese TV factory in Europe with capacity to build nearly 3 million sets annually. Sony also manufactures CRTs at this factory.

Tatung

Tatung manufactures color televisions and satellite receivers in Telford, England. The company procures most components and all semiconductors for its color TV manufacturing in Europe.

Thomson Consumer Electronics

Thomson is one of Europe's major manufacturers of color televisions, with factories in France, Spain and Germany. In 1993, Thomson closed its joint venture with JVC in Berlin, which manufactured VCRs and traded under the name of J2T. All of the Berlin factory's production has now been moved to Singapore. Thomson sells video equipment under the following brand names:

- Thomson
- Saba
- Nordmende
- Ferguson
- Telefunken
- Brandt
- RCA (USA)

Toshiba

Toshiba manufactures color TVs and VCRs in Europe at two plants in Europe. VCRs are manufactured at Mönchengladbach, Germany and color TVs are assembled at Plymouth, England. Toshiba procures semiconductors and components in Europe for its manufacturing activities at both these plants.

Unimor

Unimor was established in 1957 as a state-owned enterprise with its headquarters in Gdansk, Poland. The company has four color television plants in Poland three of which are located in Gdansk, while the fourth plant is in Tczew (approximately 50 km south of Gdansk). Unimor manufactures plastic casings, wooden casings, polystyrene packaging and TV component subassemblies, and employs some 2,900 people (1,900 in TV activities). Unimor has its own internal color TV and PCB research and development facilities at Gdansk.

Vestel

Vestel was founded in 1984, manufacturing color TVs, computer monitors, stereo systems, washing machines, microwave ovens, fridges and freezers in Manisa, Turkey. Vestel builds TVs with built-in CATV receivers (CATV S1-S2 channels). R&D is conducted from its factory in Manisa. Most of Vestel's requirements for mechanical parts are also manufactured at the same factory. The company employs more than 3,800 people.

Factories Closed Down Since Last Survey

- Ferguson, Gosport, United Kingdom
- Funai Electrics, United Kingdom
- Oceanic, France

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Company Profiles

Dataquest

Dataquest Company Profile

Semiconductors

Semiconductor Application Markets Europe

Apple Computer, Inc.

Corporate Headquarters	Apple Computer, Inc. 20525 Mariani Avenue Cupertino, CA 95014 USA
President and Chief Executive Officer	Michael Spindler
Total Employees (Year-End 1993)	11,963
Total Net Sales (Year-End 1993)	$7,977 million

Executive Summary

Apple is excited! It believes that it has found a winning formula to allow itself to transform: that is, to regain lost momentum, to move back into the mainstream market, and to differentiate itself sufficiently to win significant market share. The aim of this profile is not only to document the key elements that Apple sees as crucial to its success, but also to assess its chances.

Apple is at a crossroads: we are observing the first few months of a new generation of products based on the PowerPC processor. Likewise, the industry is also reaching a crossroads and, although not with quite the same set of issues faced byApple, common elements remain. Clearly, there is a credible challenge to the long-established Intel/Microsoft alliance, with the accepted standards for both hardware and software being questioned. Apple's strategy is a key element in this challenge and, therefore, it is important to understand what the company is trying to achieve as we move to the next generation of computing.

Apple simply summarizes its strategy as "Stand Out—Fit In." The company sees several key differentiators that will allow it to stand out from the crowd of PC manufacturers, while at the same time it will try to court the PC-compatible world, which has long been inaccessible to Apple.

Dataquest®
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Program: Semiconductor Application Markets Europe
Product Code: SAMM-EU-CP-9402
Publication Date: October 21, 1994

The company aims to undertake its strategy with the following features:

- Standing Out
  - Price/performance (adoption of RISC)
  - Component solutions (object orientation)
  - Collaboration (the next step after networking)
  - Active assistance (rather than passive graphical users interfaces, GUIs)
- Fitting In
  - Application compatibility
  - Networking compatibility
  - Interoperability

Clearly, Apple has some key strengths. The adoption of a RISC-based system does provide the company with a performance lead and, importantly, an architecture that is scalable, rather than the Intel architecture which is reaching the end of its life (reference, the HP/Intel alliance). Apple is in the rare position of controlling both hardware and software for its systems. While this is clearly a financial burden, it has allowed the company to generate a genuine lead in "ease of use," and the use of sound and image on the PC. It is also well positioned to take advantage of the explosion of multimedia. By controlling these elements, Apple is able to capitalize on the inherent performance advantages of RISC. It also has a very strong industrial and product design legacy, such that its products don't just look good, they display real innovation.

Although the Apple platform can boast much potential, there are some key questions which it needs to answer. Currently, the company has a window of opportunity to end the drought of native applications that are available for the PowerPC. The momentum generated by the CI Labs initiative (OpenDoc) will be an important test, and will decide whether a real alternative to Microsoft's current dominance can be achieved. The advent of Chicago (Windows 4.0) is also an important threat to Apple, especially as it promises to reduce or even eliminate Apple's lead in "ease-of-use." The current slowness of Apple's Windows emulation (Soft Windows from Insignia Solutions) will certainly improve, but the company's longer-term worry must be its ability to emulate Chicago at all.

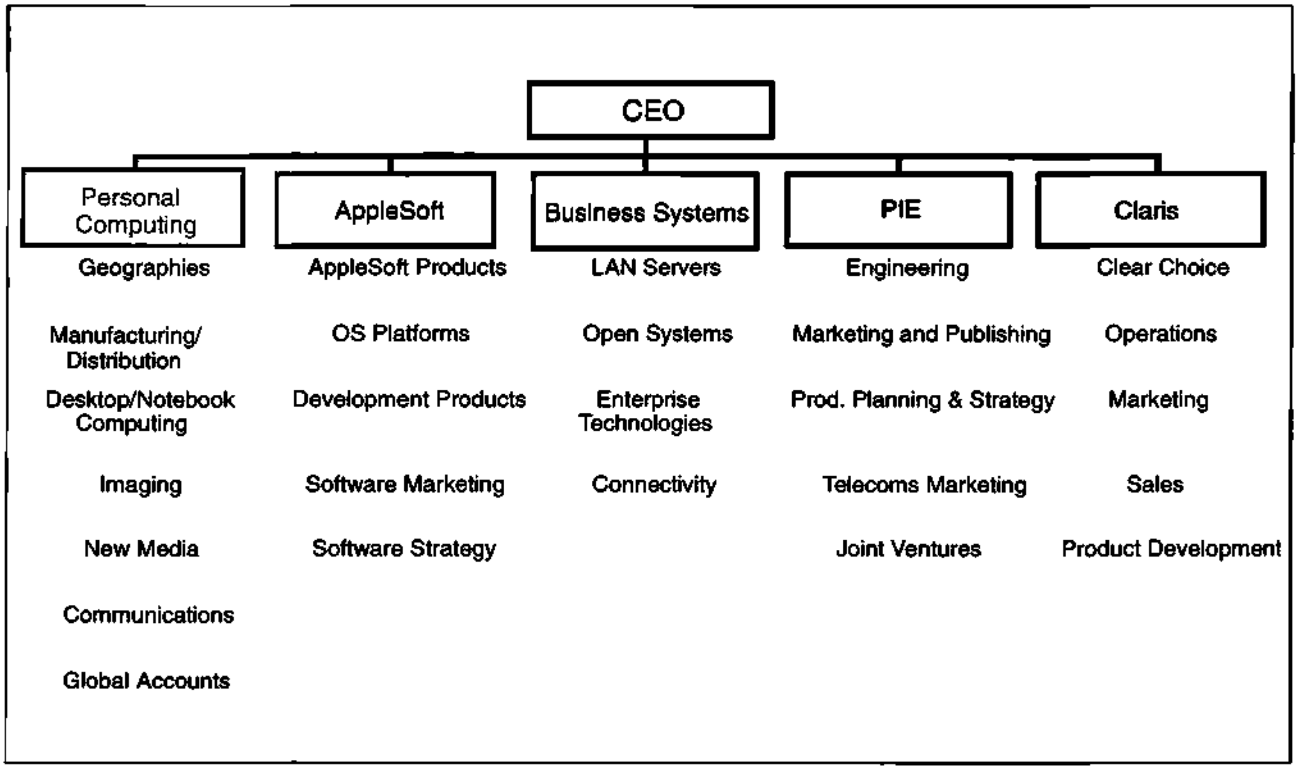
Given its strengths, however, clear opportunities exist for Apple. PCs are moving into the mainstream consumer world and Apple has good-looking products that are designed to take advantage of exciting and entertaining applications based on still and moving images and sound—the basic building blocks of multimedia. The potential growth in unit shipments is large, but the key remaining question is whether Apple has the cost model to hit the right price points in this market. It is still unclear how pervasive multimedia will become in the business world, but there is good evidence to suggest that several large niche markets or vertical aplications exist that may well allow Apple to build a leading presence in these sectors.

As far as the Intel-compatible world is concerned, simply having an offering that can be called compatible is bound to win business and a certain amount of market share for Apple. It is unlikely, though, that this will be substantial. The company's strengths will certainly encourage and reassure its current core markets, such as publishing, design and education, but it is not clear whether Apple will be able to provide a compelling argument to a typical Intel/Microsoft-based account: a user will not buy a PowerMac machine to run Windows! Both Intel and Microsoft are aggressively pushing their version of the future, aided by huge R&D and marketing budgets. As networking becomes increasingly pervasive, it is uncertain whether Apple has a strong enough argument to lift it above more standard implementations—this is vital if it is to persuade corporate groups to shift their allegiance.

Organizational Structure

Apple operates a matrix whereby it has both business and geographic organizations (see Figure 1). In other words, the key five business units are reflected in the various geographic regions covered by the company.

Figure 1
Organization Structure of Apple Computer, Inc.



Source: Apple Computer, Inc.

Personal Computer Division: Apple continues to build on its core business in this division, namely Macintosh personal computing on the desktop, including the PowerBook range of business portables.

Apple's Software Division: AppleSoft focuses on the business of delivering its software technologies and products to its customers in the Macintosh and DOS Windows environments in cross-platform solutions.

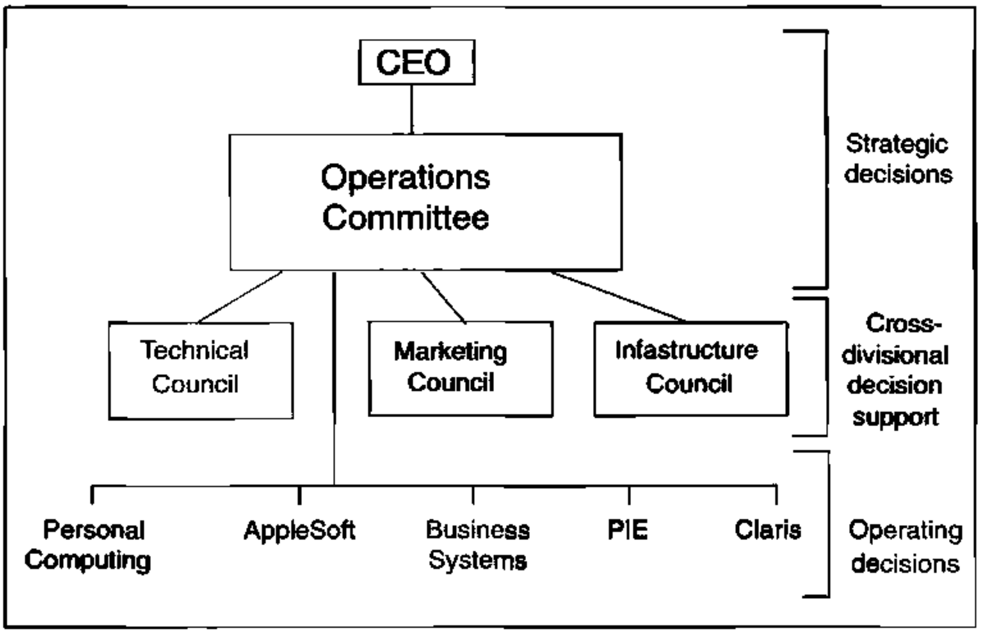
Apple Business Systems Division: This division focuses on the interoperability of Apple's products with other systems in enterprise environments, and has been given the responsibility of the marketing of Apple's server products. It is key in developing interoperability between Apple and the multivendor environments that are becoming a feature of today's IT implementations.

Personal Interactive Electronics (PIE) Division: The PIE division focuses on emerging opportunities in personal information products and services, particularly the Newton and the associated applications and interfaces accompanying this technology. This division also includes a publishing group, StarCore, whose mission is to publish and distribute electronic titles for the Newton, Macintosh and DOS/Windows platforms.

Claris Corporation is the Apple subsidiary which develops, publishes and markets software applications for business, education and the home markets. It has recently broadened its range to include Windows-based software, as well as its Macintosh-based products.

Figure 2 shows Apple's internal management structure.

Figure 2
Management Structure of Apple Computer, Inc.



Source: Apple Computer, Inc.

Company Strategy

Apple's View of the World of PCs

Clearly, users are demanding more and more from their PCs. Hence, Apple's strategy is based on its assessment of what end users are demanding from the hardware and software vendors in the next generation of computing. The company has identified four key areas:

- **Mixed environments** are everywhere. More and more end users are mixing architectures and platforms. Sites will have PCs running OS/2, Windows, System 7, on MCA-, EISA-, Macintosh- and, increasingly, on PowerPC-based hardware.
- **Productivity**, not only in terms of return on investment in systems, but also in terms of human resources which are increasingly becoming recognized as the key resource available to an enterprise.
- **Customized solutions**: End users are constantly demanding more than a standard word processing and spreadsheet package, but one that is tailored to the needs of their organization.
- **Technological advances**: Customers are exposed to, and are demanding, continued improvements in technology in order to maintain their own competitiveness.

Standing Out and Fitting In—At the Same Time!

In recognizing this environment, Apple needs to continue to differentiate itself, at the same time as "fitting in" with the industry as a whole. As mentioned, the "Stand Out—Fit In" philosophy is the backbone of the company's strategy, and Apple will be addressing this apparent dichotomy by concentrating on four key areas of differentiation. These are as follows:

- **Price/Performance**: The adoption of the PowerPC and its use of RISC rather than CISC architecture places Apple in a strong position versus the CISC camp, which Apple believes is rapidly approaching the end of its practical life, given the limit to the reduction in silicon surface area that is available to CISC manufacturers. The company fully intends to capitalize on the lead in power/performance that the PowerPC consortium has achieved.
- **Component Solutions**: This is a move from monolithic applications to what are called component solutions, which essentially means the adoption of object orientation in its approach to software design. Apple feels that the days of increasingly complex memory-intensive applications are limited, and it believes that people want applications that will allow them to create an environment in which they feel comfortable working, rather than having to fit in with the way demanded by the application. This belief is represented in the work being carried out with OpenDoc through the independently established CI Labs.

- **Collaboration**: The move from communications (networking) to "collaboration" is defined by Apple as the use of more effective teams of workers, using active interfaces that move away from ease of use to ease of work. Together with the development of component solutions, the move to customized applications that fit in with the way organizations work is becoming a real possibility. It allows for sets of applications to be built which are designed to maximize the productivity of one particular group of workers, or horizontal or vertical market segment. Effectively, we are moving into an era of customized applications, tailored to the needs of a specific user group.
- **Active Assistance**: This relates to a move away from the passive GUI that is currently prevalent, to active assistance in communication with the PC, in particular, using the voice as a natural interface with the computer. Apple believes that the extra power of RISC will allow it to deliver this new interface.

Fitting In with the Industry—A New direction for Apple

The other key axis being tackled by Apple is how to "Fit In," that is, to be compatible with its own installed base of hardware and software, while at the same time becoming compatible with the rest of the industry. The company claims to be able to achieve compatibility in three areas: standard application compatibility, networking compatibility and, finally, interoperability (see Figure 3).

As far as standard applications are concerned, the new generation of PowerMac machines can service all 68KB-based applications, as well as access all the DOS- and Windows-based applications through the utiliz-

Figure 3
Apple's "Fitting In" Compatibility

Application compatibility	68KB applications on PowerPC DOS and Windows 3.1 applications Macintosh personality on UNIX
Networking compatibility	AppleTalk TCP/IP and IPX NetWare Open Transport
Interoperability	Easy open, Macintosh PC exchange PowerTalk, MAPI interoperability OpenDoc, OLE 2.0 parts Quicktime movie format

Source: Apple Computer, Inc.

ation of "SoftWindows" from Insignia Solutions. Even if current performance is slow, the combination of future releases of "SoftWindows" and future upgrades to the PowerPC will probably solve these issues. There is also the prospect of a "Macintosh Personality" on a UNIX platform. Apple is also shooting for fuller networking compatibility on top of the current support for Token-Ring and Ethernet connectivity by using AppleTalk, and conforming to TCP/IP and IPX/NetWare standards.

Interoperability is also promised through Easy Open and Mac/PC exchange, a set of utilities allowing users to open and edit DOS, Windows or OS/2-based files in Macintosh applications. Interoperability between Apple's and Microsoft's messaging services is also possible as a result of a recent joint agreement that will ensure interoperation between their respective messaging, catalogue and directory services. In addition, CI Labs has promised the ability to port between OpenDoc and OLE 2.0 from Microsoft. The intention is to enable Macintosh users to collaborate easily with their colleagues at any time and anywhere, regardless of the systems being used.

Hardware Strategy

Apple's hardware strategy is simple: PowerPC everywhere. The company is very pleased with the performance increases it has achieved with the PowerPC chips, and has active plans to migrate the whole product range to RISC technology. Currently, Apple is the only vendor with an RISC box and it is keen to capitalize on this, cementing its number-one position.

Future PowerPC Chips

PowerPC 601+: This will provide better speed, but will still use the same systems as are currently available. It will be up to 40 percent smaller, will consume less power, and run at a faster clock speed.

PowerPC 603: This is the chip designed for PowerBooks and, therefore, will feature power management and will have a much smaller die size.

PowerPC 604: Currently in the laboratories, this is positioned as the P6 (from Intel) basher. Apple claims it will give two to three times the performance of the 601, and that the development cycle is ahead of the P6.

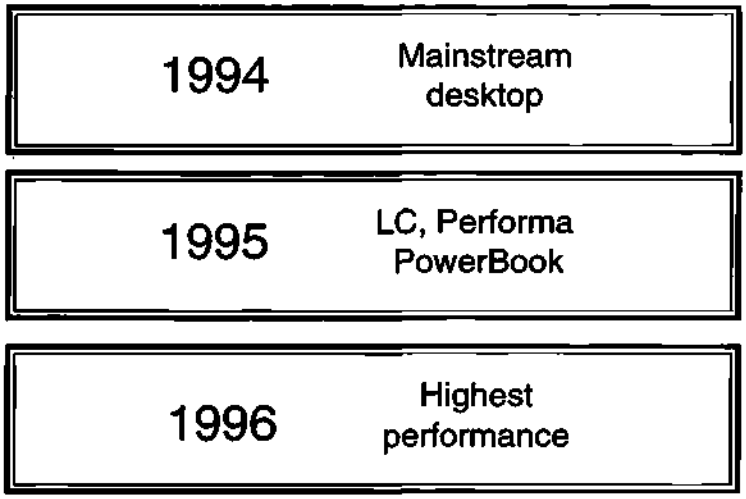
Figure 4 shows Apple's road map for its key product categories or brands in terms of how the PowerPC relates to the current product set.

Multimedia Strategy

Multimedia is one of Apple's key strengths. For many years, the company has been at the forefront of the development of PCs into sound and image, both fixed and moving. It recognizes the opportunity provided by the new performance of the PowerMac machines as a key to exploiting the technology lead held by Apple.

The company is working hard with many publishers to broaden the base of applications that currently exist, with the aim of creating the

Figure 4
Apple's PowerPC Processor Road Map



Source: Apple Computer, Inc.

impression of a multitude of "niche" markets which together add up to a significant opportunity. It is clear that the advent of multimedia on PCs is being felt primarily in the core Apple markets of publishing, design and, to a lesser extent, education. This raises the stakes for Apple, making it a key market for the company.

Multimedia plays an important role in a longer-term strategy for Apple, which sees it as a key dynamic in the convergence of the worlds of PC and telecommunications, plus all that is promised by the information superhighway. The opportunities to tap into the huge potential of the consumer market, whether through software or set-top boxes, provide a strong incentive for Apple to maintain a strategic lead over the competition.

Apple in Europe

Each of Apple's regional entities (United States, Pacific and Europe) are full business operations in their own right, with production facilities and R&D centers. Apple came to Europe in 1981 and, today, this region represents about a $2 billion business (1993 fiscal year revenue was $1.9 billion), or 25 percent of Apple's worldwide 1993 revenue of $7.8 billion. The headquarters of Apple Computer Europe is in Paris.

Apple—Its Semiconductor Consumption

Apple has ramped up its European PC production consistently over the last four years, achieving a cumulative increase of 79 percent. Total effective European PC production by all companies increased by approximately 107 percent over the corresponding time period. Therefore, although Apple has increased its production levels, this is still behind the level at which total European production has increased.

Table 1
Total European PC Production
(Thousands of Units)

	1993	1992	1991	1990
Effective European Production	10,200	7,709	5,756	4,907
Apple's European Production	800.0	658.6	530.0	446.7
Percentage of Total	7.8%	8.5%	9.2%	9.1%

Source: Dataquest (October 1994 Estimates)

Apple's proportion of effective European production has decreased from 9.1 percent in 1990 to 7.8 percent in 1993 (Table 1). More recently, in 1993 its desktop PC production increased by 56.2 percent, at a far higher rate than the overall European production increase of 23.6 percent. IBM, on the other hand, is not ramping up its levels of production to the same degree, and this is due to the market share that IBM has steadily lost to Compaq. This is further reflected by IBM's decreasing share of European desktop production, which has fallen from 20 percent in 1991 to 14.2 percent in 1993.

Apple does not share the problems many of the major PC manufacturers (IBM and Compaq) have of "clone " competition; its real battle has been in operating systems, between Windows and System 7. Another factor influencing production levels during this period has been the many newcomers to the market trying to position themselves to take advantage of the explosive PC boom that we have seen. This trend has slowed in 1994 as some of the small and medium-size players have been squeezed out, unable to compete, or to produce PCs as efficiently or cost-effectively as some of the larger companies. These larger companies have all the benefits of economies of scale and, therefore, can price their PCs more competitively. They also have the channels of distribution and marketing campaigns to increase their brand awareness and, hence, potential market share gains.

Apple's PC production strategy is primarily influenced by the demands of time to market, but issues of tariff and duties have sometimes influenced a shift in Apple's regional production. Production of Apple's range of notebook PCs, the PowerBook, was shifted from the United States to the Cork, Ireland production facility when a prohibitively high (62.7 percent) import duty was placed on color TFT liquid crystal displays (LCDs) by the United States. When this tariff was repealed by the US government in 1993, most of the production of notebook computers was returned to Apple's Sacramento, California production facility.

Tables 2 to 4 show the company's rankings in PC production in 1991, 1992 and 1993. Apple has remained among the top five PC producers over the three years. The production of PCs in 1993 is more concentrated, the top five players accounting for 32 percent of all European production, compared with 28 percent in 1992.

Table 2
Total European PC Production Rankings 1993
(Thousands of Units)

Rank	Company	Units	Percentage of Production
1	IBM	1,500	14.7%
2	Compaq	950	9.3%
3	Apple	800	7.8%
4	Olivetti	606	5.9%
5	Vobis	441	4.3%
	Total	10,200	100.0%

Source: Dataquest (October 1994 Estimates)

Table 3
Total European PC Production Rankings 1992
(Thousands of Units)

Rank	Company	Units	Percentage of Production
1	IBM	1,200	13.6%
2	Compaq	690	7.8%
3	Apple	658	7.4%
4	Olivetti	547	6.2%
5	Dell	251	2.8%
	Total	8,826	100.0

Source: Dataquest (October 1994 Estimates)

Table 4
Total European PC Production Rankings 1991
(Thousands of Units)

Rank	Company	Units	Percentage of Production
1	IBM	1,250	18.6%
2	Apple	530	7.9%
3	Olivetti	505	7.5%
4	Compaq	425	6.3%
5	Bull	200	3.0%
	Total	6,722	100.0%

Source: Dataquest (October 1994 Estimates)

Semiconductor Procurement

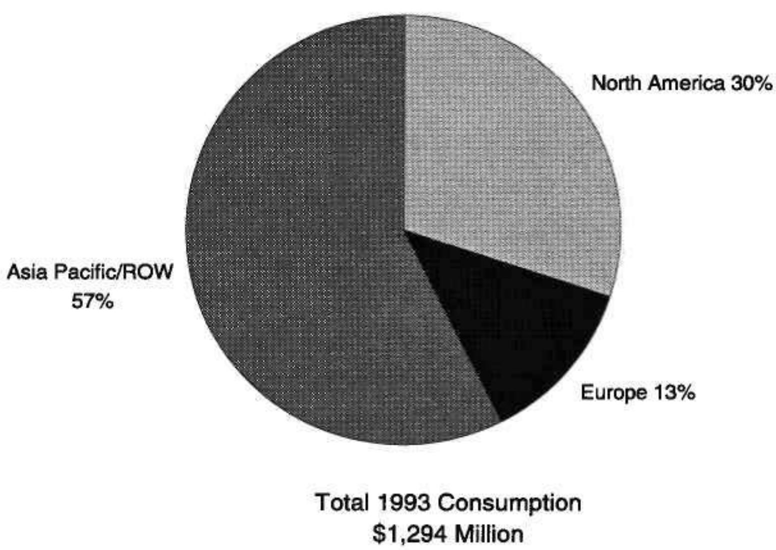
Apple ranks high in Dataquest's listing of semiconductor buyers, the company spending approximately $1.3 billion worldwide in 1993. PC companies spend 20 percent of their revenue, on average, on semiconductor consumption. As a proportion of overall semiconductor consumption in Europe, PC production accounted for over 20 percent of semiconductor sales during 1993. This makes the PC the single most important product for the European semiconductor industry. In 1993, PC production increased 32 percent to 10.2 million units as shown in Table 1, with the United Kingdom and Ireland the largest producers, contributing 50.5 percent of all European production.

As can be seen from Figure 5, some 57 percent of the company's procurement is in the Asia/Pacific region, with 30 percent in North America. About 13 percent of Apple's total procurement of semiconductor devices comes from the European market.

In line with many PC manufacturers, Apple has chosen to source and manufacture locally in order to minimize inventory holding costs and to reduce its time to market with new products. In 1993, European vendor sourcing for Europe alone was about $164 million, and Dataquest expects that this will increase to about $260 million in 1994.

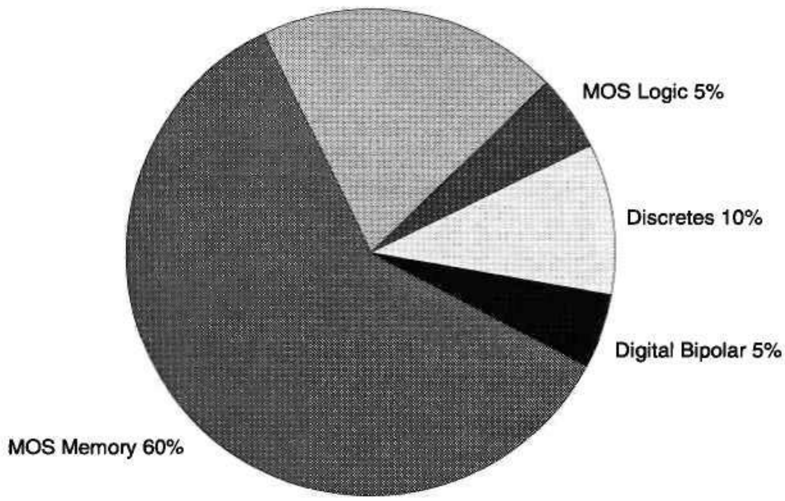
Not surprisingly, approximately 60 percent of all semiconductors procured are under the category of MOS memory—mainly DRAMs (see Figure 6). The second highest product category is microprocessors.

Figure 5
Worldwide 1993 Semiconductor Procurement by Region



Note: No procurement in Japan in 1993
Source: Dataquest (October 1994 Estimates)

Figure 6
Worldwide 1993 Semiconductor Procurement by Device Type



Total 1993 Consumption
$1,294 Million

Source: Dataquest (October 1994 Estimates)

A further 10 percent is spent on discretes, and the remaining 10 percent is split between digital bipolar and MOS logic.

Manufacturing and Operations

Apple Computer has only one European manufacturing plant, in Cork, Ireland, and this site employs about 300 people. At this site Apple performs full printed circuit board (PCB) assembly of the PC motherboard. Most desktop personal computers for the European, Middle East and African markets are produced at this site, together with a limited range of notebooks for the US market. The plant was established in 1980, and was originally 4,400 m^2 in size. The site has had several extensions; the most recent one started in 1989 and has now brought the Cork facility up to 34,000 m^2 in area.

Table 5 provides a list of Apple's purchasing, design and manufacturing locations. Most of its semiconductor products are designed into systems at its R&D site in Cupertino, California.

Apple Europe has recently completed the establishment of a $45 million operations center in Apeldoorn, Netherlands. This facility, which became fully operational in the summer of 1993, is used for the distribution of finished goods and spare parts for Europe, as well as final configuration and localization of many Apple products. As a result, Apple expects to reduce its costs, avoid double handling of products in the regions, and achieve better efficiencies in transportation and inventory management.

Table 5
Key Company Purchasing—Design and Manufacturing Locations

Company/Location	Location Function
Cupertino, California	Central design and procurement
Fountain, Colorado	Board assembly
Singapore	Board assembly, procurement
Cork City, Ireland	Board assembly, procurement
Sacramento, California	Final board assembly (SIMMs and MPU)

Source: Dataquest (October 1994)

Research and Development

Apple currently invests about 6.5 percent of its worldwide revenue in R&D. In March 1988, Apple founded its Paris-based European R&D center, which is part of the company's worldwide R&D organization. Outside of the United States, Apple's other main R&D locations are in Singapore and Tokyo.

Given Europe-specific needs in the area of telecommunications, the center's primary mandate is to focus on communications products—both hardware and software—and especially on their integration into Apple's product ranges. Until 1993, the European R&D center was Apple's worldwide development center for modems, telecommunications in notebook computers and products that comply with open system interconnection (OSI) standards. Because of the increasing differences between Europe and other regions in the telecommunications area and the acceleration of the development of new technologies, the center focuses increasingly on European telecommunications systems.

Apple's Market Position

The following section is an assessment of Apple's market position, which will provide some context for the company's current achievements.

The PC market has been experiencing something of a boom over the last two years. The continuing erosion of prices has not been matched by a decrease in spending in the markets, leading to growth in high unit shipments over a number of quarters.

Well-established brand names have been capitalizing on this high growth in no uncertain terms and, as as result, the market has experienced significant concentration of market share with the leading vendors. Apple has also benefited significantly, from this increase.

The huge uptake of Windows 3.1 in the marketplace has lessened the impact of one of Apple's key differentiators—that is, the ease of use of the Macintosh machine—reducing its ability to charge premium prices in the marketplace.

To this extent, Apple has had to follow the pace set by the IBM-compatible market in order to remain competitive and has been forced to adapt its financial model in order to survive. Until recently, the fall in average selling prices has meant declining revenue curves for almost all of the established vendors. The painful realignment that Apple experienced with the restructuring in the summer of 1993 has now allowed the company to become competitive again.

After stopping the rot in 1992 with a new set of products, namely the PowerBooks, Quadras and Performas, Apple has had a solid performance over the past year or so, keeping pace with the growth in the market and maintaining a share of about 8 percent of the market, placing it consistently in third place and at some distance from its nearest rival.

PowerBooks Play a Major Role

While many vendors have failed to see notebook computers penetrate much beyond 14 percent of all PCs sold, Apple has developed a strong following for its PowerBook range of both notebook and, more recently, subnotebook products. Portables represent about 17.5 percent of all PCs sold by Apple, reflecting both the innovative and stylish design of the product itself, as well as the propensity of loyal Apple customers to buy innovative products.

A SWOT Analysis—Some Conclusions

This section draws together the points raised in this report and tries to draw some conclusions, making predictions about Apple's strengths, weaknesses, opportunities and threats. Strengths and weaknesses refer to internal issues within the organization, while opportunities and threats assess external factors that face Apple.

Strengths

RISC-Based Systems

It is clear that by using the PowerPC processor Apple has established a lead in performance. Moreover, the 601 chip is the first implementation of a new generation of RISC chips, rather than with the Intel platform which is starting to reach its natural limits (evidenced by Intel's and Hewlett-Packard's recent agreement). This gives Apple a lead in producing RISC PCs, which it should be able to maintain for the next three years until the Intel/HP chip arrives.

Ease of Use

Despite the inroads made by Windows 3.1, Apple's operating system and software applications remain the most natural and intuitive interfaces in the marketplace. As the market for PCs expands into the small business and consumer arenas, essentially towards the less computer-literate, this inherent strength should prove invaluable.

Control Over Hardware and Software Architectures

Apple has control over the development of both hardware and software—a virtually unique position (although, IBM arguably has this as well). It should allow Apple to take advantage of the performance gains that are available to it with RISC technology. It is of little use having a performance lead over the competition if it cannot be converted into real differences in productivity by building an operating system and applications that work efficiently with the hardware implementation. If Apple can achieve this it will be able to really "Stand Out," which is a prerequisite if people are going to invest in the new technology.

Multimedia

Multimedia is a key tool to access certain markets (publishing, design and education) which, in many cases, are Apple's heartlands. Again, Apple has been able to develop a lead in this area. Sound is standard in Macintosh machines, with built-in SCSI for CD-ROMs and a strong application base. This stands the company in good stead for the future as multimedia is already, and will continue to be, a key component in cracking the consumer market. The latter will, in turn, lead the mainstream business market into the use of multimedia. It is also important to stress that by continuing to lead in multimedia, Apple is helping to protect its core markets.

Strong Industrial and Product Design

This is another Apple tradition which will again help to differentiate the company to its loyal users. Apple makes "cool" products and this is very important as PCs start to move into the home environment. Users are not going to want boring "office tan" boxes in their living rooms, whereas Apple offers more than attractive boxes and has genuine product innovation. The first PowerBooks, for example, went a long way to solving the "mouse problem" by integrating a convenient trackball below the keyboard; the latest PowerBooks take this concept one step further by utilizing a touch-sensitive pad. Apple PCs also have built-in connectivity across the range and, in general, Macintosh machines are easier to configure than PC ISA/EISA systems.

Weaknesses

The Application Drought for PowerMac Machines

Currently, PowerMac machines sales are suffering due to a lack of native applications that really take advantage of the speed of the PowerPC processor. It is vital that the base of applications grows, with the main port probably being Microsoft Office, which was due out from Apple in the third quarter. Given the increasingly tense relationship between Microsoft and Apple, this must be an unnerving situation to be in. The lack of applications also severely limits the bundling options available to Apple, which is certainly hoping to ease the porting process. One of the main benefits of OpenDoc is the relatively low cost of adapting a software package to the OpenDoc standard, and this is exactly why the company is being so open with the reference source code.

High R&D Costs

While Apple has used its unique position of providing both hardware and software to differentiate iftself, the cost of doing so is substantial.

The company is the sole supplier of Macintosh systems, which is is not an industry standard and, therefore, opportunities for economies of scale are limited. The ratio of R&D costs to sales is very high, and even after its huge cost restructuring in the third quarter of 1993, it still remains at least twice that of the mainstream industry. A question mark must therefore remain over whether Apple can maintain its lead in key areas, such as the user interface and hardware innovations, with the lower-cost structure that the industry will force it to maintain.

Windows Compatibility

Although Soft Windows from Insignia Solutions provides compatibility with the DOS/Windows world, the current performance is very poor, is slower than an entry-level 486, and has no enhanced mode emulation, hence no-one would buy a PowerPC system to run Windows, thereby cutting out a huge slice of the available market. This will certainly improve over time, but it looks unlikely that PowerMac machines will be able to run Chicago (Windows 4.0) from Microsoft. This is scheduled in the first quarter of 1995, making Intel compatibility short-lived for these machines.

Low-End PowerPCs

Currently, no low-end PowerMac machines exist. PowerPCs are very expensive compared with the standard industry 486 box, and even though it is much more powerful, it does not fill all price points. Again, this is set to change in 1995 with the LC, Performa and PowerBook moving to the PowerPC platform. In the meantime, Apple users will have to make do with the 68040, and the company will have to be very careful that users do not wait for the new systems to come, which will mean large inventory costs and cash flow problems.

Networking Weaknesses

Once users step beyond an Apple network, Macintosh machines are difficult to incorporate into corporate networks. In many cases, the department using them is an "island" hanging off the main network. Only recently has Apple started to move into the PC server world, where it is seen to be quite weak compared with Intel-based manufacturers. On the software side, Apple as yet has no offering in the groupware arena.

Opportunities

New Markets Available

The new hardware architecture enables Apple to tackle a number of key markets for the first time, allowing the company to break out of the specialized markets that it dominates and to present an offering to the mainstream market. PowerPC servers, for example, could be sold into corporate markets and act as a "Trojan horse" to get Apple's foot in the door, before starting to populate the desktops.

By exploiting its lead in multimedia technologies and products, Apple could make significant inroads into the consumer, the education and, later, the business markets.

Similarly, the company could move into new product areas by leveraging its R&D and design leadership to expand into branded peripherals, such as scanners and CD-ROMs.

Threats

Chicago

One of the biggest threats to Apple at the moment must be Chicago. If the package delivers all that is promised, Apple will lose its differentiation in "ease of use"— probably the company's single biggest edge. As mentioned, Apple may well lose the ability to emulate Intel PCs running Chicago, which is a key part of its "Stand Out—Fit In" strategy.

Native Applications

Apple has to be able to persuade software developers that it is worth developing for the PowerMac model. The installed base of PowerPCs remains very small compared with DOS/Windows machines. If the company fails to do this, the PowerMac model is in danger of being starved to death.

Intel/HP Alliance

This alliance has given current x86 users a road map (albeit a long one!) to a RISC chip, and has taken some of the wind out of the sails of the PowerPC campaign. If Intel can maintain the Pentium and P6 at reasonable levels of performance, it will remain a difficult job to persuade an enterprise using Intel-based PCs to change.

PowerPC Alliance

The PowerPC alliance is of great importance to Apple as it has enabled the company to move away from the 68K architecture, and to implement a new powerful one. The R&D costs of doing this had to be shared. Currently, this alliance is a strength for Apple, but could quickly turn into a threat if relations sour. The company is dependent on future processor evolutions to maintain its lead, and if IBM chooses not to have a PC using the PowerPC chip, it would call into question the whole viability of the architecture, effectively destroying Apple's "Stand Out—Fit In" strategy.

The majority of this profile is based on a profile produced by Dataquest's *Personal Computers Europe* service in June 1994.

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Dataquest Company Profile

Semiconductors

Semiconductor Application Markets Europe

Siemens AG

This document provides a brief overview of the operations and strategies of Siemens AG, focusing chiefly on the company's telecommunications activities.

Corporate Statistics

Company Headquarters	Wittelsbacherplatz 2 80333 Munich Germany Tel: +49 89 234-0 Fax: +49 89 234 4242	
President/CEO	Dr. Heinrich v. Pierer	
Employees	413,000	Worldwide
	253,000	Germany

1992 Financials	**DM Million**	**$ Million**
Net Sales	78,509	122,474
Order Bookings	85,409	133,238
Net Income	1,955	3,050

As Figure 1 shows, Siemens is a big and rich company whose cash, particularly during this recession, provides it with a substantial cushion. Siemens is also in the fortunate position of hardly having any debts. Of its 1992 sales, the company managed to invest almost a quarter in stocks and bonds rather than, some critics say, investing cash in its own operations. Consequently, this has earned Siemens more than half of its net income. Siemens has also reported its 1993 results with orders up by 15 percent and sales up by 2 percent.

Corporate Overview

History and Background

Siemens is a widely diversified supplier of electronic and electrical products, and systems with a strong engineering background. As such, Siemens can be regarded as the company with one of the widest ranges

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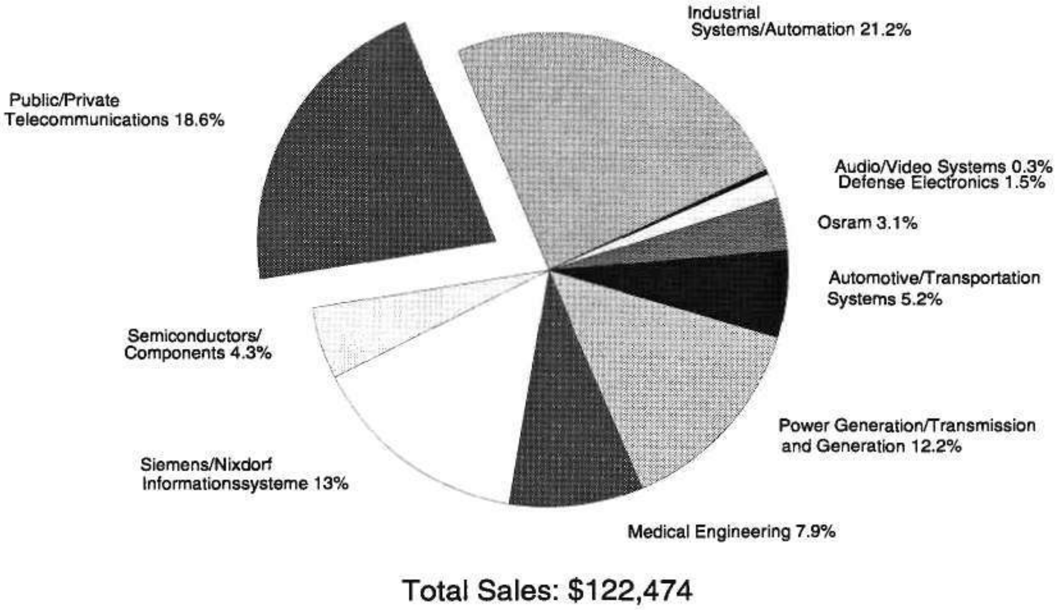
Figure 1
Siemens 1992 Sales by Business Group (Including Intersegment Sales)



Source: Dataquest (March 1994 Estimates)

of products in the world. In sales terms, however, the company ranked fifth-largest electronics and electrical company in the world and number-one in Europe. Philips of the Netherlands and Thomson of France are its main European competitors.

Such a broad range of products can be viewed as both a weakness and a strength. The weakness stems from the danger of spreading oneself too thin in too many markets, as well as the difficulty in defining a corporate strategic direction. The company must also experience cultural discrepancies between its more traditional electrical and engineering businesses and its electronics activities. The advantage of a wide range of activities used to be that it allowed a company to spread the risks but, during world recession, there is hardly an industry that has not been affected. Siemens' involvement in semiconductors allows it to obtain a competitive edge through developing fundamental chip technology in-house. Although this has enabled the company to become a leading supplier of integrated circuits (ICs) for ISDN, telecommunications is only the fourth-largest application area for its semiconductor business.

With the establishment of the European internal market, Siemens likes to regard Europe as its home market. The company is taking the European single market development quite seriously, to the extent that it has made a public statement on unified Europe, including Central and Eastern European countries. Despite this commitment, Siemens still derived 46 percent of its 1992 sales from Germany. The company is working on gradually increasing its international sales, where the largest proportion is still accounted for by Europe; the North American market accounted for just 10 percent of overall sales in 1992. The recession, together with the intense competitiveness of this market, provide Siemens with a major challenge to sustain and strengthen its position in this region.

Siemens' products are sold in more than 130 countries around the world with an extensive network of sales offices. Being part of unified Germany, the company has benefited substantially from new business in eastern Germany. The company is also active in several other Central and Eastern European states, details of which are provided later in this profile. Future growth is expected to come from Asia where, for example, the company plans to double its regional market share in public switching over the next few years.

Telecommunications accounts for approximately 25 percent of the company's entire business, but is regarded as a strategic business segment—particularly public telecommunications, part of the infrastructure systems business where Siemens claims to have established a strong position. Siemens' advantage of having the largest European telecommunications market as its home market automatically places it in a high-ranking position in the total European market. Increased liberalization and deregulation is expected to gradually impact the company's business in Germany.

Organization

The relentless pace of technological change has led to Siemens' creation of an increasingly decentralized structure. This, it believes, allows the company to focus more clearly on individual market segments. As a result, Siemens now comprises 17 operating groups, 80 business sectors and 300 business segments. About 90 percent of the company's business is in electrotechnical and electronic goods.

This report profiles the telecommunications activities of Siemens, which are split into two separate divisions:

- *Public Communication Networks:* Public switching systems; text and data switching systems; public mobile radio systems; transmission systems
- *Private Communication Systems:* Business communications systems; telephones; mobile phones; facsimile machines

These telecommunications businesses operate as independent business units and are described in detail later in this report. Although both businesses showed an overall profit worldwide in 1992, they both accounted for most of the company's losses in the United States. The declining US economy and negative currency movements, together with a fiercely competitive environment, have been the main contributing factors to Siemens' fate, despite efforts to strengthen its local presence.

Business Strategic Direction

The company's focus will remain on Germany and Europe, where it hopes it can benefit more from a unified Germany as well as a single market in Europe. World recession has weakened the company's business outside of Europe, but Siemens will also aim to consolidate and strengthen its position in the North American and Asian markets.

Like most German corporations, the quality of products and services is of utmost importance to Siemens. The German market itself has high quality standards and this has become second nature to the company. Its roots have been in technological innovation and research and the company has established itself as one of the technology leaders in Germany.

Although the majority of business is derived from its home market, Siemens has wide international presence with subsidiaries in 36 countries and sales companies, or representative offices, in another 38 countries. Overall, the Siemens network spans more than 120 countries. On the telecommunications side, Siemens is active in 80 countries and has local manufacturing facilities in 35 countries.

The company's strong cash-rich position has added to customers' confidence to the extent that they are willing to sign long-term contracts to buy Siemens' products and systems. More importantly, this financial cushion is providing the company with considerable staying power, enabling it to build on its long-term strategies. Siemens' main strategic goals can be described as follows:

- Continue to invest for a dominant share of emerging electrical and telecommunications markets in Central and Eastern Europe, especially the former east Germany. The company has already poured over $600 million-worth of factories and equipment into the unified German state since 1991 and has $260 million in its 1993 budget.
- Siemens' cash-rich position provides it with a competitive advantage to make the most of the current buyer's market. The company recently bought GTE's Sylvania North America's lighting division for $900 million, paid for entirely in cash.
- Siemens also continues its vertical integration and seems determined to maintain its own leading-edge silicon and computer technologies for its systems business.

With regard to its telecommunications business, Siemens is faced with a number of challenges resulting from the single European telecommunications market. More specifically, the company can no longer automatically assume its favored-supplier status to the Deutsche Bundespost (DBP) Telekom and is therefore looking to strengthen its position outside its home territory. Consequently, the company is concerned that it will be able to compete on equal terms with foreign companies. This applies to both R&D funding and new contracts put out to tender.

Alliances/Joint Ventures and Acquisitions

Siemens continues to pursue its drive for acquisitions, joint ventures and other forms of strategic partnerships. For the purpose of this profile, which focuses on Siemens' telecommunications business, we have listed only the most relevant alliances of the past years:

GPT: This UK telecommunications company is jointly owned by Siemens (40 percent) and GEC (60 percent). Although the GPT name continues, Siemens and GPT are increasingly combining their UK operations—reflected in the establishment of GPT Communications Systems Ltd, which combines the direct-selling business of the two companies. There has been increasing collaboration in other areas too, such as Vision Optimized Network Evolution (ONE), their combined new public network technology strategy.

Rolm: During 1992, Siemens took full control of this US company, previously a 50–50 joint venture with Siemens. This move should strengthen the company's position in the United States.

Stromberg Carlson: This company used to be owned by GPT as Plessey's US subsidiary providing public switches. After the initial merger with Siemens, the companies decided to join their US public network operations in the United States, thus Siemens Stromberg-Carlson was born.

Siemens Nixdorf: Since the beginning of 1992, Siemens Nixdorf Informationssysteme AG (SNI) has become fully integrated into Siemens AG, which now owns 95 percent. SNI continues to act as a separate operating group while retaining its status as a separate legal entity. The telephone systems business of Siemens Nixdorf was transferred into the Private Communication Systems group of Siemens during 1992.

Shanghai AJ Corporation and Shanghai Xin Guang Telecommunications: A joint-venture company, Siemens Business Communication Systems Ltd, was formed in 1993 to manufacture, market and sell jointly Hicom 300. Siemens has a 51 percent interest in the company.

ZWUT: Together with ZWUT, the largest Polish manufacturer of telecommunications equipment, Siemens formed a 49–51 joint venture at the beginning of 1993 called CEWIS, which was the first company in Poland to produce digital switching systems.

Incoms Telecom Holding: In January 1993, Siemens formed another joint venture in Eastern Europe. The venture, Digicom, is 60 percent-owned by its Bulgarian partner and 40 percent-owned by Siemens; it will produce public switching and transmission systems.

Corning Glass: Joint venture on optical cable manufacturing.

Central and Eastern Europe

Because of its location and its historic links, Siemens is obviously benefiting from developments in Central and Eastern Europe. In particular, eastern Germany has contributed to the company's revenue growth, although some of the growth in this region has been due to the consolidation of companies. Siemens has sales offices in Bulgaria, the Czech Republic and Slovakia, Hungary, Poland, Romania, the CIS and the former Yugoslavia.

Public communications is one of the most active groups in eastern Germany, which is in need of many infrastructure developments and upgrades. In total, the Public Communications Networks group has nine joint ventures in Central and Eastern Europe, and all have now started on the production of EWSD switching systems.

The Private Communication Systems group is also expanding its activities in Central and Eastern Europe with a subsidiary in the Czech Republic, sales offices in Hungary and Poland, as well as other cooperative agreements in Romania and the CIS. All these activities are centered around the company's Hicom product range.

Poland, in particular, is an important market for Siemens where the company has done business for more than 100 years. Today, the company brings in about DM 100 million a year from Polish sales. This figure, however, is not only for telecommunications, but also includes revenue from medical electronics and automation. The establishment of the joint-venture company, CEWIS, is part of supplying the country's digital overlay network. The network, which is being financed by the World Bank, consists of 12 combined local/transit exchanges spread across the country with the most powerful being located in Warsaw.

Siemens' Bulgarian joint-venture company, Digicom, located in Sofia, is another major local production facility in Central and Eastern Europe. The company plans to produce 100,00 EWSD line units in its first year (1993) and, over the medium term, is expected to increase annual production to 250,000 units.

Manufacturing

Siemens' manufacturing activities span all Triad regions, but the largest concentration is in Europe with 261 manufacturing facilities in 16 countries; this accounts for 87 percent of the company's total manufacturing capacity. After Germany, which has more than 20 production facilities, the United Kingdom and North America have the most Siemens manufacturing locations.

Siemens' private communications systems products are manufactured in 23 countries, including Germany. These companies could be either a Siemens subsidiary, associate company or licensee. The Private Communications Systems group has formulated a worldwide strategy which is currently being implemented. Its goal is to achieve cost-leadership and to reduce the time to market and product delivery substantially.

This strategy differs when it concerns an open or closed market. In the case of an open market, the group tends to concentrate its manufacturing sites near or in the major market, whereas in a closed market, the group aims to form centers of competence for components and subassemblies.

Private communications systems are manufactured at 20 locations in 15 countries including Germany. Terminals are manufactured at 17 locations in 16 countries, also including Germany.

R&D

Siemens is a relatively high spender on R&D with an average 11 percent of sales spent. The company has acquired a reputation for high technology standards and believes that R&D is one of the key components to ensure economic success and to maintain a competitive position in high-technology markets. The company has 48,000 employees involved in research and development, including 13,200 staff outside Germany. One of the main (R&D) differentiating factors from its competitors is that Siemens is much less dependent on public funds for its R&D activities, as only 2.5 percent comes from this source.

Public communication networks, automation, semiconductors, medical engineering and SNI together accounted for 60 percent of the 1992 research budget. The company regards its high R&D spending and technological excellence as a major advantage that makes it a valued partner in cooperative ventures.

Over the last few years, the number of European Commission (EC) research projects in which Siemens is involved has increased significantly, and now accounts for more than half of the company's R&D projects. The company aims to take part in more EC projects that focus on IT and communications research.

In the short term, the company is concentrating some of its R&D efforts on ISDN and related developments, such as the integrated packet handler, optical fiber interfaces and fiber in the local loop. For the longer term, Siemens is addressing issues such as ATM, SONET, remote digital terminals and telecommunications network management. Especially in North America, the company feels the pressure to be actively involved in leading-edge technology.

The Private Communications Systems group has concentrated its development activities and resources in 12 different locations in Europe and the United States. Munich, Berlin and Witten are the main centers for the development of Hicom ISDN communication systems, and Bocholt for the associated system telephones. In the United States, Rolm systems are centered in Santa Clara (California) and Rolm telephones in Austin (Texas). All consumer telephones are developed and manufactured in Bocholt. Private communications focuses on all key areas of private telecommunications, including ISDN systems and innovative communication terminals, as well as intelligent networking concepts for corporate networks based on the Siemens CorNet protocol.

Private Communications Systems

Group Headquarters	Hoffmanstraβe 51 81379 Munich Germany Tel: +49 89 722-0
Group Chairman	P. Pribilla
1992 Sales	DM 5.4 billion
Employees	27,000
Products	Corded/cordless PBX, packet switching, facsimile, telex, corded/cordless telephones, videoconferencing, ACD, voicemail, corporate networking

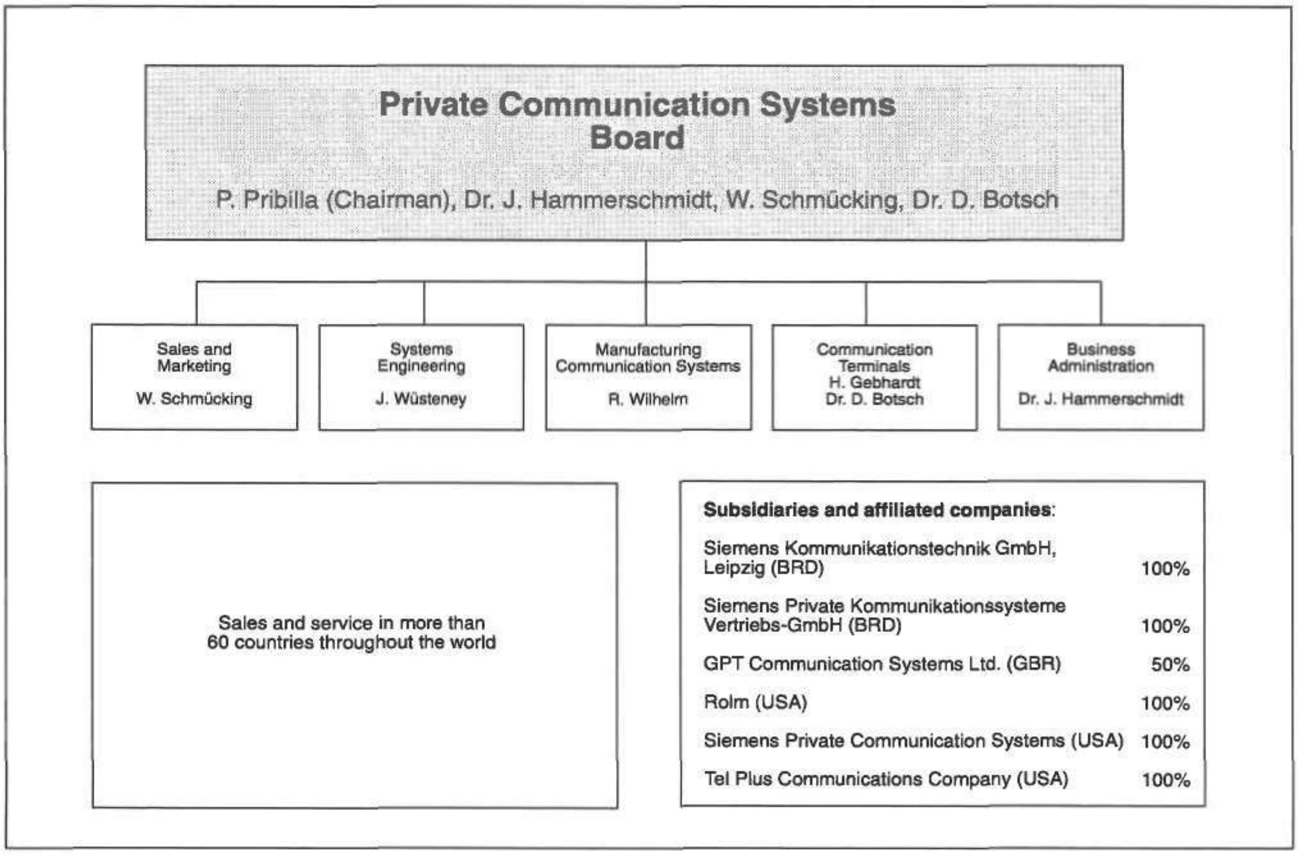
During the past few years, the group has experienced a number of organizational changes. The one with the least impact was probably the transfer of the telephone system business of Siemens Nixdorf Informationssysteme AG in June 1992. During the same year, Siemens acquired the IBM share of the Rolm joint venture, which has since become a wholly owned Siemens subsidiary. In addition, Siemens has now fully absorbed its other US PBX operation, Tel Plus, into the new Rolm organization. Figure 2 shows the organization structure of the group.

Some 50 percent of the group's revenue is derived from large-PBX systems sales with the remainder roughly distributed equally between medium-size systems, small systems and terminals. The Hicom family of products is the main product line of the Private Communications Systems group. The group's strategy is to establish itself as a truly global enterprise within Siemens' corporate structure. The private telecommunications switching industry is rapidly moving towards globalization, but Dataquest believes that only a subset of the major vendors, such as AT&T, Alcatel, Ericsson, NEC, Northern Telecom and, of course, Siemens, will successfully achieve this global status. Siemens clearly aims to be among them, with Rolm playing a key role in achieving this objective.

The company also needs to increase its Asian market penetration in order to achieve global status. The People's Republic of China, in particular, is proving to be one of the fastest-growing markets for Siemens' Hicom systems, which have been sold there since 1988. After some recent large orders, China is now the second-largest market, after Germany, for Hicom systems. Siemens has strengthened its position in China through the manufacturing joint venture in Shanghai. As part of its Asian strategy, Siemens has concentrated its activities into a regional center of competence, located in Singapore. From there, the company controls all its activities in this fast-growing region.

In Europe, Siemens has the advantage of a large home market (Germany accounts for 29 percent of total European PBX line shipments), which

Figure 2
Organization Chart of Siemens' Private Communication Systems Group

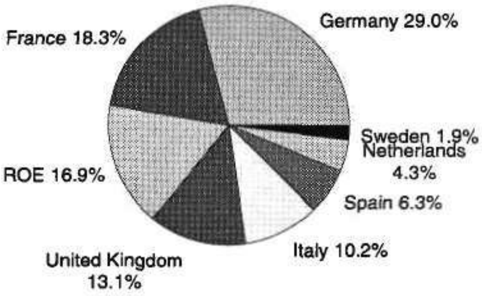


Source: Siemens

did not start to feel seriously the impact of recession until the beginning of 1993 (Figure 3). German unification also led to a continued high rate of infrastructure investment. Siemens is the second-largest European supplier in terms of PBX line shipments and accounted for 15.5 percent market share, behind Alcatel's 20.8 percent (Figure 4). Siemens' 1992 market share is an improvement on the previous year, but does not include SNI or GPT shipments. In Germany, the company had a 37 percent share of the 1992 PBX market, while of the other European markets, Siemens had less than 10 percent share in Italy and the Netherlands, and less than 5 percent in France and the United Kingdom. The latter two both have strong home players in the form of Alcatel and GPT. Siemens has a more dominant position in some of the smaller European countries, such as Luxembourg (48.0 percent), Austria (37.7 percent) and Belgium (28.2 percent). In addition, the company continues to work on expanding its market share for Hicom products in Central and Eastern Europe.

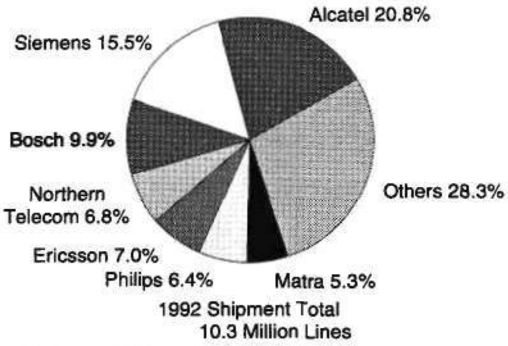
The company has a good pan-European coverage and distribution system in place, but its product portfolio is not as clean as that of its com-

Figure 3
European Premise Switching Equipment Country Shares (Analysis by Lines)



Source: Dataquest (March 1994 Estimates)

Figure 4
European Premise Switching Equipment Total Market Share by Manufacturer



Source: Dataquest (March 1994 Estimates)

petitors, for example Ericsson and Northern Telecom. Because Siemens has tended to purchase local companies, it has to integrate different product lines. In Europe, distribution takes place at two levels: indirect, through the PTOs and special dealer networks; and through direct sales channels. The company has created a rather unusual situation in Germany, where some of the indirect sales are through so-called marketing partners. Companies, such as Hagenuk, have been increasing their market shares such that marketing partners now account for one-fifth of total group sales. DBP Telekom became the group's latest partner and now acts as both reseller and partner for joint bids.

Hicom 300 is the company's ISDN PBX system, which has the potential to connect to a variety of products and applications. The key strength of Siemens' Hicom system is its modularity, which enables users to upgrade from a basic version through to a sophisticated executive communications system. For example, Siemens offers automatic call distribution (ACD) and voicemail systems that can be purchased as integrated parts of the Hicom 300 PBX system. Siemens has been a relative latecomer in the ACD market, which was initially dominated by small standalone and midrange systems from companies like STC, STS, CSEE, TAS and Telenorma; consequently, it has needed to catch up. GPT/Siemens was the first PBX manufacturer represented, but GPT still features more strongly in this market in the United Kingdom than Siemens. This results from a much more advanced ACD market in the United Kingdom, compared with Germany where the market has only just started. In addition, Siemens has to be satisfied with second place to Telenorma, which has a considerably larger share of the German market, especially in standalone ACD systems.

Siemens also has a strong position in the European telephone terminal market where it was number-two in 1992 with a 10.2 percent market share, based on unit shipments. Again, the company has been aided by a very large home market, which accounted for 22.5 percent of the total

European telephone terminal market. Dataquest believes that Siemens is equally strong in the business and residential segments where it ranks second and third respectively; in both cases it is ranked behind Alcatel. Siemens' telephones are well engineered and of good quality, which is particularly useful in supplying the business market.

In addition to Germany, Siemens is a significant player only in the Netherlands but, more recently, has started to make serious inroads into the Spanish market. Compared with its main rival, Alcatel, this is a major weakness especially in view of the current deregulation and distribution trends. Siemens has traditionally supplied most of its telephone terminals through DBP Telekom and distributors as well as through the direct sales channel. Following deregulation and the resultant increased competition, Siemens could not afford to be complacent and, consequently, developed a special sales and marketing concept for European partner companies, whereby the initial focus will be on Germany, the United Kingdom, France, Italy, and the Netherlands. This strategy should assist in tilting the balance of sales from PTO and direct sales in favor of "partner selling."

Siemens was also slow to enter the digital cordless telephony market where it now firmly supports the Digital European Cordless Telecommunications (DECT) standard. Previously, the company only sold OEM products which were analog and based on the CT1+ standard. Subsequently, the company has developed its own cordless products which are currently aimed at the low end of the market, namely the residential and small business segments. Two cordless products were introduced at the CeBIT 1993 show in Hannover: one, the Megaset, is an analog phone; and the other, Gigaset, a digital DECT single-cell-based system.

Dataquest believes that starting at the low end of the market is part of a deliberate strategy by Siemens, allowing it to generate economies of scale as well as market penetration and awareness. Siemens currently has an agreement with Ericsson to be a distributor for its "Freeset" cordless DECT product, which is aimed at the high end of the market.

Mobile computing is one of the areas where computers and telephony meet. Soon after Apple launched its Newton personal digital assistant, Siemens' Private Communications Systems group and its Rolm (US) unit joined forces with Apple to equip business and residential telephones with Newton technology. In addition, the companies will jointly develop wireless technology, integrated speech and data systems for call centers as well as personal productivity offerings. The first product to be released should be the NotePhone, combining Siemens and Rolm telephony with Newton technology for access to telephone and fax features.

Siemens and Rolm, in collaboration with Microsoft, are jointly developing and marketing products that integrate telephony, video and fax applications into a personal computer in both interactive and message modes. Both Rolm and Siemens have already integrated functions for

PhoneMail and FaxMail into their PBX systems, and intend to extend these capabilities to other modes of communication.

Rolm's third place in the US PBX market is a long way behind the market leaders, AT&T and Northern Telecom. This is not really surprising considering the organizational upheaval that the company has had to deal with over the last few years—from being purchased by IBM (1984) to being part-sold to Siemens in 1988 and, finally, wholly owned by Siemens. However, the company believes that with the brand-new release 6 of its 9751 systems it is in a position to improve its competitiveness significantly. The fiercely competitive US market requires companies to continuously improve and upgrade their product ranges, together with high levels of R&D spending. Under Siemens, the company has more cash available to increase its investments in R&D and software development, but Dataquest believes that it still has a long way to go before catching up with the market leaders.

One area where Rolm has been competitive is that of ACD and related products such as Call Center, Callbridge, Call Display, Callstat and Callcom. The attention paid to this market has been rewarded and is reflected by the company's leadership position in the switch–computer integration market. Rolm should be able to benefit from this expertise in the European ACD and computer-integrated telephony (CIT) markets, which are lagging behind those in the United States but have just started to take off.

Through its relationship with PictureTel, Rolm developed international T1-based videoconferencing capability with its CorNet product. However, in the desktop-video segment of the market Rolm appears to be somewhat behind the competition in product development, which is hardware-intensive, proprietary and also very expensive for what Dataquest believes to be a software-driven and price-sensitive market segment. On the European front, Siemens and GPT Video Systems have also been working on a videoconferencing system called Focus 300 Conference Room System. This solution is designed for personal contact with distant partners, for example in departmental meetings, project discussions, and demonstrations. In addition, Siemens is also developing videophones, and both Rolm and Siemens are awaiting full ISDN deployment before entering this market.

At the heart of Rolm's video strategy is its alliance with PictureTel Corporation. Siemens has been developing the terminals and network access, while PictureTel provides the CODECs and cameras. The ultimate objective of the joint strategy is to penetrate the desktop with high-quality, high-priced offerings that amount to smaller desktop versions of PictureTel Conference Room products.

Public Communications Networks

Group Headquarters	Hofmanstraβe 51 81379 Munich Germany Tel: +49 89 722-0
Group Chairman	E.N. Hardt
1992 Sales	DM 13.2 billion
Employees	44,000
Products	Central office switching, transmission, mobile communications systems, mobile radio networks, telecoms cables

Siemens regards itself as a strong infrastructure provider, and this area is of strategic importance for future growth. The company is one of the world's leading suppliers of central office switching systems and is ranked number-three in terms of worldwide, digital local line shipments in 1992. Alcatel and AT&T respectively were ranked first and second.

Germany is by far the company's biggest market, but through its US subsidiary it has acquired a presence in the North American market, and through its partnership with GPT it has gained potential access to the highly competitive UK market. The Siemens/GPT relationship is much closer in transmission, where they are both selling each other's products, than in central office switching. Both companies are still acting more or less independently in the switching market with closer collaboration plans for the future; currently, this is manifested only through joint R&D projects.

As a result of the company's mergers and alliances, Siemens has three different products to maintain, EWSD, DCO and GTD5. For the increasingly important upgrade business, the company does not have the same advantages in terms of economies of scale as, for example, Ericsson which only has one system to support.

Siemens' North American business has not been very successful as this market is clearly dominated by "local" suppliers, such as AT&T and Northern Telecom. The acquisition of Stromberg Carlson only marginally increased the company's market share in North America, still at about 5 percent. The company may now have achieved third-vendor status to several of the RBOCs, but it still faces major regulatory and competitive challenges in this region:

- Overcome the strength and advantages of AT&T and Northern Telecom
- Convince the large local carriers to introduce a new supplier with volume commitment
- Correctly anticipate complex regulatory forces and trends
- Develop the correct product mix for a very dynamic market

Siemens Stromberg-Carlson has yet to break even. As a newcomer, the company had to invest a substantial amount of money into marketing, especially EWSD. The company was also faced with consolidating the transmission products from GTE, the DCO central office switch from Stromberg Carlson and its own EWSD switching system.

The company's performance in Asia has been improving and it now accounts for 30 percent of its international business. Like other companies, Siemens also established manufacturing facilities in the People's Republic of China in collaboration with local partners. Other regions where Siemens continues to invest in public telecommunications infrastructure are India and, of course, Central and Eastern Europe. Owing to political instability, the growth rates in India were lower than expected, but the company has stated that it has a long-term strategy for India in the form of a major foray into rural telecommunications.

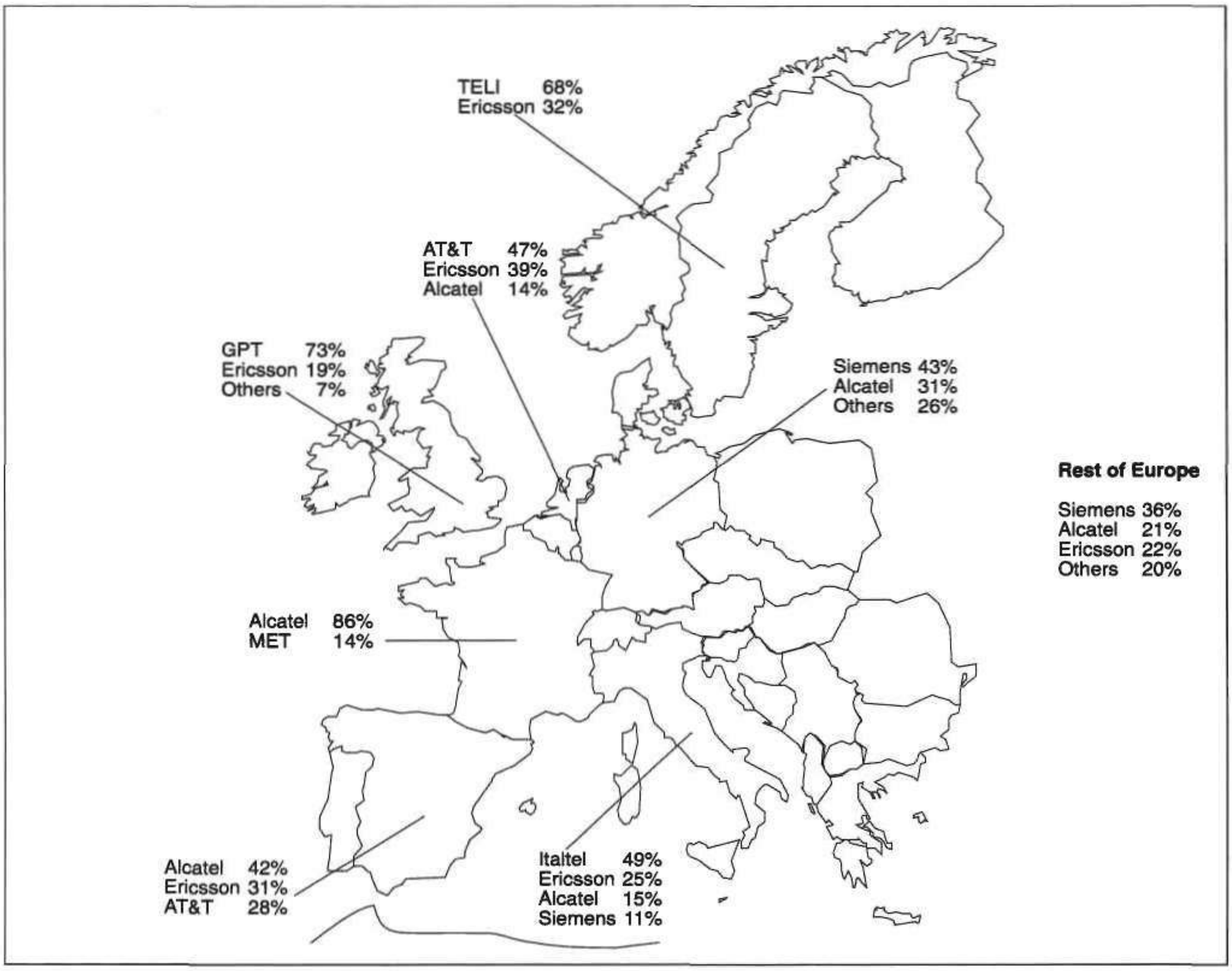
Unification presents a whole range of issues to be overcome by DBP Telekom, but it also offers major opportunities for equipment suppliers. In Central and Eastern Europe as a whole, it is Alcatel-SEL which has really made substantial volume shipments and, according to Dataquest estimates for 1992, it has outstripped its nearest rival by a factor of 2.5. When considering eastern Germany, however, Siemens is by far the biggest supplier of public telecommunications equipment.

On a (Western) European level, Siemens is among the three suppliers that dominate the European central office market (Figure 5). Together with Alcatel and Ericsson, the company accounted for 77 percent of the market in 1992. This was also the year that Siemens became European market leader, having overtaken Alcatel. GPT, in which Siemens has a 40 percent equity interest, ranked number-four. Again, Siemens has the advantage of a big home market with Germany as the largest public switched telecommunications network (PSTN) in Europe. Germany also has the highest growth rate; together with Spain, Germany still has the lowest rate of digitized local switching: 25 percent compared with 81 percent in France. To comply with EC recommendations, Germany has to be 60 percent digitized by 1997. On the negative side, Germany still has the highest price per line and with current pressure on prices will experience the largest price reductions per line. Inevitably, this will have a negative impact on Siemens' revenue stream from this area of business (Figure 6).

Of note is that Siemens sells its EWSD digital switch both directly to DBP Telekom and through two licensees: Bosch Telekom and DeTeWe. The two licensees now have a combined share of 25 percent of the German market and continue to gain dramatically, at the "expense" of Siemens, which will still earn substantial revenue in license fees. This unusual setup may have been a move by DBP Telekom in order not to be seen as having one dominant supplier.

After Germany, where Siemens had a 38 percent market share of digital local line shipments, Italy is the company's other major market in

Figure 5
Map of European Central Office Market

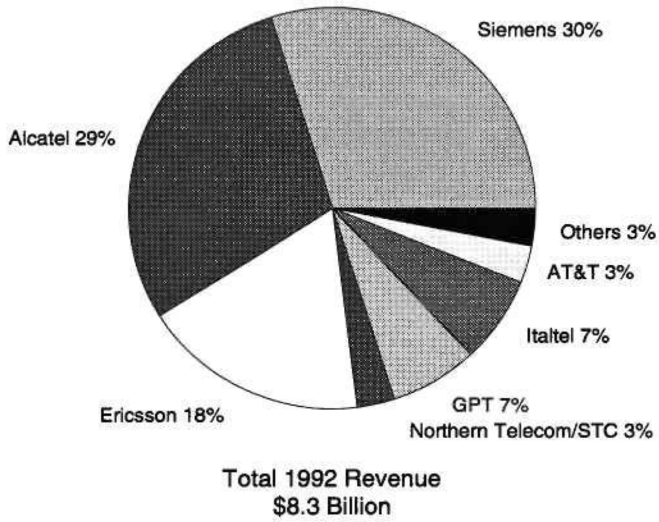


Source: Dataquest (March 1994 Estimates)

Europe. Siemens ranks number-four in the complex Italian market and supplies two different systems: GTE's GTD5 (now being phased out), and Linea UT (under license from Italtel). The company is also well represented in the smaller European countries.

Siemens' method of addressing broadband technology is in the form of Vision ONE, a joint strategic development involving Siemens, GPT (United Kingdom) and Stromberg Carlson (United States). This aims to map out the route from the communications networks of today, towards the universal broadband communications network of the future, incorporating all the necessary products. It is an evolutionary process, starting with its current product range, and gradually introducing new application options and services, as well as greater power, flexibility and economy into the public networks.

Figure 6
European Central Office Supplier Market Share Revenue



Source: Dataquest (March 1994 Estimates)

The overall plan comprises several individual measures, which can be rougly divided into four phases as outlined in Table 1. The first phase of "supplementary measures" started in 1991/1992 and will be followed by the next two ATM phases during the middle of the 1990s. The fourth phase, an ATM network for narrowband and broadband access, is dependent on further technological and market developments and is not likely to start before the late 1990s.

Siemens has already been experimenting in broadband technology through a number of pilot projects. Together with GPT, for example, the company set up a pilot project in Düsseldorf, Germany. Closely related are the activities of Siemens Stromberg-Carlson in the high-speed linking of metropolitan area networks (MAN). The company is also supplying broadband technology for commercial use or field trials to several of the RBOCs as well as to MCI Communications. Siemens claims to be the only manufacturer in the world with experience of operating MANs both in Europe and in North America and, in addition to the US companies, has also received high-speed data network orders from several European PTOs.

Siemens/GPT account for about 25 percent of the European transmission market and, together with Alcatel which has a 30 percent market share, are the dominant leaders. No other single supplier has more than a 7 percent market share. Germany represents the largest market in Europe, accounting for about 30 percent of the total market value. Growth in Siemens' home market continues to be driven by an aggressive digitization program and increasing levels of traffic. In addition, the unification process resulted in a massive investment drive from which Siemens has been one of the main beneficiaries.

Table 1
Network Evolution Overview

- **Additions to the existing networks**
  - Synchronous digital hierarchy (SDH) multiplexers, cross-connectors, transmission systems
  - Metropolitan area network (MAN)
  - Fiber in the loop (FITL)
  - Radio in the loop (RITL)
  - Intelligent Networks (IN)
  - Telecom managed networks (TMN)
- **ATM cross-connect**
  - ATM multiplexer (AMUX)
  - ATM cross-connectors (ACC)
  - Connectionless server

  ATM exchange cross-connect
  - ATM exchange/CC (as supplement to narrowband exchange)
  - Interworking between ATM and STM networks
  - Application processing platform (EWSD, System X, DCO)
- **ATM network for narrowband and broadband**

Source: Siemens

Although most PTOs, including DBP Telekom, have a small number of preferred suppliers, the introduction of synchronous digital hierarchy (SDH) is changing the supplier pattern. As a result, operators have started talking to, as well as buying from, different companies, including "nontraditional" transmission suppliers. Traditionally, Germany was one of the most difficult markets to penetrate, but DBP Telekom has recently started to open up its procurement policies, which has resulted in new suppliers in the transmission market, namely Ericsson, Nokia, NKT and ECI.

The company supplies transmission systems to the PTOs in 27 countries around the world. Currently it is working on meeting their demands in terms of increased network flexibility and intelligence. Key to future transmission networks will be Siemens' network node, NK 2000, which is used to connect, switch and manage digital bit rates between 64 Kbit/s and 155 Kbit/s—referred to as cross-connectors (CCs) and cross-connect multiplexers (CCMs). One application of the network node is automatic alternate routing in the event of line impairment whereby the link can be restored automatically. These new cross-connect systems are based on the international SDH standard.

Siemens is also working on fiber to the home (FTTH) and has already been testing its FTTH system in collaboration with DBP Telekom in a pilot project in Leipzig. This project, however, uses an interim (more economic) solution whereby the fiber is not directly laid into the home or office, but is linked up to a "distance unit" (DU) at the street kerb or in the basement.

As a result of recent networking developments and the concept of enterprise networking, Siemens is also developing its LAN offerings—not at all a strange move, especially as it provides some synergy with SNI. Coming from this division, Siemens is naturally focusing on fiber-distributed data interface (FDDI), a high-speed data network based on existing local computer networks. In addition, the company is also developing a LAN-system concept, incorporating network management, and active and passive components, as well as the relevant cabling technology. Its Integrated Communications Cabling System (ICCS) is to make LANs more cost-effective and can be used to interconnect systems from different vendors. Siemens also has OEM agreements with Cisco (internetworking products) and SynOptics (intelligent LAN concentrators).

As the main supplier to DBP Telekom, Siemens was chosen to build the analog cellular network in Germany, designing the C-450 system for this purpose. A complex and innately expensive technology, C-450 was also chosen in Portugal and South Africa—countries in which Siemens is a dominant supplier—but failed to find supporters elsewhere. The company has not developed infrastructure products for any of the more popular analog standards.

In the terminals market, the bulk of Siemens' business again has been as the dominant supplier of C-450 products. The complex nature and limited economies of scale kept handset prices high and sales have fallen dramatically since GSM was launched in Germany and Portugal. Siemens has also established a minor presence in some of the NMT markets, mainly through badging other company's products.

Overall, Siemens' activity in analog cellular has been limited, concentrating on its own proprietary standard. GSM, on the other hand, is of much more strategic importance to the company than analog, with involvement ranging from chip sets right through to systems.

A major focus has been placed on Siemens becoming a leader in GSM networks, with the EWSD switch at the heart of its solution. While the company's expertise in digital switching provides a good platform upon which to build, Siemens does not have the same level of experience in base station technology, and has relied on partners to help overcome this shortcoming. Its major collaborator has been the DMCS 900 consortium of Philips and Bosch, originally formed to provide complete solutions itself, based around licensed EWSD technology. In reality the main partnership has been with Philips, the senior contributor to DMCS base station products, which Siemens subcontracts or manufactures under license. Unfortunately for both partners, well-publicized problems with these products have had a negative impact on their ability to win new contracts.

Siemens is also working with Motorola to supply several operators, having joined forces after the latter was unable to develop its own GSM switch. The relationship is more a "marriage of convenience," however, compared with the ongoing development agreement with DMCS 900.

With GSM, Siemens' presence in cellular infrastructure has increased dramatically—the company currently having been chosen as a supplier to 15 operators in 14 countries. There is a danger, however, that its perceived inability to provide complete, reliable and competitive solutions will threaten its potential in this market; contracts awarded during 1993 increasingly favor traditional radio specialists, such as Nokia and, particularly, Ericsson.

Siemens developed its own GSM handsets and was among the first four companies to obtain type approval. The company has clearly benefited from the strong take-up of GSM in Germany and Portugal. Its early products were quite competitive, but the challenge for Siemens will be to keep up with the competition in the continuing drive for size and price reductions, and time to market. It also needs to develop its distribution network, currently far behind those of its major competitiors. Fortunately for Siemens, as the channel structure changes, most other GSM handset suppliers are also having to review their channel strategy.

Siemens was, again, one of the first companies to develop DCS-1800 terminal products, supplying Mercury One-2-One in the United Kingdom from the launch of services. Its increasing expertise in the terminals sector bodes well for the future.

Semiconductors

Dataquest estimates that Siemens' total 1993 worldwide semiconductor spend was $1,379 million as shown in Table 2. The European semiconductor spend was $1,032 million, nearly 75 percent of its worldwide total. This made Siemens the largest purchaser of semiconductors in Europe. However, in the European communications application sector it was the second largest behind Alcatel, with an estimated $499 million spend. Table 3 shows the manufacturing locations of Siemens' telecommunications companies.

Like most major European telecommunications equipment manufacturers, Siemens maintains a significant semiconductor capability, which makes it a major worldwide merchant supplier. Its major semiconductor fabrication facilities are in Regensberg and Villach, Germany. Siemens also has a joint manufacturing facility with IBM Microelectronics in Corbeille Essonne, France. Siemens also announced in late 1993 its plans for a new major manufacturing facility in Dresden, Germany to begin production in 1996.

Table 2
Siemens 1993 Worldwide and European
Equipment and Semiconductor Consumption by Application

	DP	Communi-cations	Industrial	Consumer	Military/ Aerospace	Transpor-tation
Worldwide equipment production	$3,881	$8,995	$3,809	$162	$289	$948
Worldwide semiconductor consumption	$281	$692	$278	$14	$6	$105
European equipment production	$3,143	$6,327	$2,693	$113	$208	$856
European semiconductor consumption	$229	$499	$196	$10	$5	$94

Source: Dataquest (March 1994 Estimates)

Table 3
Siemens Telecommunications Manufacturing Locations

Company	Town	Country	Main Production	Other Production
Siemens	Alfragide	Portugal	Central office	
Siemens	Bruchsal	Germany	Central office	
Siemens	Berlin	Germany	Transmission	Fax
Siemens Public Communication Network	Colfontaine	Belgium	Central office	
Siemens	Vienna	Austria	Central office	
Siemens	Helsinki	Finland	Central office	
Siemens Private Communications	Bocholt	Germany	PBX/key telephone systems	
Siemens	Oslo	Norway	Transmission	
Siemens—ATEA	Herentals	Belgium	Central office	
Siemens—Albis AG	Zurich	Switzerland	Transmission	Central office
Siemens	Oostkamp	Belgium	Central office	
Siemens Public Communications	Witten	Germany	PBX/key telephone systems	
Siemens	Kamp Lintsort	Germany	Cellular	
Siemens	Thessaloniki	Greece	Transmission	Central office
Siemens	Munich	Germany	Standard telephones	Cordless telephones/ modems
Siemens	Munich	Germany	Central office	
Siemens Telecomunicazioni	Milan	Italy	Central office	Transmission
Siemens Telecomunicazioni	Caserta	Italy	Communications	
Siemens Private Communications	Bocholt	Germany	Customer premise equipment	
Siemens Private Communications	Leipzig	Germany	Customer premise equipment	
Siemens Public Communications	Greifswald	Germany	Transmission equipment	

Source: Dataquest (March 1994)

The telecommunications divisions of Siemens accounts for 48 percent of the estimated $1,032 million European semiconductor consumption; this large percentage has a major impact on the semiconductor spend analysis by product type. Table 4 shows the worldwide and European semiconductor spend of the telecommunications divisions of Siemens. The company's success in switching systems with its EWSD exchange is reflected in the high value of digital MOS, $266 million—53 percent of the total European communications semiconductor spend. The value of MOS memory is also high, indicating the continued push of complete digital systems, but here the demand is for SRAMs, first-in/first-out (FIFO) memory and high-performance DRAMs. MOS logic is dominated by digital ASICs, and linear is split between high-performance standard products and the growing demand for mixed signal ASICs.

As communications technology develops Dataquest expects to see Siemens' spend on semiconductors as a percentage of equipment revenue to grow. We also expect to see in the future Siemens' semiconductor spend by type slowly changing as a result of communications technology evolution, the company's strength in switching, and the recent success of cellular telephones. This will influence a change in purchases of product types, where there will be a further reduction in bipolar digital and discretes. Increased demand in linear is also expected, particularly for mixed signal ASICs and for RF components.

Dataquest Perspective

Despite recessionary trends hitting its home market, Germany, particularly hard this year, Siemens as a whole is still in good shape thanks to the cash-rich nature of the company.

Telecommunications, accounting for 25 percent of the company's revenue, is obviously an area of strategic importance for the future of the

Table 4
Siemens' Telecommunications Estimated Semiconductor Consumption (Millions of Dollars)

Division	Worldwide	Europe
Total semiconductor	$692	$499
Total IC	$547	$393
Digital bipolar	$23	$16
Total MOS	$371	$266
MOS memory	$106	$76
MOS micro	$123	$88
MOS logic	$142	$102
Linear	$154	$110
Discrete	$105	$75
Optoelectronic	$40	$29

Source: Dataquest (March 1994 Estimates)

company. Although Siemens is a strong player in both public and private communications areas, this has been based on a very strong presence in an extensive home market. In this case, worldwide presence does not equate to being a global player which is strong in all regions. While the Asian and Central and Eastern European regions are presenting the company with immediate growth opportunities, the North American market remains a major challenge for Siemens.

Without exception, Siemens' telecommunications products are technologically very sound, but at a high price which, at times, has limited its market potential, for example in analog cellular. Despite spending a large proportion of revenue on R&D, as well as being at the forefront of several technological developments, Siemens is rarely the first to market a new product. Once the company launches, however, its sound engineering and organizational skills will make it a strong competitor.

Deregulation in the European telecommunications market will present Siemens' hierarchical culture with some interesting challenges. In order to remain competitive at home and expand further into foreign markets, Siemens will have to review its high cost strategy as well as time to market.

Acknowledgement

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Dataquest

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Semiconductors

Digital Local Line Card Regional Markets, Production and Semiconductor Opportunities

Focus Report

1994

Program: Semiconductor Applications Market Europe
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Chapter 1
Introduction

The central office market is by far the largest single-product segment within the telecommunications equipment market. For all of the world's leading telecoms equipment suppliers, central office products are fundamental for their businesses. A leading indicator of the condition of the central office exchange market is shipments of digital local lines.

This report analyses the market, production and semiconductor opportunities of digital local line cards. In the report we measure each of these opportunities in four world regions: North America, Western Europe, Japan, and all the "other world regions" (OWR). The OWR category includes all the Asia/Pacific region, Oceania (Australia, New Zealand, and so on), Central and South America, Central and Eastern Europe, Africa, and the Middle East.

The telecoms industry is notorious for reporting its financial results late, so throughout this report we refer to the latest common set of actual data available—for the year 1992. Although some companies' 1993 results were available at the time of preparation of this report, not all data were available, sufficient for us to provide a comparative view for 1993.

Central Office Market

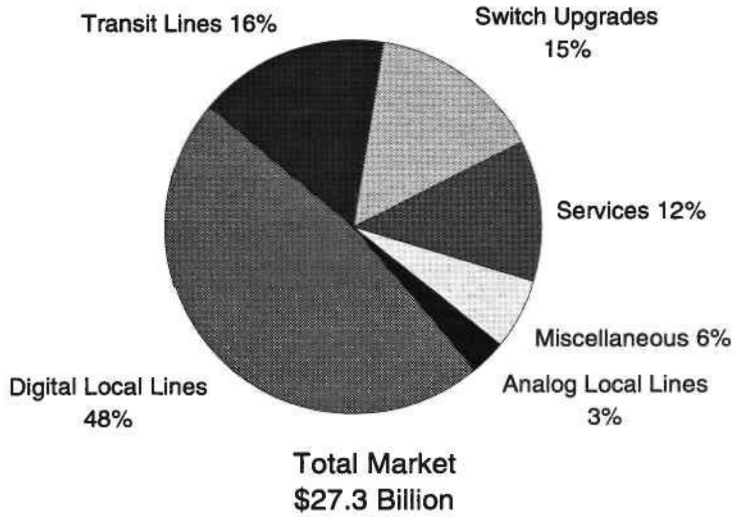
The central office market includes a number of different elements. Figure 1-1 shows that in 1992 digital local line cards represented 48 percent of the value of the central office market; this is by far the largest indicator of the size of this market. The segment that is growing most rapidly and becoming increasingly important is the market for upgrading existing switches—adding additional functions and capabilities (usually software) without increasing the line capacity.

This will become an increasingly important aspect for central office providers in the future, but this revenue stream is, of course, dependent on installed base. The importance of increasing the installed base is key to securing substantial revenue streams in the future, and accounts for the intense competition in the emerging markets of the other world regions to gain share of the installed base. This competition in the emerging markets is so intense that in some cases the cost per line is substantially less than in the telecoms companies' home regions.

The United States is the single largest country market; in 1992 it represented 25 percent of the world central office market, as shown in Figure 1-2. Europe is the largest regional market—36 percent of the world market in 1992. However, it is not one single cohesive market but a set of individual country markets with different conditions and drivers.

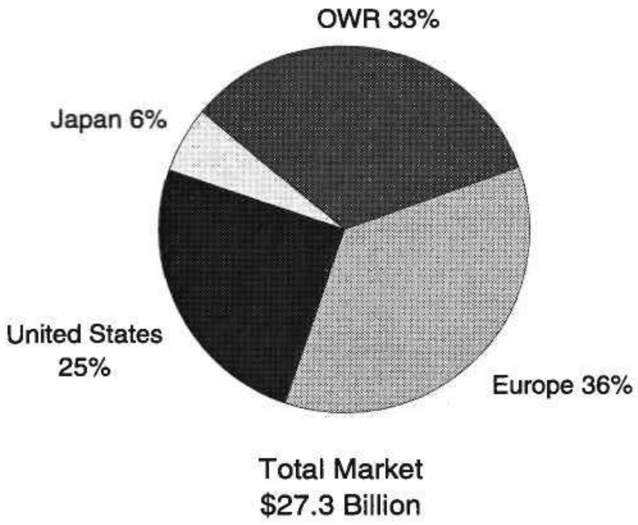
The revenue by segment of the world central office market is shown, in Figure 1-1, but this split is the world average; the individual regions

Figure 1-1
1992 Worldwide Central Office Market by Segment



Source: Dataquest (September 1994 Estimates)

Figure 1-2
1992 Worldwide Central Office Market by Region



Source: Dataquest (September 1994 Estimates)

show a very different picture. These differences are due to two main factors: systems are sold in some regions as a total systems price; and by some vendors—mainly US companies—in an "unbundled" form, pricing equipment, service, training, upgrades, system software and "the right to use" licenses.

In a more mature market such as the United States, far less of the central office market revenue is digital local lines, with a much greater proportion of revenue from switch upgrades, usually software and services. In the United States, for instance, nearly 50 percent of the central office market is software and services whereas this is only 20 percent in Europe.

This observation of mature markets points to a future central office market that is less and less hardware-oriented. But this drive by switch vendors may still be under threat as a result of increasingly open interfaces and world standards. Software system specialists could focus on providing new system upgrades as a result of Intelligent Network standards. Also, the supply of subscriber line cards—the bread-and-butter revenue of today's switch vendors—could be under threat from a range of access products providing a direct interface to the switch.

Major Equipment Players

We have measured the market share and installed base of each switch vendor based on digital local line shipments, representing nearly half the central office market, as shown in Table 1-1. In our assessment of market shipments and installed base by vendor, we have attributed all line shipments to the company responsible for the development of the original switching product line. Technology and products developed by a switch manufacturer may be sold by other divisions of a company or by licensees.

In 1992 Alcatel was ranked by Dataquest as the world's number-one telecommunications equipment company, with 28 percent more equipment revenue than its nearest competitor Siemens (see Table 1-2). This dominance is partly shown in the ranking of digital local line shipments and installed base in Table 1-1.

Even though the worldwide central office market is so large, valued at $27.3 billion in 1992, it is dominated by a small number of players. In 1991 the top five vendors controlled more than 76 percent of the world market; in 1992 this rose to 78 percent (85 percent if Italtel and GPT are included). It has been argued that the industry can only maintain five or six long-term suppliers in the central office market; the constant restructuring witnessed by this industry is clearly moving in this direction, as witnessed by the situation of GPT and Italtel.

None of the Japanese companies are present in the top five as they have had little export success in Europe or the United States and, surprisingly, little success in the Asia/Pacific region. Continued lack of success will make it difficult to fund long-term R&D demanded by this industry to

Table 1-1
1992 Worldwide Digital Local Line Market Share and Installed Base Ranking

Manufacturer	Central Office System	Shipment Ranking	Installed Base Ranking
Alcatel	1000 E10/1000 S12	1	2
AT&T	5ESS/GTD5	2	1
Siemens[1]	EWSD/DCO/GTD5	3	5
Ericsson	AXE	4	4
Northern Telecom	DMS	5	3
NEC	NEAX61/D70	6	6
Fujitsu	Fetex 150/D70	7	9
GPT[2]	System X	8	7
Italtel[3]	Linea	9	10
Others		10	8

1. The figure for Siemens now includes both Stromberg-Carlson and the international switching business of GTE.
2. At the moment, GPT is still listed separately, although Siemens now owns 40 percent of GPT.
3. At the moment, Italtel is still listed separately, although Siemens now owns 50 percent of Italtel.
Source: Dataquest (September 1994 Estimates)

Table 1-2
1992 Worldwide Top 10 Telecommunications Manufacturing Companies
(Billions of Dollars)

Rank	Company	Revenue 1992	Country
1	Alcatel	15.32	France
2	Siemens	11.92	Germany
3	AT&T	10.81	USA
4	Northern Telecom	8.41	Canada
5	Motorola	7.81	USA
6	Ericsson	7.32	Sweden
7	NEC	6.84	Japan
8	Fujitsu	3.74	Japan
9	Bosch	3.49	Germany
10	Philips	2.57	Netherlands

Source: Dataquest (September 1994 Estimates)

maintain product competitiveness and at the same time to remain competitive.

As shown, European companies continue to dominate the central office market. The European market is only 34 percent of the world, but European companies account for 56 percent of the world market; this clearly shows the international focus of these companies. In contrast, although the US and Japanese suppliers are strong in their home markets, international success is very limited.

Chapter 2
Regional Markets

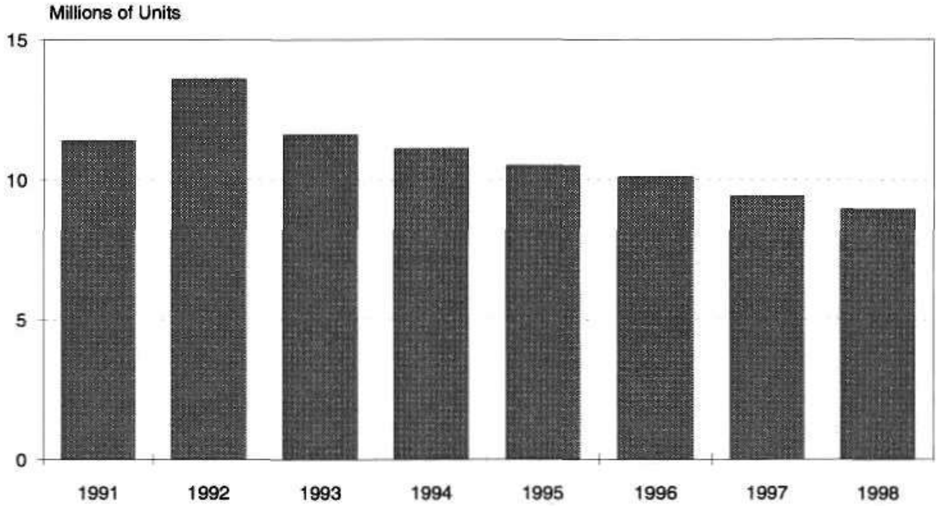
US Market

The primary factor influencing the US digital local line market is the replacement of analog technology, now that all the old electromechanical central office switches have been replaced. There are approximately 56 million analog lines left in the United States to be replaced. This market represents the vast majority of the opportunity for the 9 million to 10 million lines to be shipped each year over the forecast period, as shown in Figure 2-1.

Underlying this replacement market is a modest growth in the size of the network, which will continue at 2 to 3 percent compound annual growth rate (CAGR) over the forecast period to 1998. The peak in line shipments occurred in 1992 as the race to meet digitization of the network reached the halfway point, and we now expect a steady decline in market shipments.

The US market is dominated by AT&T and Northern Telecom; in 1992, together they shipped nearly 89 percent of the lines. Both Ericsson and Siemens have a small percentage of the US market. Siemens is consolidating its position after the acquisition of Stromberg-Carlson; together these two European companies control more than 10 percent of the market. Siemens showed impressive shipment growth in 1992 over 1991 at nearly 35 percent, in a bid to steal the number-three position away from its European competitor, Ericsson.

Figure 2-1
US Digital Local Line Market



Source: Dataquest (September 1994 Estimates)

European Market

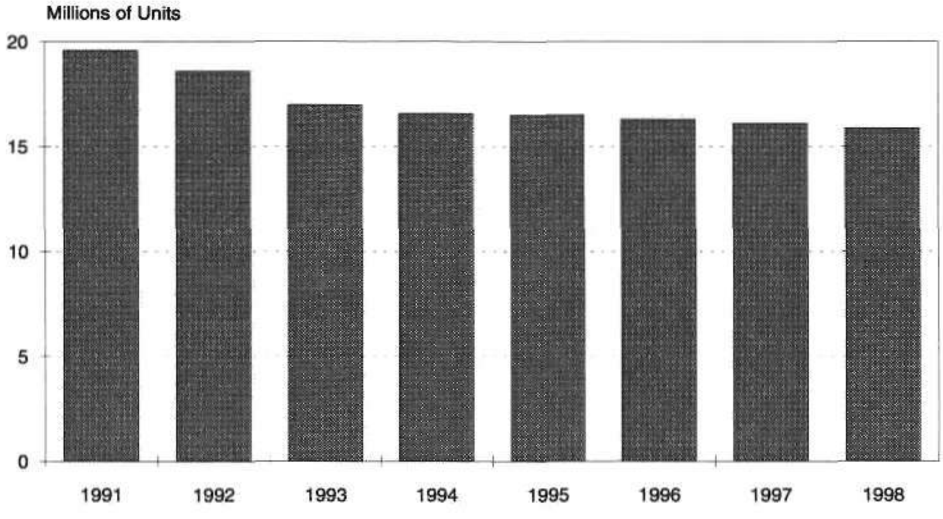
There are two factors affecting the European digital local line market: organic growth in the network size, and replacement of old analog technology with digital lines. The European network had 179 million lines in use at the end of 1992 and is expected to exceed 200 million lines by 1996. At the end of 1992, 50 percent of all local lines were served by digital central office switches; this will increase and exceed 80 percent by 1998.

The European network will continue to grow at a modest 3.1 percent CAGR. However, the bulk of market shipments are digital replacements for old analog technology, which reached its peak in 1991. We now expect a steady decline in market shipments as the balance of the network is upgraded, as shown in Figure 2-2. Not all analog systems will be replaced in the forecast period, though, as some analog systems can be upgraded to give near digital performance and features.

Further market deregulation will lead to the introduction of new network operators, in the recently liberalized markets. These market conditions will create the framework for a more common price across Europe, although there will continue to be strong differences between some countries. Prices per line will continue to fall, with an expected 3.8 percent fall per annum over the next five years.

This market is totally dominated by European suppliers, the top five European suppliers accounting for 92 percent of the market, with Alcatel, Ericsson and Siemens accounting for 77 percent. Although some markets are starting to become more open, it is still the established European suppliers that dominate each country market. AT&T and Northern

Figure 2-2
European Digital Local Line Market



Source: Dataquest (September 1994 Estimates)

Telecom together have attained some penetration, achieving a 6 percent market share, but both are still striving to increase their presence. Japanese companies have gained very little success in the European market.

The largest markets in Europe are Germany, the United Kingdom, France and Italy. These four countries together account for 66 percent of the market.

Other World Regions

The "other world regions" category includes Asia/Pacific, Oceania, the Middle East, Africa, Central and South America, and Central and Eastern Europe (which includes all the countries of the CIS). This region is set to become the most important world market in the future. In 1992 this region overtook Europe as the largest regional market for digital local lines and by 1996, with 31.8 million lines (Figure 2-3), it will be more than 52 percent of the world market.

Not surprisingly, the major worldwide telecoms equipment companies (see Table 1-2) are achieving some of their success from activities in this large and fast-growing region, although this success may not always be in central office—it may be in transmission, or private telecoms or mobile telecoms.

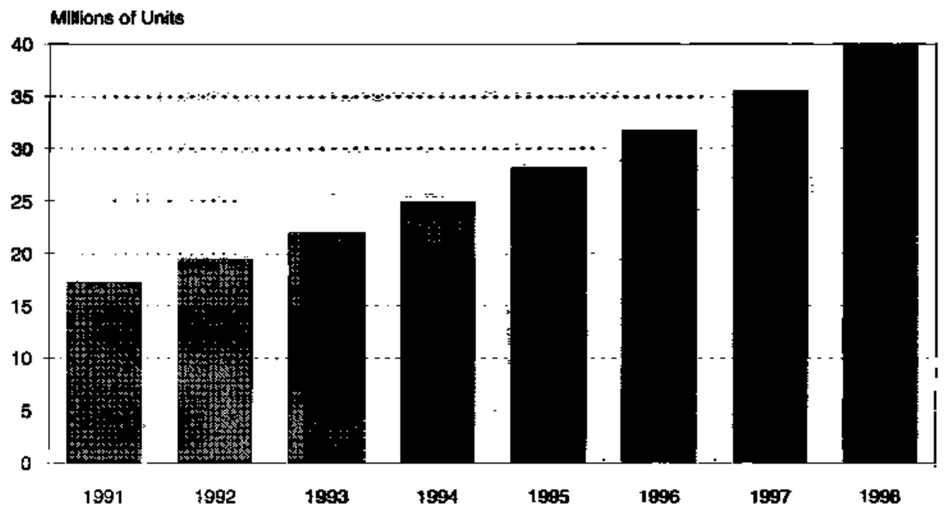
Telecommunications infrastructure has long been associated with an economy's ability to grow and prosper. This factor is the main driving force for the emergence of the fast-growing telecommunications markets of Central and Eastern Europe, China, India and the newly industrialized economies (NIEs) of Southeast Asia (Singapore, Hong Kong, Taiwan and South Korea).

Asia has shown the most rapid growth so far. China is the fastest-growing market in the world, with an estimated 20 percent growth per annum in network size over the forecast period. These growth rates are currently easily achieved, as China is starting from a very small installed base—an estimated 8.4 million lines in 1992, less than 1 line per 100 inhabitants. This compares, for instance, with the United States at more than 50 lines per 100 inhabitants. We expect Central and Eastern Europe to rival China in growth rate by the end of the century.

This market differs from all the other major central office markets of the United States, Europe and Japan, which are a mixture of single-digit growth in the network and replacement of old technology. Nearly all the market shipments (more than 95 percent) in this market are for network growth using the latest digital technology.

There are very few indigenous companies in this region that can offer competitive, state-of-the-art digital central office technology. Most of this market is addressed by the world's major telecoms equipment companies (see Table 1-2) from North America, Europe and Japan. Although most of this market opportunity comes from the Asia/Pacific area, Japanese companies have achieved a low market share so far, despite

Figure 2-3
Other World Regions' Digital Local Line Market



Source: Dataquest (September 1994 Estimates)

their geographical and cultural links and their early entry into some of these country markets.

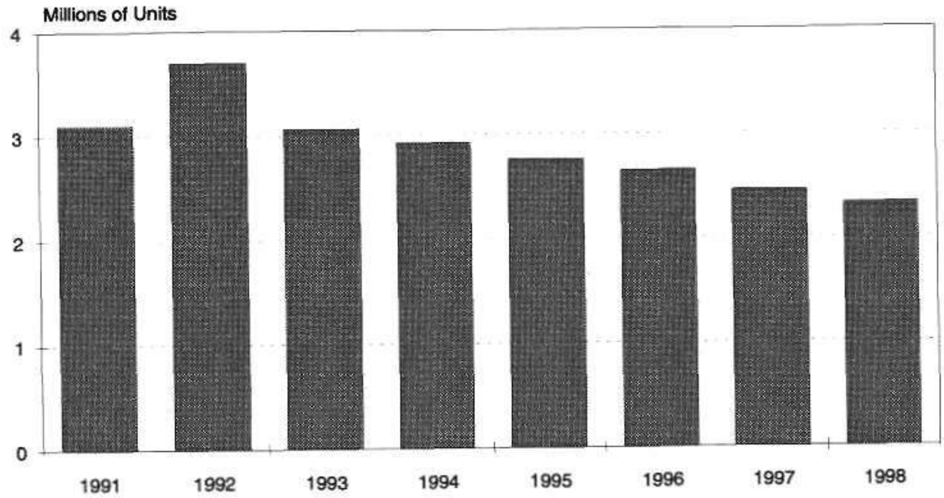
In this region, Alcatel has now grown its market share to more than 34 percent, due in part to its success in Asia, particularly in China. Also, Alcatel's market share has been boosted by its success in Central and Eastern Europe, where we should expect most European companies to be more successful, due to the geographical, colonial and political links. Alcatel, Ericsson and Siemens together had a 64 percent market share in this region in 1992, European companies are far ahead of the two major North American players, AT&T and Northern Telecom, which together had an estimated 14 percent market share in 1992.

Japanese Market

Japan has the second-biggest telephone network in the world after the United States, yet still it has some way to go to match the penetration level of the US network. In Japan the penetration level is about 45 percent, similar to most Western European countries, with the United States nearer to 55 percent. The process of upgrading Japan's network from analog to digital is already very well advanced, with more than half of the market shipments resulting from network growth. We expect the network to grow 4 to 5 percent per annum over the forecast period.

The peak of the digitization of the Japanese network occurred in 1992, and we now expect a steady decline in the market shipments to some 2.5 million lines per year over the forecast period, as shown in Figure 2-4.

Figure 2-4
Japanese Digital Local Line Market



Source: Dataquest (September 1994 Estimates)

The Japanese market is effectively controlled by one network operator, NTT, and is one of the most closed markets in the world. There are two dominant suppliers in the Japanese market, NEC and Fujitsu. These two vendors together control more than 90 percent of the market, with NEC having the larger market share. No foreign competition effectively exists, with the exception of Ericsson, which has managed to gain about 1 percent market share.

Chapter 3
Regional Production

Assumptions

This forecast is based on a number of fundamental assumptions. Dataquest believes that the current European companies' domination and share of the world telecoms market will grow. European telecoms companies will dominate the emerging markets and production opportunities in the other world regions. Within the forecast period, the major North American telecoms equipment companies will have limited impact on production, outside their home region. The production of line cards will lead the market shipments. There will be more line cards manufactured in any year than are shipped in a growing market.

North American Production

North American companies have historically been slow to convert opportunities outside of their home markets into real business. This is due in part to the huge opportunities that exist from the size of their home market, currently the largest installed base in the world at an estimated 140 million lines.

As the US market has maturated, the opportunities for line shipments have decreased, to the point where the United States has one of the slower growth rates in installed base at 2.0 to 2.5 percent per year. As discussed in the US market section (chapter 2), except for organic growth in the network, other shipments are to replace "old technology." When this technology upgrade is completed, market shipments will reduce dramatically.

It is against this background of a dwindling local market that US companies have begun to look for export opportunities, to keep their manufacturing plants at maximum capacity. We expect production in North America to fall from a peak of nearly 16 million lines in 1992 to less than 12 million in 1998, as shown in Figure 3-1.

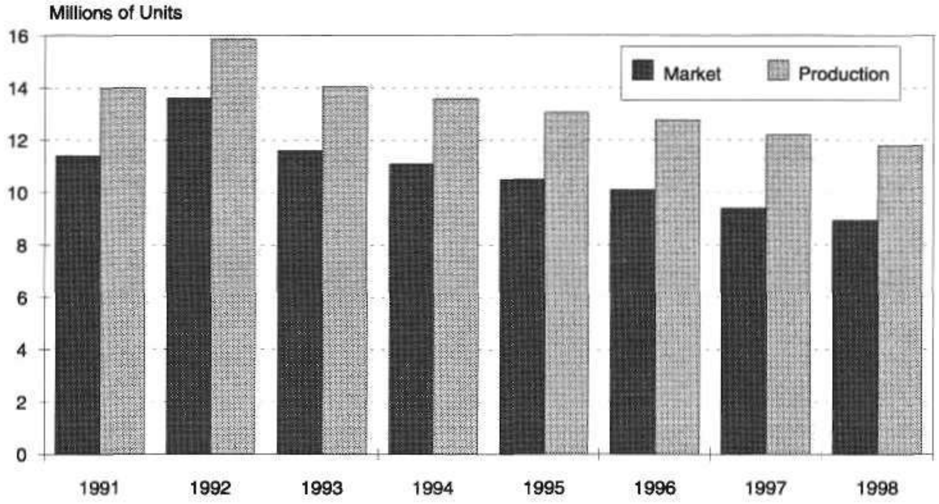
Definition of Manufacturing

Full stuffing of the printed circuit board (PCB) means where all semiconductors are loaded onto a PCB, while **part stuffing** of the motherboard refers to when some components (usually high-value socketed devices) are loaded onto a PCB at a later stage of manufacture.

Subcontract assembly applies to the manufacture of PCBs that are contracted to an outside company.

Screwdriver assembly involves the assembly of equipment from brought in subassembled components and PCBs, and involves no PCB assembly.

Figure 3-1
US Digital Local Line Production and Market Forecast



Source: Dataquest (September 1994 Estimates)

Both of the major North American vendors—fighting over a dwindling home market—have realized how imperative it is to expand into overseas markets. From the early 1980s they have pursued these external markets more and more vigorously, but to date their success has been limited considering the relative size of the two North American vendors, AT&T and Northern Telecom. Their initial successes have been in Europe. This may have been because of the ease of cultural and political links, but Europe's fragmented individual country markets have meant that success in one country provides no advantage in other countries.

There is some demand from the fast-growing emerging markets of Asia/Pacific–Rest of World (ROW) to offer local manufacturing via joint ventures or licensees. The plus side of entering into such long-term agreements is that technology transfer and local manufacturing capability take a considerable time to complete. During this period products are still delivered from the company's home manufacturing base. Whereas European companies accepted local manufacturing as a requirement to enter a market many years ago, North American vendors have only recently accepted these requirements.

The early reluctance of North American companies to enter into local manufacturing and technology transfers to these emerging markets has hindered them in two ways. In the short term they are not manufacturing line cards in their home manufacturing facilities. In the long term they are reducing the opportunity to increase the installed base, which may well be the long-term revenue earner for these equipment companies, with system and feature software upgrades.

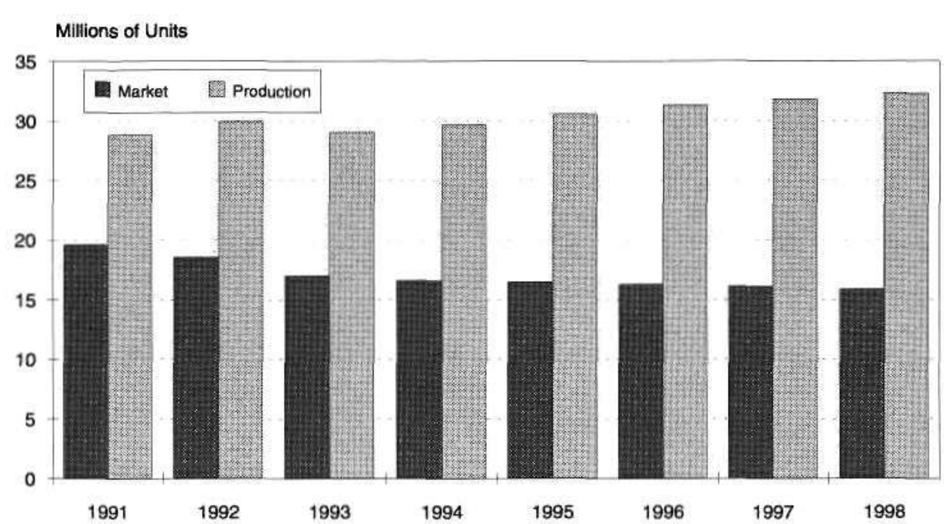
European Production

European production of digital local lines far exceeds its local market. In 1992 production was estimated to be nearly 30 million lines, with a market of only 18.6 million lines, as shown in Figure 3-2. This production export was to serve the needs of the growing opportunities in Asia/Pacific. Although the European market will be declining over the forecast period, we expect modest growth in production over this period, growing from 30 million lines produced in 1992 to more than 32 million in 1998. Towards the end of the forecast period European companies will also be benefiting from export success in Central and Eastern Europe.

Unfortunately the major opportunities in the Asia/Pacific–ROW region will not all be realized by exports from European companies' production, but more and more from local production as technology is transferred. So far, European companies have the best export success to this region, beating both the US and Japanese suppliers for volume of shipments.

All major European telecoms equipment companies are entering various forms of long-term joint-venture and licensee agreements in the major country markets, notably China and countries of the CIS. Usually these agreements result in production of central office exchanges in kit form (screwdriver operation) and slowly evolve into total production including complete printed circuit board (PCB) assembly and test. In fact, some of these agreements go so far as to transfer component technology and manufacturing operations, even to setting up semiconductor facilities. A prime example of this happened in Europe in the 1980s with AT&T establishing both a central office exchange manufacturing facility and a semiconductor fab in Spain.

Figure 3-2
European Digital Local Line Production and Market Forecast



Source: Dataquest (September 1994 Estimates)

We estimate that Alcatel had the biggest share of this European production in 1992 at 10.8 million digital local lines. Siemens and Ericsson were ranked second and third with over 7.5 million and 6.3 million respectively.

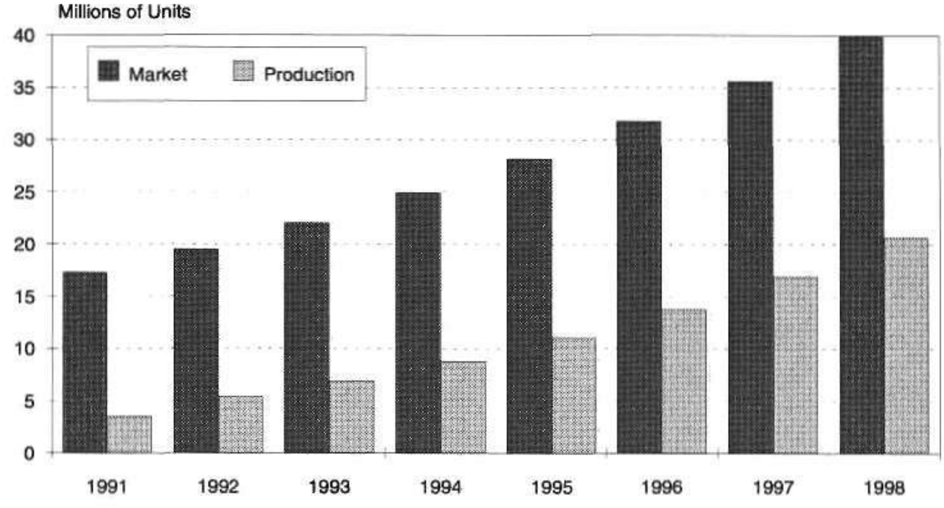
Production in Other World Regions

As discussed in the market section, "other world regions" includes major world regions and countries, such as China, and Central and Eastern Europe. This area became the largest single market in 1992 at 19.5 million lines with local production of 5.4 million lines, as shown in Figure 3-3. Although only 28 percent of the market is currently serviced by local production, this figure will rise to 52 percent by 1998. Production growth is faster than market growth for digital local lines.

Many of the emerging country markets of Asia/Pacific–ROW want to reap maximum local benefit from the expansion of their telecoms infrastructure. With all the world's major telecoms equipment companies seeking these opportunities, some of these countries are aiming at more than just to buy the latest technology, but also to build up their own capabilities. In most cases, success is won only when local manufacturing is agreed.

Only some of these emerging country markets can justify the establishment of a total manufacturing capability for digital local line card and central office switching. The markets of China and India certainly justify this level of investment and commitment. The plus side to the equipment companies of entering into these long-term agreements is that technology transfer and local manufacturing capability takes a considerable

Figure 3-3
Other World Regions' Digital Local Line Production and Market Forecast



Source: Dataquest (September 1994 Estimates)

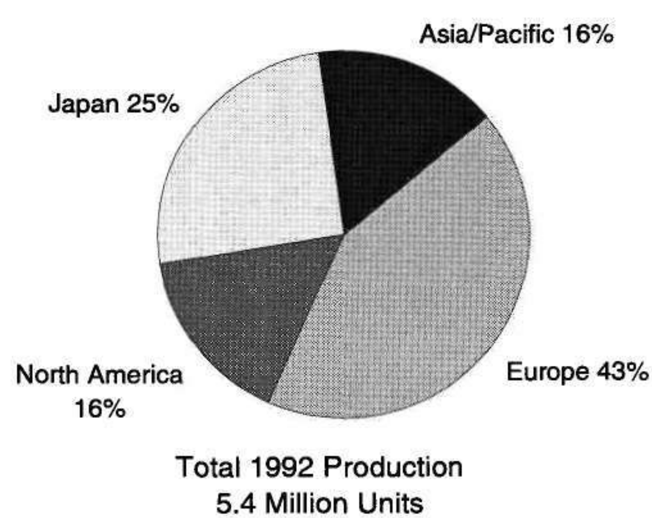
time to complete. During this period products are still delivered from the companies' home manufacturing bases.

Although there are numerous reported joint ventures and licensees in many countries of this region, only a few perform full manufacturing. There are many different levels of agreement for these joint ventures or licenses. These could include: local configuration/installation/maintenance of equipment; "screwdriver" assembly from kits of parts; through to total full assembly, including full PCB assembly.

Virtually all these agreements proceed along this route, over a period of time, adding more and more value locally as capability and investment are increased. It is only this last defined category we are evaluating here, where digital local lines are produced in this area. Indeed, there may well be many more central office exchanges manufactured in this region, but from fully finished line cards imported from the vendors' own home manufacturing facilities.

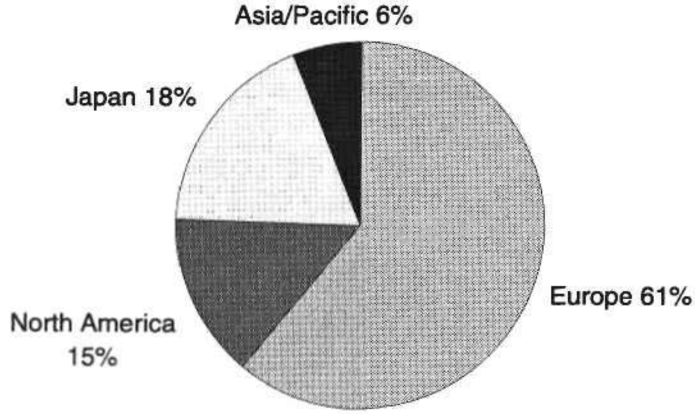
The rapid growth in line card production is a function of the move from imported line cards to increasing levels of full local manufacturing of line cards. We estimate that 43 percent of the line cards produced in 1992 in this region were from line cards originally designed by European companies, as shown in Figure 3-4. As this local production grows, we expect the share of European companies to increase to more than 60 percent, as shown in Figure 3-5. This increase in production share is primarily at the expense of Japanese and Asian companies, which will fail to increase their market and production shares as this region experiences the forecast future growth.

Figure 3-4
1992 Other World Regions' Digital Local Line Card Production by Vendor Origin



Source: Dataquest (September 1994 Estimates)

Figure 3-5
1998 Other World Regions' Digital Local Line Card Production by Vendor Origin



Source: Dataquest (September 1994 Estimates)

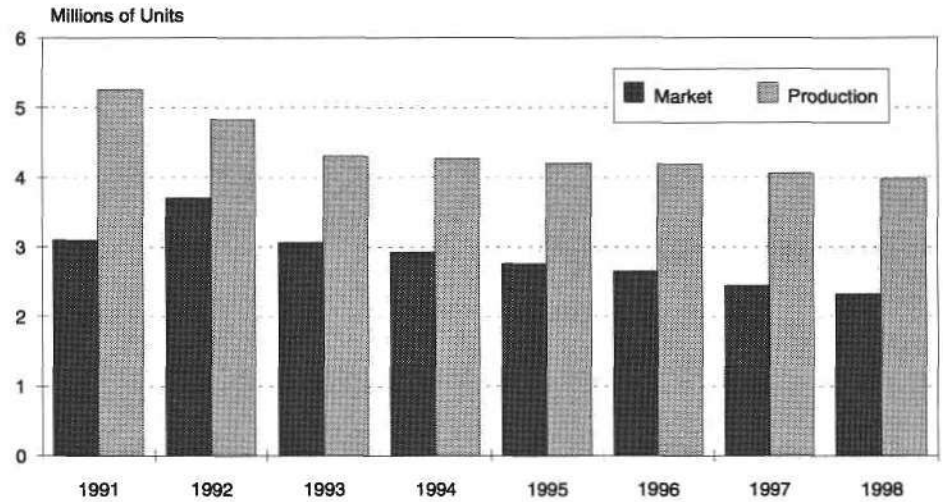
Japanese Production

Japanese telecoms equipment manufacturers have the benefit of serving one of the most closed markets in the world. It was estimated to be the second-largest installed network in 1992 after the United States at more than 57 million lines, but the market in Japan shows little growth.

Dataquest estimates that line production in Japan was 4.8 million in 1992 and will steadily decline to 4 million in 1998, as shown in Figure 3-6. Japan has been surprisingly unsuccessful in exporting its technology in any significant volume to the United States and Europe. Also, Japan has had little success in Asia, considering that this is its "own backyard." The reason for this is that the major telecoms equipment companies of Europe and North America have better solutions, or are more flexible in technology transfer. In addition, government support by export credits and loan guarantees are offered to US and European companies.

Japan's vendors' market penetration in both the US and European markets has never warranted siting manufacturing facilities in these regions; all products for these markets are produced in Japan. Although Japanese telecoms companies have had little success in Asia/Pacific–ROW, most of Japan's export production is for this region. Production destined for this region is estimated at more than 1 million lines in 1992 and will grow to over 1.5 million lines by 1998.

Figure 3-6
Japanese Digital Local Line Production and Market Forecast



Source: Dataquest (September 1994 Estimates)

Chapter 4
Semiconductor Markets

Assumptions

This semiconductor market forecast is based on Dataquest's models for semiconductor content in each of the major designs for central office digital local line cards. The market forecast uses a number of assumptions. We assume that the semiconductor suppliers defined in the original system design will be used by all licensees and in all joint ventures. There are a limited number of suppliers of the key semiconductor devices for digital local line cards, with little second sourcing. Although the equipment manufacturers continue to offer aggressive pricing for line cards, to gain market share and installed base, there will be very little price erosion on semiconductor devices.

Semiconductor Consumption Forecast

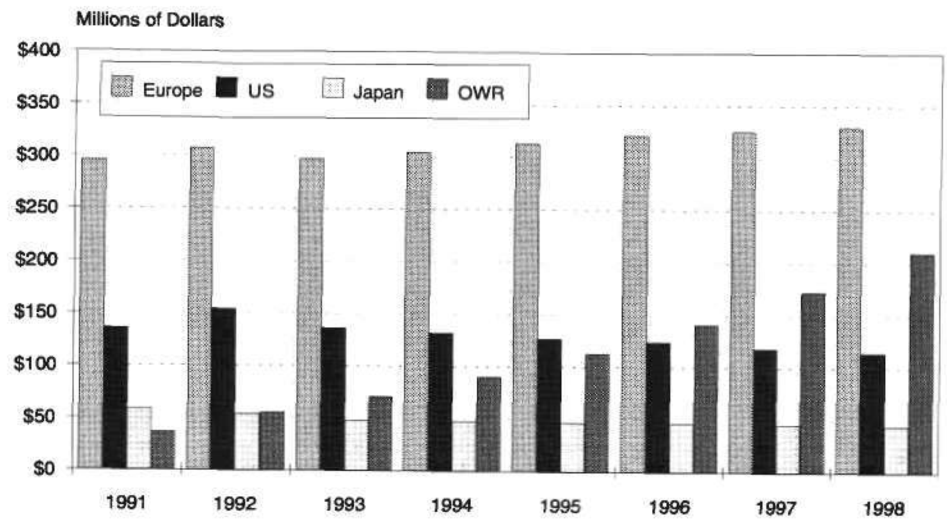
The previous chapter discussed regional digital local line production, which provides the basis for the regional semiconductor consumption. Europe will have the largest semiconductor consumption throughout the forecast period, rising to more than $330 million in 1998, as shown in Figure 4-1.

The key components in any digital local line are the subscriber line interface circuit (SLIC), the subscriber line access circuit (SLAC), the card controller—a microprocessor (MPU) or microcontroller (MCU)—and the multiplexing logic usually an application-specific integrated circuit (ASIC). We expect very little price erosion over the forecast period for these key components. Although there are some minor differences in the line card architecture from each of the major system vendors, the semiconductor content of each line is similar.

Figure 4-2 shows that in 1992 Europe had 54 percent of the worldwide semiconductor consumption, with the United States at 27 percent. As the other world regions' local production over the next five years grows, we estimate its semiconductor consumption will grow from 10 percent in 1992 to 30 percent by 1998, greater than Japan and North America combined, as shown in Figure 4-3. During this period the semiconductor consumption of both the United States and Japan will fall, while Europe and the other world regions will grow, the latter at a CAGR of 24 percent between 1993 and 1998.

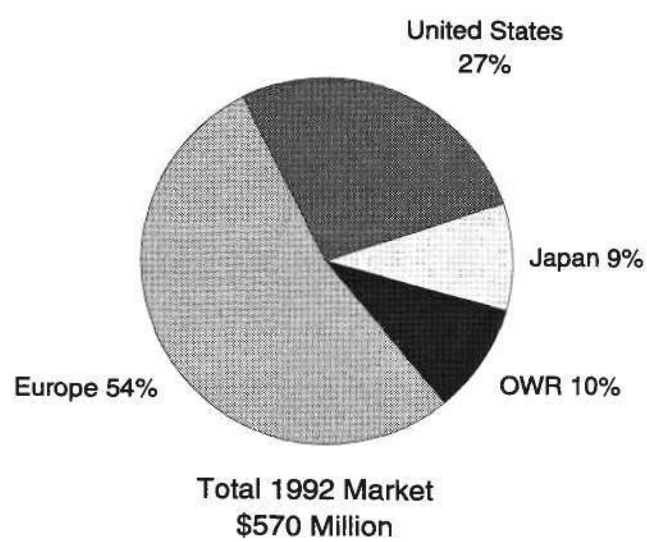
As the "other world regions" category grows in importance—both as a center of production and as a semiconductor market—it will still be the original telecoms equipment companies' design that is manufactured. The joint ventures and licensees will still rely on the original equipment manufacturers to provide design improvements and upgrades, so design-in success is likely to be in the home country of the equipment manufacturer rather than in this region.

Figure 4-1
Regional Digital Local Line Semiconductor Market



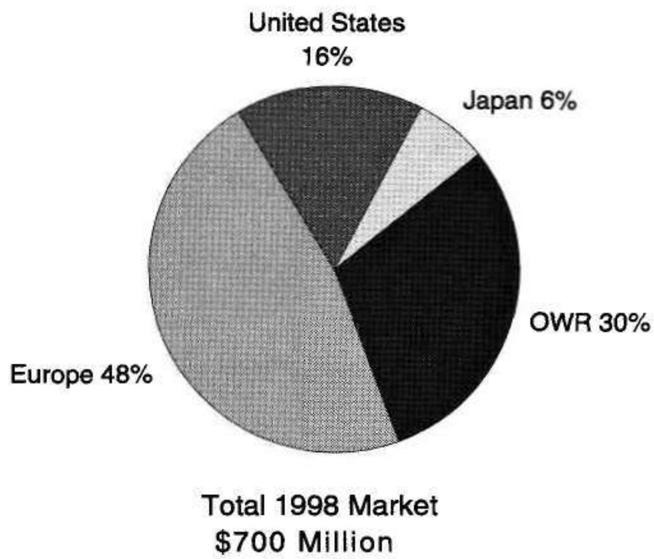
Source: Dataquest (September 1994 Estimates)

Figure 4-2
1992 Worldwide Digital Local Line Semiconductor Consumption by Region



Source: Dataquest (September 1994 Estimates)

Figure 4-3
1998 Worldwide Digital Local Line Semiconductor Consumption by Region



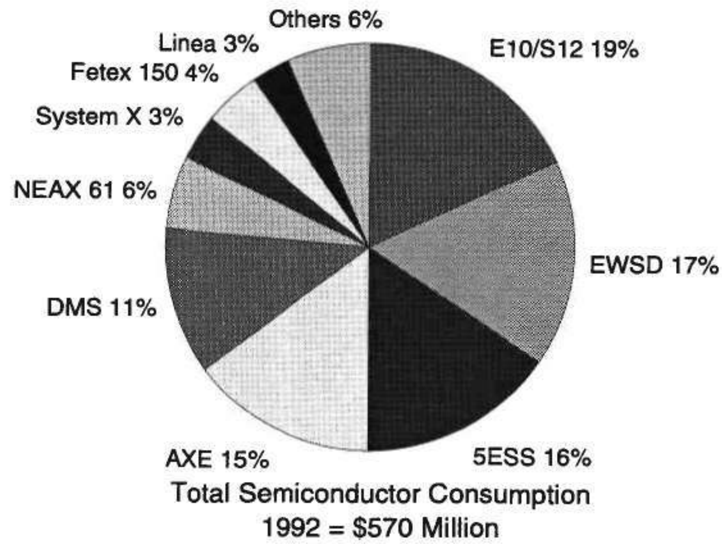
Source: Dataquest (September 1994 Estimates)

Figure 4-4 shows our estimates for worldwide semiconductor consumption by system for 1992. The E10/S12 systems of Alcatel have the largest share of this market at 19 percent, with the top five systems taking more than 78 percent of this semiconductor market. The worldwide digital local line semiconductor market is expected to grow to $700 million by 1998; by then, the E10/S12 systems semiconductor demand will have grown to more than 23 percent, as shown in Figure 4-5.

The success of the Alcatel E10/S12 central office systems has greatly benefited SGS-Thomson, which is the major semiconductor supplier. In 1992 SGS-Thomson had the largest share of this semiconductor market at 18 percent. AMD had the second-largest share of this market with a number of major system "design-ins," as shown in Figure 4-6. AT&T and Siemens are primarily in-house suppliers to their parent system companies, with very little merchant sales of these products. Motorola and Intel both have some share of this market, but this is for microprocessor and microcontroller products.

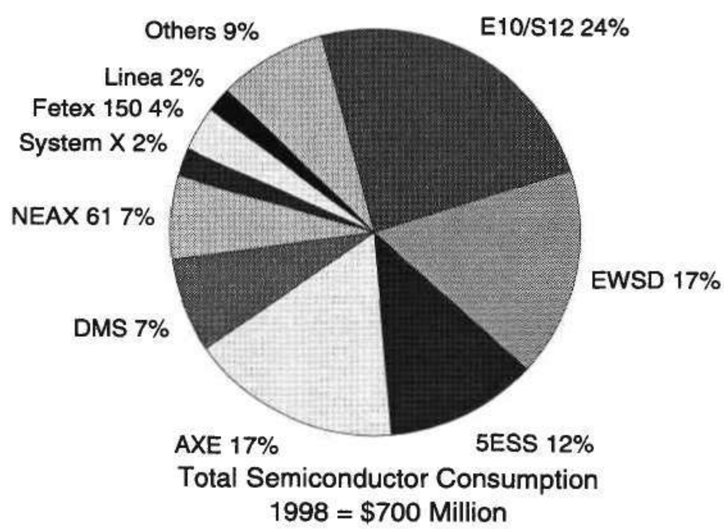
Figure 4-7 shows our estimates for the semiconductor market by the four key product types. The largest-value product type is the SLAC, accounting for about 50 percent of the total semiconductor cost per line. The apparently low percentage share of the market for the multiplexer and the microprocessor/microcontroller is because both these functions are shared resources on a line card. Each line card would, for instance, have eight SLICs, eight SLACs, but have one device for multiplexing shared by all eight lines; similarly for the microprocessor.

Figure 4-4
1992 Worldwide Semiconductor Consumption by System



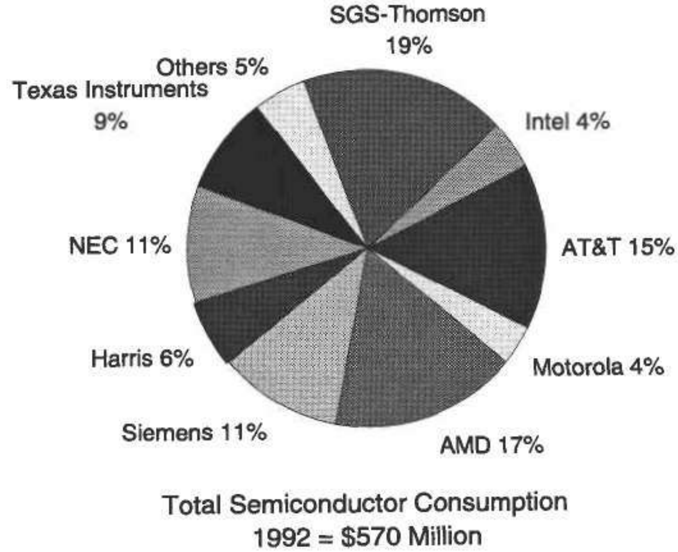
Source: Dataquest (September 1994 Estimates)

Figure 4-5
1998 Worldwide Semiconductor Consumption by System



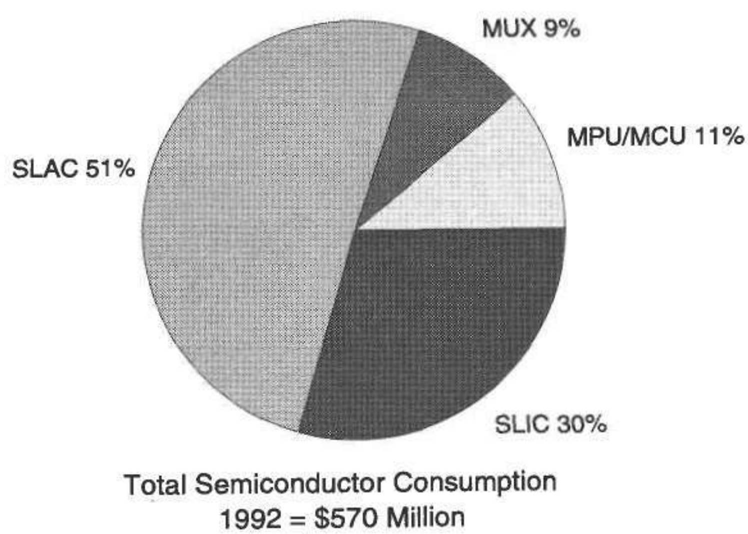
Source: Dataquest (September 1994 Estimates)

Figure 4-6
1992 Worldwide Digital Local Line Semiconductor Market Share



Source: Dataquest (September 1994 Estimates)

Figure 4-7
1992 World Digital Local Line Semiconductor Market by Product



Source: Dataquest (September 1994 Estimates)

As discussed earlier, the move away from an eight line per card solution is not a straightforward logical progression, so semiconductor vendors are looking at other areas for improvement. A number of semiconductor vendors are offering two SLACS integrated into one device—the so-called dual SLAC or D-SLAC. The disadvantage of these devices is that if a fault occurs, it will potentially disable two subscriber lines at once. Therefore, such displays of integration will only be accepted by equipment vendors if there is a corresponding increase in reliability. This can be achieved by a substantially lower power consumption and the benefit that will be derived from a lower package pin count, as common data buses and control lines are now shared.

As the annual production of line cards increases in the other world regions, there becomes a growing justification (based on volume) to site local semiconductor fabrication capacity. The long-term joint-venture and licensing agreements between telecoms equipment companies and newly emerging industrialized economies, includes the transfer of technology. This technology transfer can move all the way down the "food chain" to include components, but obviously only if the volume can justify it.

Semiconductor technology is one key area to consider; the components are high-value and the capability is attractive to own. Of course, it is one of the most expensive capabilities to acquire. Similar to the transfer of central office exchange technology, the semiconductor capability transfer is progressive, first starting with assembly and test, and possibly progressing right through to full wafer fab over an extended period of time. Examples of this technology transfer so far have not included state-of-the-art sub–1 µm capability, but rather "commodity" capability, 6-inch wafers, 1 to 5 µm geometry. In many ways these technology transfers are politically motivated and do not always make economic sense.

Alcatel, via its semiconductor company Mietec, has established a semiconductor manufacturing facility in China to supply its joint-venture line card manufacturing company. Other examples include the recent acquisition by Northern Telecom of part of the joint-venture semiconductor company established by Philips and the Chinese government. Northern Telecom's stake in this enterprise will be to support its joint-venture telecoms equipment manufacturing company in China.

Chapter 5
Digital Local Line Technology

The key challenge in the design of central office switching systems is the subscriber line card. In modern digital systems the cards represent more than 50 percent of the system cost, and so are a major target for optimization in terms of cost, reliability and power consumption. Therefore, they represent a major opportunity to semiconductor vendors.

An important issue affecting all central office systems is how many subscriber lines should be accommodated on each line card. Historically, as component technology has improved, the number of lines has increased from two or four, to today where most systems now have eight lines per card, as shown in Table 5-1.

Semiconductor integration and packaging technology today allows much higher levels of integration, with perhaps 16 or 32 lines per card. The options open to the equipment manufacturer are as follows:

- Increase the number of lines per card, while keeping the line card the same physical size.
- Maintain the same number of lines per card, and reduce the size of the circuit board.
- Both reduce the circuit board size and increase the number of lines per card.

The number of lines per card has not increased, because there are more important factors that affect the number of lines per card than the enabler of semiconductor component integration.

The equipment manufacturers are heavily influenced in the "lines per card" decision by the public telecoms operator. They will consider factors like cost of spares, revenue loss due to line failure, minimum levels of service to customers (guarantees of the maximum time users will be without service), cost of line replacement in the field, and cost of line card diagnostics and repair. In fact, we can see that these drivers are the operating and maintenance costs, not the initial capital costs. All these elements and the associated costs are governed by one factor, reliability. There are two overriding factors that affect system reliability: temperature (thus the need to reduce power dissipation), and the number of solder joints to the printed circuit board.

The equipment manufacturers also have requirements which affect the "lines per card" decision; these are centered around the equipment packaging or racking systems. In modern digital exchanges, there are more "line" cards than any other type of card and so they are the major influence on the racking system used. The physical dimensions of the line card will probably be used by all other cards in the system, including the central processor and the switch. Therefore, the card size (and the

Table 5-1
Line Card Semiconductor Supplier by System

Manufacturer	System	Lines per Supplier	SLIC	SLAC	MUX	MCU/MPU
Alcatel	E10/S12	8	SGS-Thomson	SGS-Thomson	SGS-Thomson	Intel
AT&T	5ESS	10	AT&T	AT&T	AT&T	Motorola
Siemens	EWSD	8	AMD	Siemens	Siemens	Intel
Ericsson	AXE	8	AMD	Texas Instruments	Texas Instruments	Texas Instruments
Northern Telecom	DMS	8	AMD	Harris	Harris	AMD
NEC	NEAX61	8	NEC	NEC	NEC	NEC
Fujitsu	Fetex	8	NEC	NEC	Fujitsu	NEC
GPT	System X	8	AMD	AMD	GPS	Intel
Italtel	Linea	8	SGS-Thomson	SGS-Thomson	SGS-Thomson	Motorola

Source: Dataquest (September 1994)

associated racking system) must also be able to accommodate these highly complex functions, which may not be practical if cards were minimized.

As levels of component integration increase, the benefits of moving from a 4-line to 8-line per card configuration may not be repeated in a move from 8 lines to 16 lines. Therefore, the decision to move to a 16-line configuration will not be taken lightly, just because technology allows it.

So what can semiconductor vendors offer to these equipment manufacturers in the future? One of the aspects critical to reliability is power dissipation. Central office exchanges consume significant amounts of power, and the associated heat dissipation usually requires that these facilities have some form of "forced air cooling" and air-conditioning, to keep component temperatures lower. Any developments designed to reduce power and increase reliability will be important; these include:

- 3V operation
- Power management
- Power-down capabilities

Other capabilities that are desirable include the following:

- Self-test
- Self-diagnostics
- Self-calibration

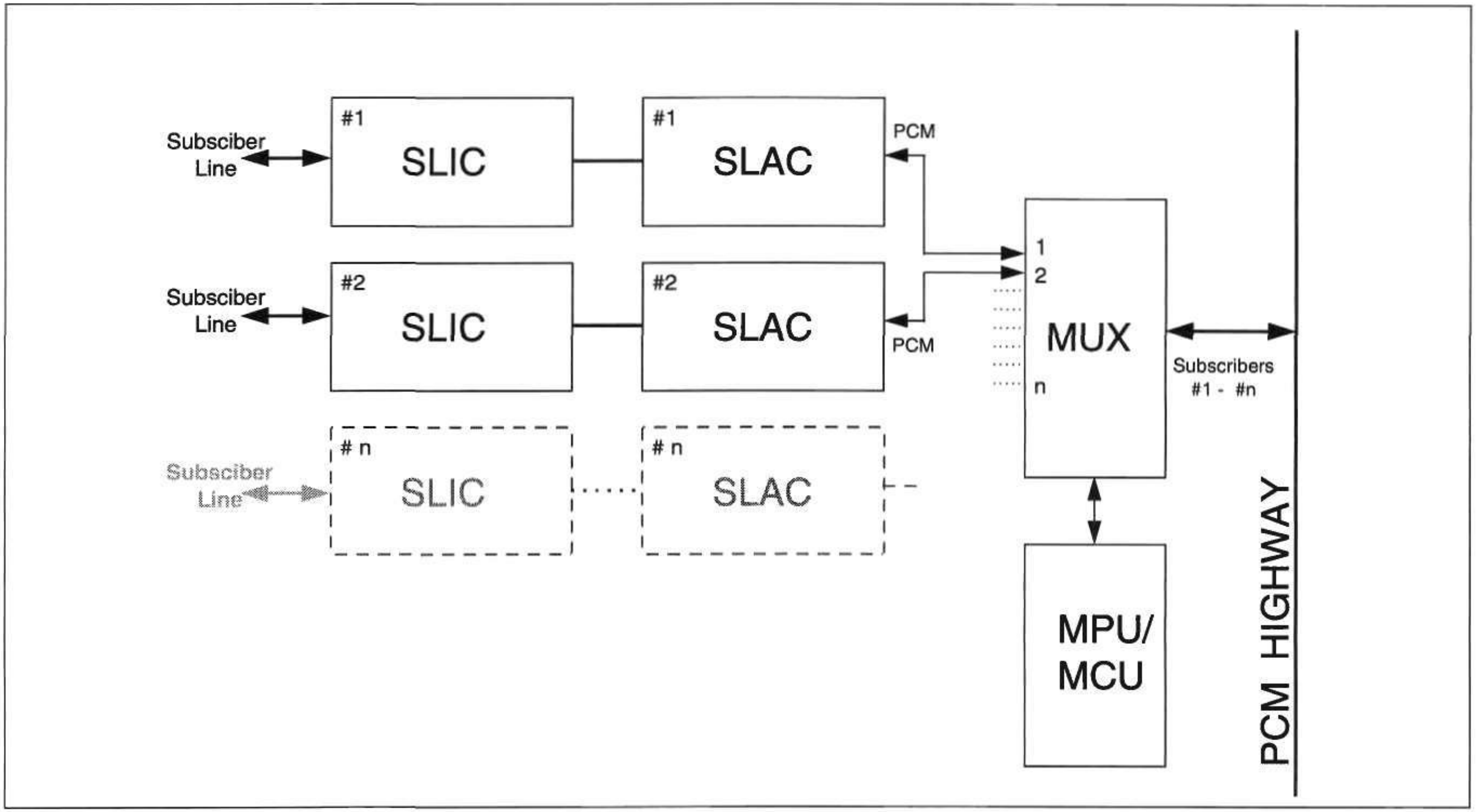
The line interface circuitry of each line on the card provides the link between the subscriber's analog telephone and the digital exchange switch and the telephone network. The major requirement of the line card is to convert the analog signals from the subscriber's analog telephone remote from the exchange and convert it to a digital, pulse-code modulated (PCM) bit stream, which can then be directed by the switch and the telephone network, as shown in Figure 5-1.

The basic function of a line card is known under the acronym BORSHT (battery feed, over voltage protection, ringing, supervision, two-wire to four-wire hybrid conversation, and test); these features are necessary to provide basic telephone service. Other important tasks are voice frequency band limitation, analog to digital conversion, and time slot assignments onto the PCM highway.

SLIC

The requirements of the line interface are implemented by two major functional blocks, the subscriber line interface circuit (SLIC) and the subscriber line access circuit (SLAC), as shown in Figure 5-1. The subscriber line card usually includes two other functional blocks, the multiplexing circuitry (MUX) to direct and control the PCM bit streams from each SLAC to the exchange PCM backplane. Each line card also includes local

Figure 5-1
Digital Local Line Card Functional Block Diagram



SLIC = subscriber line interface circuit
SLAC = subscriber line access circuit
MUX = multiplexing/demultiplexing logic
MCU/MPU = microprocessor/microcontroller
PCM = pulse-code modulation
Source: Dataquest (September 1994)

control and management function (which includes metering, and feature control) via a microprocessor or microcontroller.

All of the BORSHT functions are usually implemented in the SLIC, but in some implementations the BORSHT functions are shared across both the SLIC and SLAC. The SLIC and the SLAC are implemented as individual devices for historical reasons when these functions were first implemented in hybrid technology. They now remain as separate devices because there is clear difference in the technology demands: the SLIC is essentially analog in function, with the requirements to use high voltages, whereas the SLAC is purely digital—a very specific digital signal processor (DSP). Thus, the SLIC is implemented in bipolar technology and the SLAC is best implemented in CMOS.

The SLIC is essentially a collection of independent analog functions. The device is connected directly to the subscriber's telephone line at the exchange. The SLIC will still be exposed to very high voltages, despite the connection of a number passive and active protection devices, in fault conditions and lightening strikes. Due to these possible conditions, the device is implemented in high-performance, high-voltage bipolar technology. The technology demands of the SLIC are further complicated by the need to use high-precision resistors (possibly thin film) on chip, minimizing the use of external precision passive components.

SLAC

The SLAC provides two primary functions filtering and the coder/decoder (CODEC). In fact, the SLAC is a highly specific DSP with integrated on-chip digital-to-analog (D/A) and analog-to-digital (A/D) converter. These functions are ideally suited to integration in low-power CMOS technology. Earlier SLAC solutions were based on separate CODECs and filters. To make volume manufacturing possible, adjustment of passive components is not possible, so the DSP is ideal where all the solution is provided via programming.

Multiplexing Logic

The multiplexing logic usually implemented in an ASIC or ASICs is a pure digital function; the speed of operation is unlikely to exceed 1 MHz, and so CMOS is the ideal technology solution. As semiconductor and ASIC technology has progressed, the complexity of this multiplexing function has easily been accommodated into fewer and fewer devices.

Although the equipment manufacturer has the benefit of lower device counts and smaller die sizes, with lower power consumption, this inevitably means a reducing market value for these components. Unfortunately, ASIC vendors have little else on the line card to integrate. The options are the microprocessor/microcontroller, but this is not a preferred solution by the equipment manufacturer as it reduces flexibility. The only other possible level of integration is the SLACs, but this is unlikely as the logical device would include eight SLACs, which is beyond the current levels of capability.

Microprocessor/Microcontroller

The microprocessor/microcontroller provides a supervisory and control function to each of the line cards. This provides some autonomy of control for each line card to control the characteristics of each of the SLIC/SLAC combinations for each of the lines. These are usually 8-bit commodity devices and are therefore subject to the greatest levels of price erosion.

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