European
Semiconductor Application Markets
Newsletters

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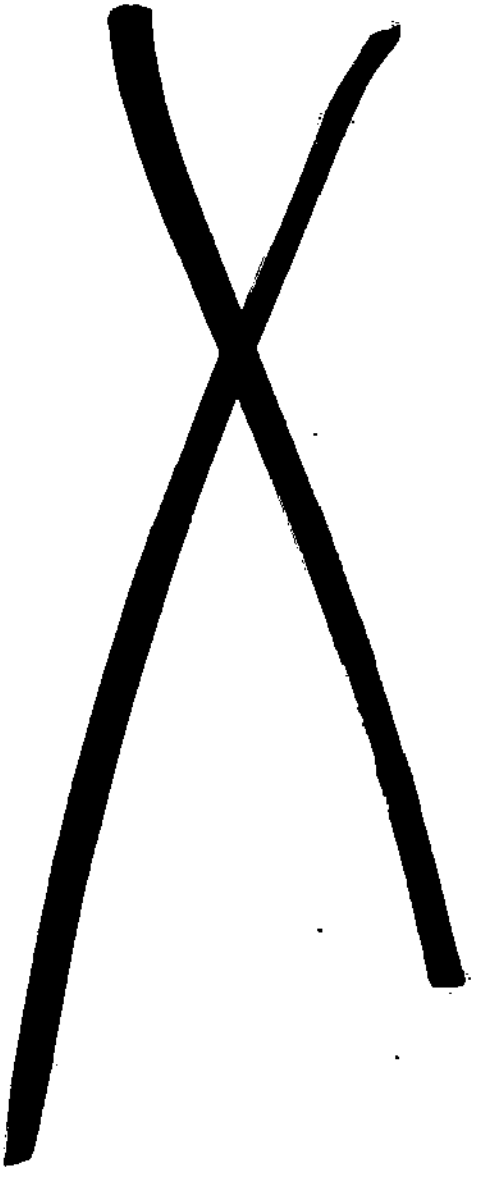

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Research Newsletter

EUROPEAN PC PRODUCTION IN 1992: YEAR OF THE NO-NAMES

INTRODUCTION

Leading European PC manufacturers have seen innovation and competition drawing in many new players to the personal computer industry over the last few years. During 1992, their response to "no-name" clone manufacturers eroding their combined market share was to become even more competitive.

The European Semiconductor Application Markets (ESAM) group has completed its annual survey of PC production in Europe. A second report, to be published shortly, will give full details of the PC market in 1992, PC production versus effective PC production, production by processor type, manufacturing by country, and semiconductor consumption estimates. In this newsletter we present Dataquest's estimates of the top 15 PC manufacturers in Europe for 1992.

THE MANUFACTURERS

Table 1 shows estimated total PC production for the top 15 manufacturers in Europe. Brief notes on these companies follow.

Overall, 1992 was a tough year for PC manufacturers worldwide. In Europe, 1992 was the year of the "no-name" computer manufacturers. The big names led by Compaq, IBM and Apple fought unsuccessfully to maintain market share, as the clone manufacturers expanded their presence. Figure 1 shows the effect that the no-name clone manufacturers had on the European market from 1989 through to 1991. Clearly, the overall share of no-name manufacturers has increased as a proportion of the total market.

In retaliation, each of the big names launched new entry-level and clone competitive products designed to win market share from the clone makers. Compaq launched its very own brands, the "Prolinea" and "Contura" ranges, also designed to fight off aggressive clone manufacturers in Europe. IBM also formed a new company named Individual Computer Products International (ICPI) to develop and market a new range of computer products branded Ambra, to compete in the PC clone market segment. Apple reacted to pressure from PC clone manufacturers offering Microsoft Windows software by delivering a new range of competitive products for the market, and relaunched a series of budget-priced Macintosh LC and Classic products. These new products signify a change of strategy (from high-premium, quality products to products offering good value for money) from the big, blue-chip players in the industry, as the competition gets ever more fierce.

Eminent no-names in the top 15 ranking include Dell, Vobis and Aquarius Systems International (ASI). The battle for PC market share will continue in 1993, but some players will not make it as this battle becomes ever more competitive. In a forthcoming *Dataquest Perspective*, we will focus on the impact of software technology on hardware requirements and the implications of further development in microprocessor performance.

REVIEW OF TOP 15 MANUFACTURERS

Apple Computer announced in 1992 that it was to lay off 45 of the 345 people at its plant in Cork, Ireland, but the company still plans to shift some assembly work currently performed in Singapore to the plant in Cork. Apple also plans to open a new facility in Apeldoorn, Netherlands to provide systems configuration and direct shipping services. Currently the PowerBook 170 and 180 models, which use active-matrix LCDs, are made in Ireland to avoid duties on the screens in the United States.

Aquarius Systems International (ASI) was founded in late 1989 and acquired the old Robotron

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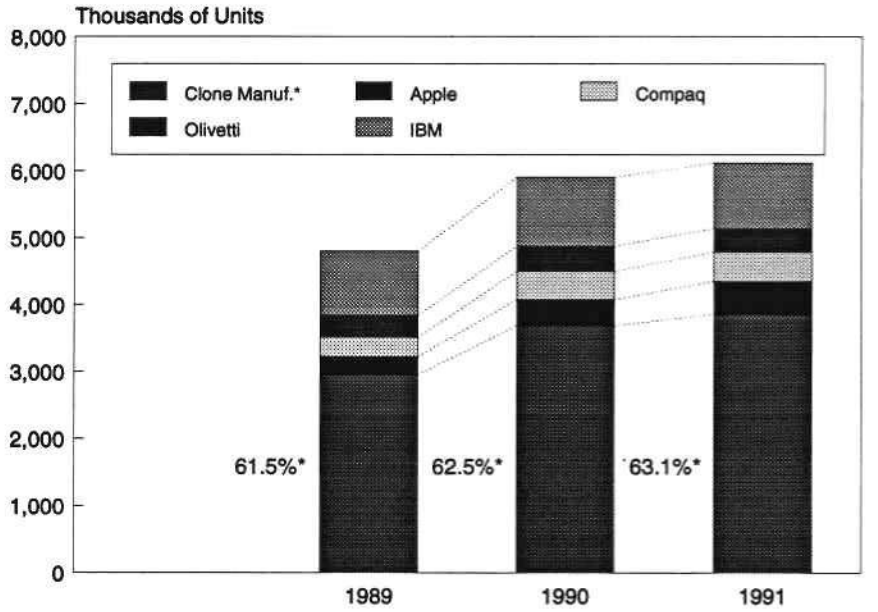
TABLE 1
Preliminary European PC Production 1992 by Format
(Thousands of Units)

Rank	Brand	Desktop	Laptop	Notebook	A5	Palmtop	Total 1992
1	IBM	1,185	-	15	-	-	1,200
2	Apple	428	-	179	-	-	607
3	Olivetti	522	23	58	-	-	602
4	Compaq	450	-	90	-	-	540
5	Psion	-	-	1	-	250	251
6	Vobis	238	-	-	-	-	238
7	ICL	209	-	-	-	-	209
8	Dell	165	-	7	-	-	172
9	Bull (inc. ZDS)	170	-	-	-	-	170
10	Tandon	160	-	-	-	-	160
11=	Hewlett-Packard	130	-	-	-	-	130
11=	Siemens Nixdorf	130	-	-	-	-	130
11=	Tulip Computers	113	-	18	-	-	130
14	Commodore	123	-	-	-	-	123
15	Aquarius Systems (ASI)	100	-	5	-	1	106
	Others	898	9	79	-	14	1,000
	Total Survey Production	5,020	32	450	-	265	5,768

Source: Dataquest (December 1992 Estimates)

FIGURE 1
Professional European PC Market Shipments
Market Trends 1989-1991



Source: Dataquest (December 1992 Estimates)

factory in former East Germany. A new factory is being built alongside the existing one, which should increase total production capacity to 300,000 units a year; this new plant should be ready by late 1993. At present motherboards are manufactured by ASI Taiwan which then ships them to Germany for partial assembly by ASI GmbH. The microprocessor and memory products are purchased in Europe. It is believed that ASI GmbH also purchases semiconductors for ASI Taiwan in Europe, thus giving it more power when purchasing components. It is also understood that ASI GmbH builds machines for Commodore, Digital-Kienzle, Triumph-Adler, and Vobis.

The **Groupe Bull** numbers also include Zenith Data Systems (ZDS), which Bull acquired in December 1989. During 1992, Groupe Bull completed an agreement where IBM took a 5.68 percent stake in Bull. Assembly and manufacture takes place at Villeneuve-d'Ascq in France.

During August of 1992, **Commodore** shifted production of its Amiga 600 home computer from its factory in Hong Kong to subcontractor SCI Systems in Irvine, Scotland. SCI was contracted to build 200,000 Amiga 600 machines by the end of 1992. SCI currently employs 750 people at its plant, and the Commodore machines will be manufactured using the surface-mount facilities there. Commodore has recently opened a new manufacturing plant in the Philippines, which has also taken capacity from the Hong Kong plant.

At the end of 1992, **IBM** announced more redundancies, but the Greenock, Scotland PC plant is thought to be safe due to the strong demand for its products. During 1992 IBM founded **ICPI** to market the Ambra range of PCs. At first, Wearnes Group of Singapore was contracted to manufacture the range, but the Greenock plant has since won an open tender to make the products. The numbers for ICPI have been excluded from IBM from 1992 onwards, as ICPI is now included in its own right.

Olivetti owns Triumph-Adler and Acorn Computers, although our production estimates for the Olivetti Group include production for Olivetti and Triumph-Adler alone. Olivetti's subnotebook, the Quaderno, is being manufactured in Japan by Y-E Data, but Olivetti plans to move production to its own plant in Singapore. In October, Olivetti announced that it intended to close the Triumph-Adler factory in Nürnberg, Germany.

Psion has expanded its factory in the United Kingdom to include an integrated surface-mount assembly line. It is also believed to be subcontracting some production in the United Kingdom. Psion recently signed an agreement whereby it will supply Acorn with a modified version of its Series 3 product.

Tandon announced in November 1992 that it is to phase out manufacturing at its Vienna, Austria plant and use more subcontracted manufacturing.

Rest in Peace

The following companies have ceased production of PCs in Europe since the last survey conducted by Dataquest:

- **Epson** stopped production at its Telford, England factory in October 1991.
- **SMT-Goupil** ceased manufacturing and went into liquidation in 1991.
- **Sunnytech** ceased manufacturing and went into liquidation in 1991.

Philips is to halt its PC assembly in Tilburg, Netherlands only a year after starting assembly there; it will now only install and configure software there for the European market. All other PC manufacturing activity will be concentrated at Philips' Canadian plant.

Mike Williams
Andrew Norwood

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Research Newsletter

GPS CONSTELLATION—WILL GPS BE A BRIGHT STAR?

INTRODUCTION

The ability to travel, and to navigate has always been an important aspect in the development of a civilization. From the earliest times, the stars were used for many forms of positioning. The most modern form of celestial navigation uses a sextant, an accurate clock and printed locater tables. Sextant-based navigation has represented a state-of-the-art positioning system for over 200 years and was used as the primary form of position fixing until the middle of the 20th century. This system stood the test of time because it was the only "global positioning" method.

As technology developed, electronics and radio techniques provided some alternatives to celestial navigation. Most early electronics systems had some advantages over celestial positioning but none could provide a combination of 24-hour, all-weather, global positioning. However, a system of this nature was conceived using a constellation of satellites.

Such an enormously expensive system could only be justified by a world superpower: the US Department of Defense (DoD) initiated the development and implementation of a satellite-based global positioning system (GPS) as a strategic defense need. A GPS provides position coordinates and high-accuracy time data anywhere on the globe. This system provides the beginning of a new age for position, location, navigation and time measurement equipment for both the consumer and professional markets.

SUMMARY

During the past couple of years, GPS has emerged as a key technology for many other applications in the electronics industry. The Gulf war helped raise GPS product awareness and its importance, and is beginning to grow a potentially big semiconductor market. Although the market for GPS semiconductors is not substantial today, Dataquest expects this technology to penetrate and replace many major existing markets (such as aviation navigation systems, marine navigation, land surveying, in-car navigation systems and even the most basic land navigation systems). The worldwide semiconductor market for GPS is worth $131 million.

Many manufacturers (including several that are European) are expected to market global positioning systems towards the end of this decade. Currently, the most significant growth for GPS is in Japan, and we expect the Japanese market to lead in the development of consumer systems (such as handheld navigation systems for backpackers, leisure activity and so on). The most promising end-application market for GPS technology in Japan is in-car navigation systems. Although today, few semiconductor companies have the semiconductor processing technology required to support GPS, several opportunities do exist in this product market for those vendors not able to offer solutions for this application (GPS signals are transmitted at 1.575-GHz frequency).

This newsletter reviews GPS market opportunities worldwide and presents Dataquest's estimates of the volume of semiconductor business. We also give an indication of what type of semiconductor product is needed for GPS, and present a semiconductor market forecast.

WHAT IS GPS?

A GPS receiver relies on the principle of triangulation to calculate its set of location coordinates, by measuring accurately its distance from four satellites that are in view. This is accomplished by measuring precisely the time taken for a radio transmission to travel from a GPS satellite to

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the GPS receiver. A receiver uses an internal database (called an Almanac) to look up the exact 3-D coordinates at a particular time of any of the 21 satellites in space. It is now possible using highly sophisticated 3-D trigonometry to calculate an exact location. Thus, the GPS system relies on highly accurate time information provided by each satellite, and high degrees of computation in each GPS receiver.

If the receiver had to perform both the complex trigonometric calculation, as well as generate accurate timing, it would be too expensive for the potential mass market that is starting to open up. Also, a satellite-based positioning system has only recently become a practical, cost-effective proposition with the availability of very large-scale integration semiconductor technology. To summarize:

- The GPS system relies on a constellation of 21 self-identifying satellites.
- Each satellite has an atomic clock which provides absolute time information to GPS receivers to better than one-millionth of a second.
- Each satellite has one primary and four backup clock systems.
- Each satellite transmits a total constellation Almanac that can be received and stored by all GPS receivers.
- GPS satellites have low-power transmitters which cover a large portion of the hemisphere at any moment. Therefore, the signal level at any GPS receiver antenna is very low. A GPS receiver is able to receive and decode very low-level signals.

A positioning or location system provides only longitude and latitude usually in some form of digital information. A navigation system provides more than just position information, the position is superimposed on some form of map. Other navigation systems may provide distance and heading information to a set of predetermined way points.

GPS MARKET APPLICATIONS

GPS was originally conceived for military use. However, it is now finding many applications in civilian and commercial systems, and future market growth will come from this area rather than military. Uses for GPS can be split into five areas:

- Handheld units for personal use
- In-car navigation systems
- Aviation
- Professional precision/survey units
- Commercial/pleasure marine navigation systems

Figure 1 shows the worldwide market share of GPS equipment by end-application area. The figure shows that currently marine navigation systems are the biggest use for GPS, representing 38 percent of a market totalling 377,000 units in 1991. However, by 1996 in-car navigation systems will have grown rapidly to take 74 percent of a worldwide market totalling 3.8 million systems.

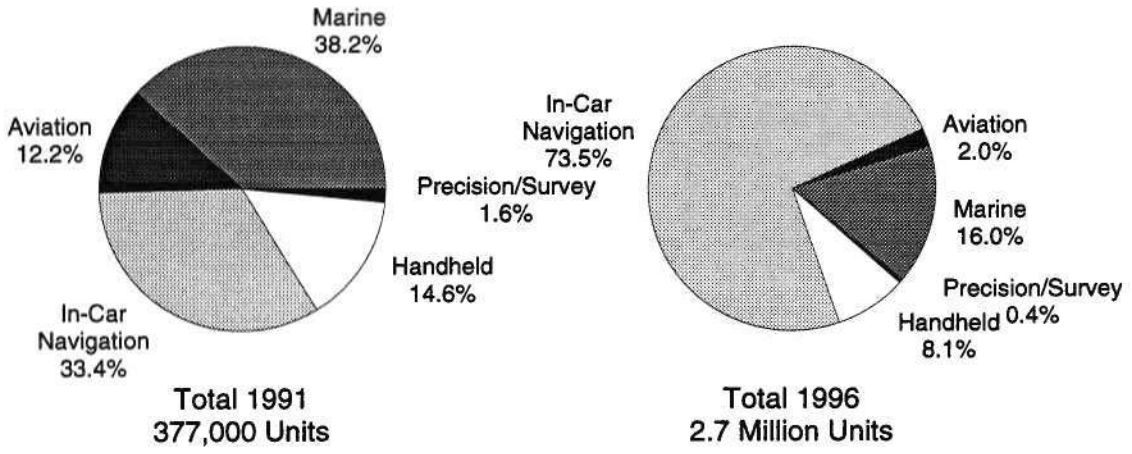
Handheld

In 1991, 55,000 units of handheld GPS receivers were shipped worldwide. Handheld consumer applications include portable leisure marine navigation systems and adventure navigation products. Since the Gulf war of 1991 these systems have gained significant market size. During the war, the US military realized that commercial global positioning systems are as accurate as their highly restricted military counterparts. Since the war, manufacturers such as Trimble Navigation Inc. and Magellan have been offering low-cost handheld systems as GPS chip set prices began to fall in line with market forces. There is an immense opportunity here for a possible opening in the consumer market when GPS chip set/module prices begin to fall. The fundamental issues remain price, size, power consumption and the user-friendliness of the man/machine interface.

In-Car Navigation Systems

In-car navigation systems are forecast to become the most important single application market for GPS technology. There were 126,000 units shipped in 1991. Most car manufacturers and suppliers of automotive electronic systems are designing hybrid navigation systems for this segment. These comprise a combination of some other navigation systems (such as dead-reckoning or compass) with GPS. GPS receivers are susceptible to intermittent reception in built-up areas; in these situations a hybrid system would continue to navigate when a GPS satellite is out of view. Car radio manufacturers are looking to GPS technology and forthcoming navigation systems as an extension to their product range, as in-car entertainment systems become more complex audiovisual systems. A key

FIGURE 1
Worldwide Market Share by End-Application System



Source: Dataquest (December 1992 Estimates)

market issue deciding the rate of acceptance of GPS-based in-car navigation systems will again be system price relative to dead-reckoning and map-based navigation systems.

Aviation

Aviation has a requirement for very precise navigation. This has so far been addressed by inertial navigation systems (INS), but GPS is becoming increasingly popular as an adjunct to the INS because of its relatively low cost. However, the ability of GPS to measure altitude accurately diminishes the further it is raised above ground level. Therefore, its use is likely to be restricted to small private planes rather than commercial airliners which fly at altitudes in excess of 9,000 m. In 1991, 46,000 units were shipped worldwide. Because of the limitations described, we expect this to grow to only 56,000 units by 1996.

Precision/Survey Positioning

Dataquest defines precision/survey as high-precision positioning systems required for professional geographic survey, security/military and navigation work in the construction or mining industries (like oil, gas and minerals). Professional systems available on the market for these types of application tend to be very expensive because semiconductor modules have to meet stringent reliability and environmental standards. Precision/survey is something of a niche application. There were 6,000 systems shipped worldwide in 1991 and this will grow to only 12,000 units by 1996.

Marine Navigation Systems

Marine systems make up the fourth application segment. Marine applications have historically taken up systems designed for, and offered to, the military. Marine applications do not require very sophisticated multichannel receivers as they are used in open areas which allow relatively superior GPS signal reception. Presently, marine is the largest GPS market segment. In 1991, 144,000 systems were shipped, and by 1996 this will have grown to 437,000 units. There are now many subsystem suppliers in North America, Europe and Japan offering GPS marine positioning and navigation units. The cost of a GPS engine (see "GPS Engine Component List," page 8), will be a key factor deciding the growth of navigation systems. System prices must come down quite a lot in order to make it an attractive alternative to existing Loran-based systems. Dataquest believes that this is achievable.

Other Potential Future Applications

Other potential markets will be fleet location/security systems which include those used by road transport, haulage operators and emergency services for the monitoring and control of vehicle fleet

movement. Because GPS receivers give location information, they are also an attractive option as a security feature. GPS can, for example, be used to identify one's location when sending out an SOS message, thus reducing the amount of time for rescue.

The potentially small form factor of a GPS engine will mean that it could be fitted into a PCMCIA card. This opens up opportunities for GPS to be used in personal digital assistants (PDAs) and in digital mobile telephone handsets. A GPS would provide personal information on location and time of day.

REGIONAL GPS ACTIVITY

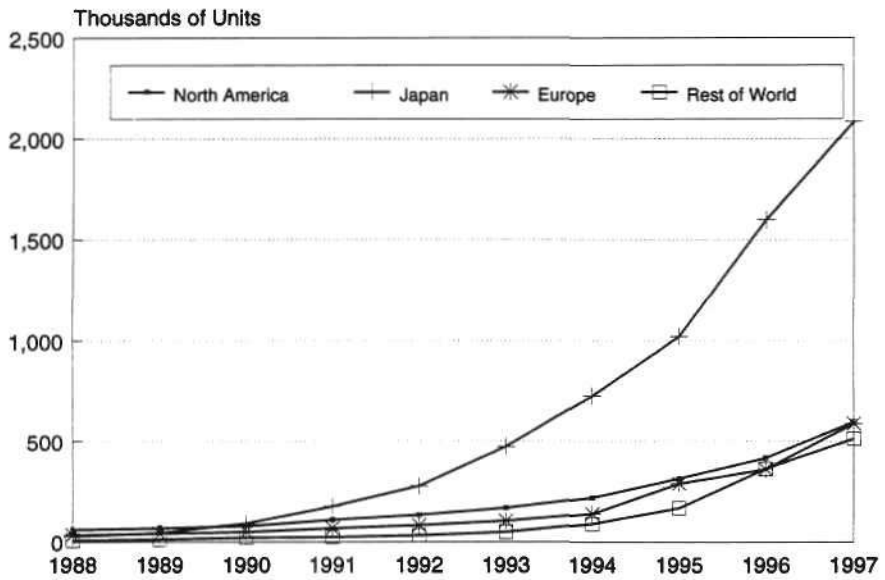
Until recently, GPS had been the domain of the US DoD, which owns the satellites, and thus the market for GPS equipment has primarily developed in the United States. However, following the success of commercial systems in the Gulf war, there has been an explosion of product ideas for use in the private sector. Nowhere has this occurred more than in Japan. In particular, Japanese car manufacturers have leapt onto the idea of in-car navigation systems. Figure 2 shows Dataquest's worldwide unit shipment forecast, split by region.

In 1991, the Japanese market for GPS systems emerged as the world's largest market for the first time, at 177,000 units compared with the 109,000 units in North America. Europe was third with 67,000 units, larger than Asia/Pacific which shipped 24,000 units. However, by 1996 the explosion of in-car navigation systems in Japan will mean the country will represent 58 percent of the worldwide market of 2.7 million units. The remaining three regions will be of almost equal size at about 380,000 units each.

Japan

In Japan, various research activities in the road transport and traffic area are being conducted for navigation systems using GPS. Japan has developed a very advanced and functional road traffic information infrastructure where all Japanese regions are covered by special radio stations transmitting traffic and weather information. The most common station in Japan is the one run by Vehicle Information Communication Systems (VICS) for the Ministry of Post and Telecommunications' wider area FM radio network. Already in Japan, the police force and emergency services (fire and ambulance) are using GPS navigation systems for controlling their fleet and as an aid to improving their effectiveness. The Advanced Mobile Traffic Information and Communication Systems (AMTICS) pilot project founded in 1984 is sponsored by the Japanese National Police Agency to provide real-time traffic information. Alongside

FIGURE 2
GPS Equipment Production Forecast by World Region



Source: Dataquest (December 1992 Estimates)

AMTICS is Road/Automobile Communications Systems (RACS) sponsored by the Japanese Ministry of Construction. The demonstrations of these research activities in Japan are being combined into the VICS project, which aims at developing vehicle navigation and real-time traffic information.

Many of these in-car systems combine a color map display, joystick, CD-ROM (map) player and GPS receiver. The major GPS product-based developments are given below:

- Clarion
- Kenwood
- Maspro Electric Industries
- Mazda
- Pioneer
- Sony
- Toshiba
- Toyota

A detailed description of each of these manufacturer's systems is given in "Company Notes" at the end of this newsletter.

United States

The United States is the second most advanced market for GPS systems. It is initially a primary market with design expertise and overall control or ownership of the satellites for military applications, but most US efforts have been focused at the military market. The US system houses and semiconductor companies have developed the Navstar GPS for the US government. With this high level of technology, the US companies will be best able to exploit it for non-military applications.

Rockwell is the biggest player in this region as it was the first to emerge with many important GPS contracts with the DoD. It now offers GPS engine products to the merchant market allowing systems houses to develop their own products. The US market continues to be predominantly military handheld and geographic survey systems. In its intelligent vehicles highway systems (IVHS) program, in-car navigation systems have not yet reached anywhere near the stage of the Japanese market. The US IVHS program is seeking ways of extending the use of GPS for vehicle location or identification systems for traffic management and commercial fleet operators.

Following is a brief list of major GPS product-based developments. Many of these US companies now provide components which are a spin-off from developments for the military market. These products are finding applications in all market sectors including marine, aviation and survey. The major players are:

- Ashtech
- Garmin International
- Motorola
- Pacer Systems Inc.
- Rockwell International

See "Company Notes" at the end of this newsletter for further details of these vendors. Other significant vendors include Delco, H-Tek Inc., Magellan Systems, SCI, and Trimble Navigations.

Europe

European manufacturers have been relatively slow to use GPS in commercial car navigation systems. Although dead-reckoning and other car navigation systems have become available as a result of the EC-funded Road Transport Informatics (RTI) program, GPS is only now beginning to find applications in Europe. At the moment there is limited activity in car navigation because a reasonable return on the development investment cannot be foreseen in the near future. Any in-car navigation system developed for Europe will be too expensive for the local market for the next few years. Other issues affecting the rapid development of pan-European equipment include the lack of digital maps, standardized CD-ROM formats, in-car display legislation, and software standards.

Automatic vehicle location is an area which European manufacturers have identified as important. Location is very critical for high-security vehicles; for these types of application it is necessary that a controller (from a central control room) knows where a vehicle is and the route it should be taking so that any detour from the planned route would signal an early warning alarm.

In Europe, further research is being carried out through the EC-funded research program, Socrates, to link GPS with GSM—a cellular telephone network. Although Europe is potentially the largest regional market for GPS (particularly in car

navigation), it still lags behind the two leading regions.

Major European system manufacturers known to be developing GPS systems include:

- Bosch (Germany)
- Philips (Netherlands)
- Renault (France)
- Ford (United Kingdom)
- Becker Radio (Germany)
- Marconi Marine (United Kingdom)
- Sagem (France)
- STC (Northern Telecom, United Kingdom)
- Columbus Positioning (United Kingdom)
- Navstar (Peek, United Kingdom)

Asia/Pacific/ROW

In Korea, **Samsung** has recently developed and launched a GPS navigation system similar to the in-car systems that have been developed by Kenwood and Sony for the Japanese markets. A company in Singapore known as **Singapore Technology** is also known to be developing and providing an OEM assembly facility for GPS products in the consumer handheld segment and the in-car navigation systems area.

DIGITAL MAPPING FOR GPS NAVIGATION SYSTEMS

We have indicated the size and importance of in-car navigation systems in the development of the GPS market. Digital maps will form a critical aspect for any GPS navigation system. While digital maps already exist for other computer applications outside of GPS, GPS is clearly starting to accelerate the process. However, the current status is that maps for only a few major cities in Japan, the United States and Europe have been completed, and there are no country maps. The next phase of digital mapping will be to accurately label all map features (roads, buildings, bridges, and so on) with absolute geographic coordinates—ultimately, all locations on earth will have a unique global address.

Digital maps for GPS navigation purposes are currently available in two formats: CD-ROM and smart card formats in the JEIDA/PCMCIA standards. Some of the companies involved in digital mapping are as follows.

Etaks Inc. is a News International Inc. company based in the United States. Etaks specializes in digital mapping for CD-ROM and has extended its services to Europe, mainly in Germany. Etaks now provides a digital map for major cities in Germany, the Netherlands and France and is currently working with Bosch to provide digital maps for Bosch's Travelpilot CD-ROM–based in-car navigation system.

Zenrin (Navisoft is a registered trademark for Zenrin) of Japan is one of the earlier Japanese software houses that provided digital maps on CD-ROM for the Japanese commercial market. Zenrin has now developed an enhanced software library for GPS navigation systems that incorporates games and a CD-ROM resort map guide for navigation systems.

Carrozzeria is the digital mapping subsidiary company of the Pioneer Electric Company of Japan. Carrozzeria provides digital maps for GPS navigation systems in a memory card format. Pioneer also provides CD-ROM–based navigation games codeveloped with Sega (the computer games vendor) and Hudson Soft (a graphic animation software house in Japan).

Other companies known to be working in the mapping area are **JTB** in Japan, Geographic Management Systems, European Geographic Technologies, Action Information Management, Terra-Mar Resource Information Services, Strategic Mapping Inc. in San Jose, and **Erdas Inc.** of Atlanta.

SEMICONDUCTOR VENDORS FOR GPS RECEIVERS

Dataquest has identified a number of semiconductor manufacturers undertaking fundamental research and development in GPS engines or components. Table 1 presents some of these companies and a brief summary of their activities in this area.

Because this is a newly emerging semiconductor market, Dataquest has not developed any market share data as it will have little meaning. However, it is clear from our research that Japan has the fastest-growing market at the moment, and could offer a significant opportunity for non-Japanese semiconductor vendors.

The worldwide GPS equipment market is dominated by Japanese products. Table 1 also illus-

TABLE 1
Semiconductor Manufacturers' Involvement with GPS Engines

Company	Activity
Japan Radio Company	First-generation modules in single chip
Motorola	Currently developing single GaAs chip solution
Rockwell International	Currently offers a GaAs-based module
Toshiba	First-generation modules in single chip
GEC Plessey Semiconductors	Developing first silicon solution using low-noise amplifier (LNA) for front-end signal processing
Magnavox (a Philips company)	Has developed a first-generation GPS module
Sony	Believed to have developed first-generation GPS module
TriQuint	Highly integrated GaAs RF front end

Source: Dataquest (December 1992)

trates the strength in numbers of the Japanese semiconductor suppliers for GPS.

Rockwell's background in the initial development of GPS satellites and receivers for the US DoD has enabled it to develop semiconductor solutions with a performance edge. These US semiconductor solutions seem to offer higher levels of performance which are even more suitable for the type of product on the Japanese market. It is noteworthy that this US-developed system is not dominated by US semiconductor suppliers.

GPS RECEIVER ENGINE TECHNOLOGY

Figure 3 shows a functional diagram of a GPS receiver engine.

The elements include an antenna, a receiver, signal processor, and position processor. This engine will perform all the functions of establishing its own global position in terms of longitude and latitude. The GPS engine could also incorporate an RS-232 port, or similar interface, to output data which the engine can compute including relative position, altitude, velocity and time of day. However, in order to use this information, peripheral circuitry is required. In this newsletter Dataquest limits analysis to the engine alone.

Receiver

GPS satellites transmit low power levels. The GPS system allows the use of small-area antenna to receive satellite transmissions. The level of signal provided by a typical GPS antenna is a similar order of magnitude to the inherent Schott noise of a silicon amplifier. To improve the system signal-to-noise ratio, GaAs is used because of its low inherent electrical noise and the GPS operating frequency of 1.575 GHz.

Therefore, the design of a receiver (as shown in Figure 3) has four primary considerations:

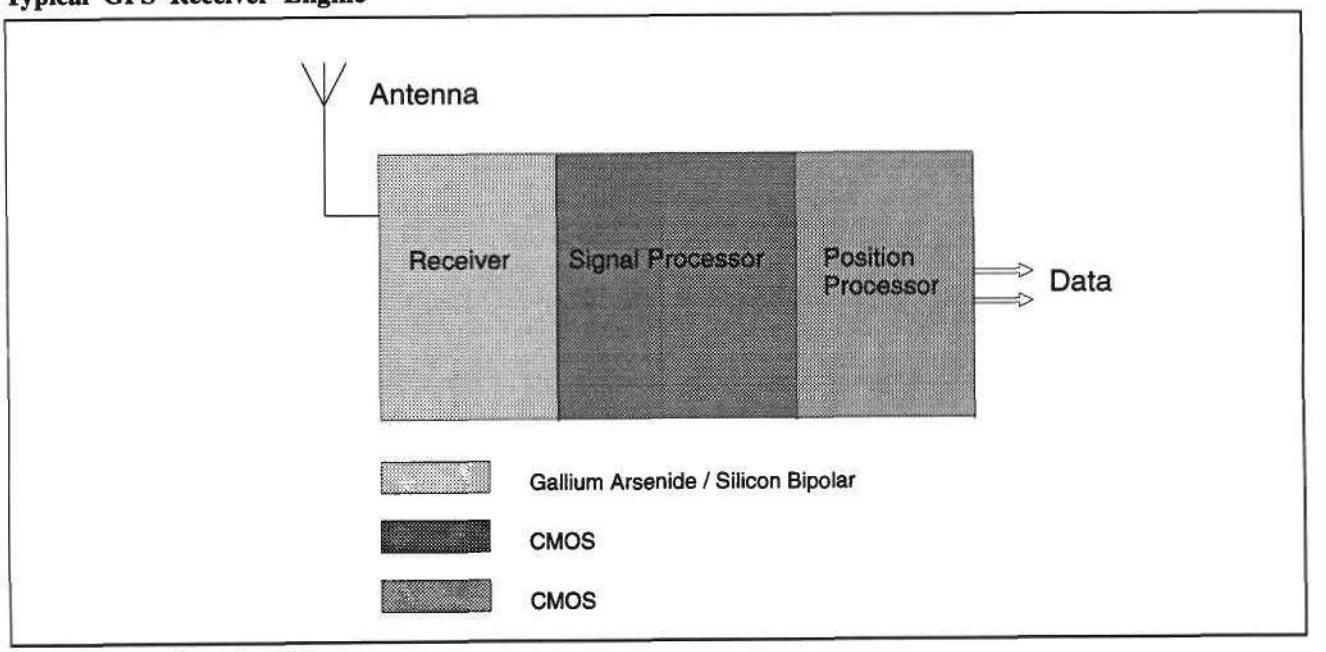
- Operates at frequencies of up to 1.575 GHz
- Downconverts to intermediate frequency suitable for signal processing
- GaAs implemented LNA
- Sampling and A/D conversion for use by digital processing

Signal Processor

A minimum of four GPS satellite distance vectors are required to calculate a position. The signal processor calculates and stores distance/time measurements for those GPS satellites in view. Each satellite in the constellation transmits its unique information as a pseudo-random code. A correlator, within the signal processor, produces distance information by matching a received signal with a satellite's defined pseudo-random code. Thus, the position processor determines from the Almanac which four satellites in view will give the strongest signal. The signal processor using the appropriate pseudo-random code for each of the satellites correlates these codes with the received signal.

State-of-the-art GPS engines use multiple-channel correlators in the signal processor to track multiple satellites in view. The signal processor is best implemented in CMOS because of the signal rates and the requirement for low-power operation.

FIGURE 3
Typical GPS Receiver Engine



Source: Dataquest (December 1992)

In early implementations of GPS engines, the correlators were implemented using general-purpose digital signal processors (DSPs). The new generation of GPS engines are now implemented in hard-wired dedicated DSPs.

Position Processor

The final element of a GPS engine is the position processor. The position processor will compute general-purpose navigation data, such as longitude, latitude, altitude, speed and time. The position processor also:

- Maintains Almanac data
- Instructs the signal processor to monitor those GPS satellites in view
- Constantly tracks alternative satellites to use (from Almanac)
- Calculates worldwide grid references (longitude and latitude)
- Outputs data to peripheral port

Because of the complex computational requirements of calculating longitude and latitude, the software requires a processor performance of about 3 Mips. Associated with the position processor are some memory products: 2MB ROM for the application software; EEPROM to hold Almanac data; and 2KB SRAM for computational variables and temporary storage. All elements in the position processor are ideally suited for implementation in CMOS, which provides the benefit of low-power operation.

GPS ENGINE COMPONENT LIST

The three elements of receiver, signal processor and position processor are currently being implemented using the components list given in Table 2. In total, eight semiconductor components are used. Dataquest estimates the value of these to be $250 currently in 1,000 unit volume. A complete engine "board" currently sells for $395 in 1,000 volume and this includes a printed circuit board, oscillator, two ceramic filters and two crystals in addition to the semiconductors.

Dataquest believes that a state-of-the-art GPS engine can be implemented in a module approximately 60 × 100 mm. Already GEC Plessey Semiconductors claims to have reduced the semiconductor component count to six devices. This size is fast approaching that of a PCMCIA card which we envisage to be possible by 1994. Dataquest believes that companies like Rockwell, Motorola and GEC Plessey Semiconductors are developing

TABLE 2
Component Parts List for GPS Engines

Component	Functional Block
2 RF ASICs	Receiver
1 Digital ASIC	Signal processor
1 Microprocessor (16-bit)	Position processor
2 SRAM ICs	Position processor
1 EEPROM	Position processor
1 ROM	Position processor
1 Oscillator (1 PPM TCXO)	Receiver
2 Ceramic Filters	
2 Crystals	

Source: Dataquest (December 1992)

PCMCIA cards for GPS engines of the future. This means that a GPS engine could be incorporated into a PDA or perhaps a digital mobile telephone handset in the future. The estimated OEM price of overall board (in 1,000 volume) is $395.

GPS SEMICONDUCTOR MARKET FORECAST

Dataquest's forecast for worldwide GPS semiconductor consumption is given in Table 3. The table shows that the semiconductor market for GPS engines in 1992 is worth $131 million. For that year we estimate 526,000 engines will be shipped worldwide, with an average semiconductor content of $250. Most engines will be for use in marine navigation. However, the fastest-growing application will be in in-car navigation systems in Japan. By 1997 the semiconductor market will have grown to $212 million, a 10 percent compound annual growth rate (CAGR) over 1992. This relatively slow growth is due to the rapid drop in the value of semiconductor content which we expect to occur over this period. Actual GPS engines shipped will have grown to 3.7 million units, a 48 percent CAGR over 1992. By then in-car navigation systems will represent by far the largest portion of shipments at 74 percent.

The key assumptions behind the forecast are:

- The semiconductor content of a GPS engine is currently $250, but by 1997 this will have dropped to $50 through a significant increase in integration levels and a substantial increase in production.
- In-car navigation systems will take off strongly in Japan where there are currently more than 12 different proprietary systems available from at least 6 companies.
- Handheld systems have become popular since the Gulf war, and will grow in popularity with outdoor-pursuits enthusiasts.
- Precision/survey as an application will remain very niche. Usage will be limited to specialist mapping and survey work.
- Marine is largely a replacement market, where both commercial and private marine users will want to improve on existing DECCA and Loran

TABLE 3
Market for GPS Engines (Thousands of Units)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	CAGR 1992–97
In-Car Navigation Systems	4	15	60	126	213	415	708	1,168	2,012	2,799	67.4%
Handheld	26	32	41	55	80	103	133	182	222	280	28.5%
Precision/Survey	3	4	5	6	7	8	9	11	12	12	11.2%
Marine	73	85	100	144	178	220	273	380	437	637	29.0%
Aviation	23	27	33	46	48	50	52	57	56	56	3.2%
Total Market for GPS Systems	129	164	238	377	526	796	1,175	1,798	2,739	3,785	48.4%
Semiconductor Content ($)	$700	$595	$473	$333	$250	$200	$150	$100	$70	$56	-25.9%
Semiconductor Market ($M)	$90	$97	$113	$125	$131	$159	$176	$181	$192	$212	10.0%

Source: Dataquest (December 1992 Estimates)

systems. However, in the southern hemisphere the "first-time" market will dominate.

- In the forecast, aviation is primarily private. GPS multidimensional altitude calculations have the potential to be least accurate at high altitudes at the moment.
- The United States will have completed a full constellation of satellites by 1994. These will be available for civilian use in 1995 and the US government guarantees its availability to the public for 10 years. This will encourage usage considerably.
- Some potentially very high-volume emerging applications for GPS will begin with the advent of PCMCIA engine cards. These will include GPS in personal digital assistants and mobile digital telephone handsets.

This semiconductor market forecast deals with the GPS engine. There are other significant semiconductor business opportunities associated with GPS. These include LCD and CRT display monitors, CD players used for maps, circuitry used to support map tracking systems, and fleet/taxi tracking systems.

CONCLUSIONS

Dataquest expects GPS to rapidly take off in the Japanese market, especially in the market for in-car navigation. Most Japanese GPS systems are not specifically targeted at the high-precision market segment. Japanese products that have reached markets address the potential volume automotive and handheld consumer areas. Currently these products are expensive, retailing at what is considered market-introduction prices, which will reduce substantially as the market grows.

In the US market, the emphasis is not particularly on developing consumer GPS systems but on high-precision GPS systems. Products available in the United States are comparatively sophisticated high-reliability positioning engines. GPS engine manufacturers in the United States have for many years been working towards winning contracts from the US DoD which is regarded as the ultimate customer in this market. The detailed knowledge of the GPS system by US companies has allowed it to dominate the high-precision market. As consumer products evolve and require higher levels of performance, US companies may begin to benefit from this market.

In Europe, GPS systems will begin to take off towards the end of this decade. The strongest segment for GPS growth in Europe will be in-car navigation. There are many reasons why it is anticipated that Europe will become a strong market for GPS car navigation systems, but the underlying benefit of GPS here will be reducing the difficulty of road travel throughout the continent. However, legislation in most EC countries prohibits the use of display monitors at the driver's dashboard. Any GPS car navigation development in Europe may therefore have to be based on audio narration.

Semiconductor vendors looking to target this market will need to provide technology covering GaAs, high-performance bipolar silicon, and low-power VLSI CMOS. There are few companies which possess these technologies, this limits the number of vendors who can supply a total solution. Today, GPS engines are board-level products/modules requiring a broad range of technology and integration expertise from the semiconductor vendor. The next generation of products will be offered as a GPS chip set allowing the user and equipment manufacturer a greater level of flexibility and a substantial reduction in costs.

Mike Williams

COMPANY NOTES

Clarion

Clarion has developed a digital map narration system based on paper maps. The Clarion system is code-named the NAC-200. It has no GPS now, but the company plans to include it later this year. The system uses a memory card for storing paper map codes and provides information on direction of travel and distance travelled. An audible alarm signal is fed through the car speakers if the driver makes any detour away from the programmed destination. This is seen as a safer system as it provides less distraction to drivers than the detailed maps displayed on VDUs described in earlier models.

Kenwood

During 1992 Kenwood launched a GPS navigation system for in-car use code-named the KNV-100. The new Kenwood system incorporates a CD-ROM player and display processor, a full-color LCD unit, a GPS receiver unit, a GPS antenna, and an integral GPS joystick command unit. Kenwood's system is designed to be compatible with a special integral component, a GPS system (code-named PX990) which consists of a complete in-car entertainment system incorporating CD, radio-cassette player and amplifier speakers.

Maspro Electric Industries

Maspro Electric Industries has developed a GPS car navigator (GP2) which features compact disc interactive (CD-I) playback function. The system, which includes processor, display and antenna, was introduced on the market at the end of 1992. The CD-I function allows vocal operation as well as display of still pictures on the LCD. The actual processor unit is detachable and can be connected to a color television, which allows users to plan their travel course and itenerary in advance. All the user has to do is follow the set course while listening to the vocal instructions.

Mazda

Mazda has announced plans to offer satellite navigation systems for all its vehicles within the next few years. The company has spent 15 years investigating in-car navigation equipment and has recently installed the first satellite-linked version into a production car in Japan. Mazda's CCS system is available as an optional extra on the company's Eunos Cosmo range of cars. It combines a satellite-linked navigation system, a TV set with multiplex broadcast receiving capability, FM/AM radio with radio data system, automatic CD changer, cassette tape deck, handsfree cellular phone and climate control equipment. The navigation system uses radio signals from GPS satellites.

Pioneer

Pioneer has finally launched its own GPS "satellite cruising system" for in-car navigation. Having first developed its own digital mapping software company Carrozzeria, Pioneer has launched into the mainstream GPS market and now offers a range of GPS navigation systems based on the CD-ROM digital mapping standard.

Sony

Sony has developed and launched onto the market a handheld GPS positioning unit called the Pyxis. The Pyxis is a four-channel GPS which allows 2-D positioning. The Pyxis is powered by four "AA" alkaline batteries (up to two hours continuous-use battery life), and is also adaptable for a car battery. Sony has also launched a car system that comprises two main components, a digital map navigation system (NVX-1) and a new special LCD color monitor (XVM-61) launched in July 1992. The complete system includes GPS antenna, CD-ROM drive unit, GPS signal receiver, a joystick, an electronic control unit and the LCD color monitor. Key features of this system include map scroll (high-speed map scroll); memory input (for a maximum of five destinations); processing capacity (to store the best route for each of the five destinations); and real-time map and travel processing to show distance travelled, time travelled, distance remaining and an estimated time of arrival at the selected destination.

Toshiba

Toshiba has recently (summer 1992) introduced two new car navigation systems, the NPA 01 and the NPA 02. Toshiba's NPA 01 system offers basically the same features as the Sony NVX-1 product, the only significant difference being in the

display technology. Toshiba features an enhanced display system (a 5.9-inch square TFT color LCD) and character display module. The NPA 02 is a more advanced navigation system which allows an early warning system of road and traffic conditions specifically related to the driver's selected route and has the processing intelligence to reroute the journey upon receiving any such information. The NPA 02 system has an additional function allowing it to receive radio information from traffic and weather information centers, regularly updated by the special local information stations.

Other GPS suppliers in this region that have commercially available products are **Nippon-Denso (Toyota)** and Sanyo.

Ashtech Inc.

Ashtech Inc. of Sunnyvale, California specializes in GPS receivers for geographic survey information systems and databases. Ashtech receivers are available in several versions. A standard receiver system (code-named the M-XII) includes 1MB of memory, a 10 m antenna cable, an external power cable, an RS-232 data cable, precision antenna platform assembly, a receiver operating manual and a complete set of Geodetic Post Processing Software (GPPS) with manual.

Garmin International

Garmin International of Lenexa, Kansas has developed a GPS sensor board that can locate a vehicle anywhere in the world to within 15 m at a cost of $500 in 1,000 volumes.

Motorola

Motorola has a new GPS navigation system called the Traxar GPS Navigator. The Motorola system is a six-channel handheld GPS receiver with 2-D and 3-D positioning. The Traxar offers positional accuracy of between 25 and 100 m.

Pacer Systems Inc.

Pacer Systems Inc. recently acquired Computer Applications Software Technology, US maker of precision navigation systems.

Rockwell International

This company was a leading partner with the DoD at the inception of the NAVSTAR GPS satellite program and has emerged as a major GPS technology center. Rockwell's products include GPS engines (called the NavCore V GPS receiver engine), a GPS NavCore V sensor unit, a handheld navigation system and advanced GPS communication equipment used in warfare vehicles and applications, Earthcall V and Earthcall V sensor products. Rockwell has also developed GPS subsystems for sale to OEMs worldwide.

Robert Bosch

Robert Bosch (Blaupunkt) announced a GPS-based variant of its CD-ROM map-based Travelpilot in June 1992. The Bosch GPS Travelpilot is now available through commercial sales outlets in Europe (Germany, France and the Netherlands). Already, the Travelpilot has been dogged with problems associated with digital maps on CD-ROM formats and intellectual property map patents within the EC. The Bosch Travelpilot is designed not for mass consumer market applications but for professional applications where financial cost benefit savings can be gained and readily extrapolated.

Philips and Renault

Both companies have in-car navigation systems named the Carin and Atlas systems respectively. Both Philips and Renault are developing a GPS variation of their systems (see ESAM newsletter 1991-18 "In-Car Navigation Systems: The European Way Forward"). More recently, **Ford** of Europe has announced plans to launch a security/mobile GSM car telephone handset with GPS towards the end of the 1990s.

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Research Newsletter

TEMIC: EUROPE'S NEW SEMICONDUCTOR COMPANY

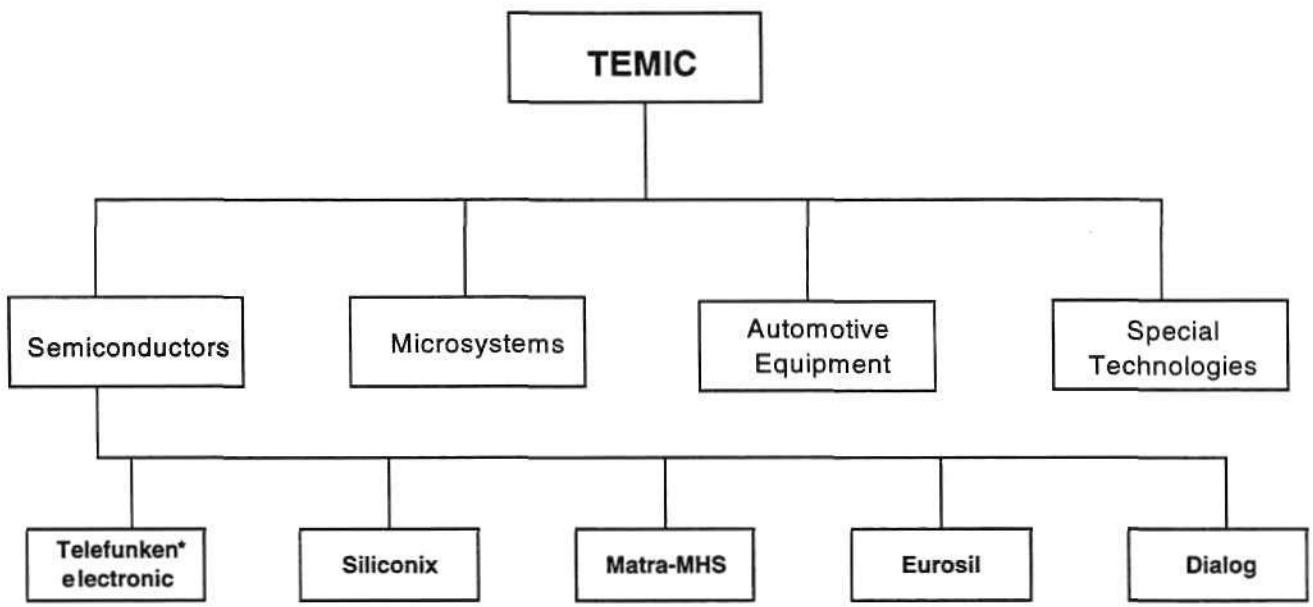
The consolidation of electronics companies continues in Europe, with the formation of another large manufacturer, TEMIC. The electronic component and subsystems operation of Daimler-Benz is being formed into a new company this year, and it will focus on the areas of semiconductors, microsystems, automotive equipment, and special technologies. The new company's semiconductor operations comprise the former Telefunken, Siliconix, Matra-MHS, Eurosil and Dialog. It will present a formidable competitor in the European marketplace, with strong backing from the parent company, Daimler-Benz.

Figure 1 shows the four principal business divisions (namely, Semiconductors, Microsystems, Automotive Equipment and Special Technologies), and the companies that have formed the semiconductor group. The company will be formally named TEMIC at Electronica '92 in November this year.

THE SEMICONDUCTOR OPERATIONS

Dataquest estimates the five companies' combined sales in 1991 were $593 million, positioning the new company at number 24 in the world semiconductor rankings. It is now Europe's fourth-biggest semiconductor company. In its domestic market of Europe the company's combined 1991 sales would be $391 million, positioning it as tenth-largest supplier in Europe. Table 1 gives the revised European market share ranking table for the

FIGURE 1
TEMIC Organization and Semiconductor Group



* As from November 1, 1992, Telefunken electronic will become TEMIC-Telefunken microelectronic GmbH.
Source: Dataquest (November 1992)

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top 10 suppliers in Europe, based on Dataquest's market share estimates for 1991.

From an operational standpoint the division has already merged its worldwide sales force. The principle it has used is based on the regional strength of the five companies' operations; for example, the ex-Siliconix sales force in the United States now markets the entire company's products there. Similarly, Matra-MHS manages France, Telefunken manages Germany, and so on.

From a technology and product perspective the five companies have a good contrast of expertise—as such, the intent is to have centers of excellence. So, Telefunken will lead the development of analog/RF products; MHS will concentrate on VLSI components; Eurosil on low-power digital functions; Siliconix on power processes; and Dialog and Telefunken will combine on mixed signal developments.

Table 2 shows Dataquest's estimates of the companies' combined 1991 worldwide revenue, and illustrates the revenue and expertise contribution each is bringing to the new venture.

TABLE 1
European 1991 Total Semiconductor Market Share Ranking (Including TEMIC)

1991 Rank	Company	1991 Sales ($M)
1	Philips Components	1,144
2	Siemens	970
3	SGS-Thomson	855
4	Motorola	776
5	Intel	765
6	Texas Instruments	632
7	Toshiba	441
8	NEC	405
9	National Semiconductor	400
10	**TEMIC**	**391**
	Total All Companies	$11,014

Source: Dataquest (November 1992 Estimates)

DATAQUEST PERSPECTIVE

Complementary Strengths

The combination of the five companies gives a whole which should be greater than the sum of its parts. Daimler-Benz's semiconductor acquisitions have clearly been strategic, as the products supplied by these companies fit in well with the equipment manufactured by Daimler-Benz. The semiconductor group will have ready access to the latest systems developments in the group's automotive, aerospace and defense operations. There is a danger that the newly formed division will become too dependent on the parent for orders, and to counter this Daimler-Benz has stated that only 20 percent

TABLE 2
TEMIC Semiconductor Group Worldwide 1991 Revenue of Member Companies by Product (Millions of Dollars)

	Dialog	Eurosil	Matra-MHS	Siliconix	Telefunken	Total	Percent of Total
Total Semiconductor	$20	$29	$104	$140	$300	$593	100.0%
Total Integrated	$20	$29	$104	$64	$137	$354	59.7%
Bipolar Digital	0	0	0	0	7	7	1.2%
MOS Digital	0	22	99	0	12	133	22.4%
Memory	0	1	35	0	0	36	6.1%
Microcomponent	0	0	37	0	0	37	6.2%
Logic	0	21	27	0	12	60	10.1%
Analog	20	7	5	64	118	214	36.1%
Discrete	$0	$0	$0	$76	$89	$165	27.8%
Optoelectronic	$0	$0	$0	$0	$74	$74	12.5%

Source: Dataquest (November 1992 Estimates)

of the output of the new company will be supplied to the parent by the middle of the decade.

In the end the overall success of the new semiconductor group will depend on how successful the equipment divisions are in their respective markets. There is very little doubt that the automotive sector is well-positioned, but there is a danger that automotive, which represents 4.5 percent of the total available market, is not adequate in size and volume to justify the required investment in services and parts. The new group needs to develop vertical integration where the Daimler-Benz group is weak—in telecoms, EDP and consumer electronics. This could easily be achieved by extending the ongoing relationship between Daimler-Benz and Mitsubishi.

Matra-MHS's main area of expertise is in memory and microcomponents, specifically SRAMs and microcontrollers. Telefunken has most of its revenue in analog, discrete and optoelectronic products, largely focused in Europe. Siliconix has significant expertise in power ICs and smart power, and is mainly focused in the United States. Dialog is one of the leading suppliers of mixed signal ASICs into Europe, and Eurosil has expertise in low-voltage CMOS devices.

Matra-MHS has a great deal of expertise in both defense and aerospace applications, and the reliability and harsh conditioning these applications areas demand will be very suitable for underbonnet automotive applications. The outlook for military and defense markets is weak, as peace breaks out in the world, and military budgets are reduced, so Matra-MHS will have to turn more towards other applications if the growth of the company is to be maintained. However, Matra-MHS is one of the few space-approved suppliers in Europe, and its major contribution to the parent will be its space expertise.

Telefunken has a significant presence in consumer products, and this is apparent from its focus on analog, discrete and optoelectronic products. However, the outlook for this market is more optimistic than for the military market. Telefunken's contribution to the new company will be its knowledge of high-volume, low-cost manufacture, gained in consumer markets.

Siliconix's strength lies in its power transistor expertise. This will position the company well in the rapidly growing automotive sector, where the demand for smart power applications is showing high growth. This expertise will contribute significantly to Daimler-Benz requirements in its automotive applications, particularly in high-end products.

Eurosil and Dialog are perhaps the companies which fit least well into the parent company's strategy, but the high-performance mixed signal ASICs designed by Dialog find many applications in the automotive sector. The design knowledge which lies within the company can therefore be put to good use. It is when the future is considered that the inclusion of Dialog and Eurosil makes sense. Daimler-Benz has insisted that the new company will not depend completely on the parent for orders, so the new operation will have to compete in the open market.

A major applications area in Europe is in telecoms, and both Dialog and Eurosil can make a significant contribution here. The low-power expertise in Eurosil will prove to be tremendously useful in portable applications, and the mixed signal expertise of Dialog will also be valuable in telecoms applications. The emerging GSM and CT2 markets for consumer-based wireless telecom products will utilize the consumer manufacturing expertise available in Telefunken. It is thus in the telecoms market that the commercial success of the new venture lies.

Semiconductor End Applications

Table 3 shows the split by application for each of the TEMIC semiconductor companies. The applications analysis shows that more than 65 percent of combined sales is in the industrial, consumer and communications segments. This is a clear reflection of the dominance of Telefunken's sales on TEMIC's semiconductor business.

Figure 2 shows the end-application splits for the whole of the TEMIC semiconductor companies during 1991. Dataquest's perception of the TEMIC semiconductor application profile by 1996 shows substantial changes, with transportation growing to 20 percent, communications to 25 percent and consumer up to 25 percent. The industrial segment will decline to 15 percent from the present 21 percent. The reduced dependency on military/aerospace and TEMIC's limited product range to service the EDP sector will see these two sectors together accounting for only 15 percent of sales. The change in application split between 1991 and 1996 highlights TEMIC's strategy to focus on consumer and communications equipment markets. Dataquest believes the fragmented structure of the industrial segment makes it difficult to forecast and forge strategic product developments. It is therefore unlikely that TEMIC would invest its resources (research and development, marketing, etc.) in this segment, thus

TABLE 3
TEMIC Semiconductor Group
Worldwide 1991 Revenue of Member Companies by Application
(Millions of Dollars)

	Dialog	Eurosil	Matra-MHS	Siliconix	Telefunken	Total	Percent of Total
Electronic Data Processing	0	0	27	45	6	78	13.2%
Communications	7	3	30	15	60	115	19.4%
Industrial	6	8	9	37	63	123	20.7%
Consumer	2	18	0	4	120	144	24.3%
Military/Civil Aerospace	0	0	31	35	0	66	11.1%
Transportation	5	0	7	4	51	67	11.3%
Total	$20	$29	$104	$140	$300	$593	100.0%

Source: Dataquest (November 1992 Estimates)

accounting for the decline in importance of the industrial segment.

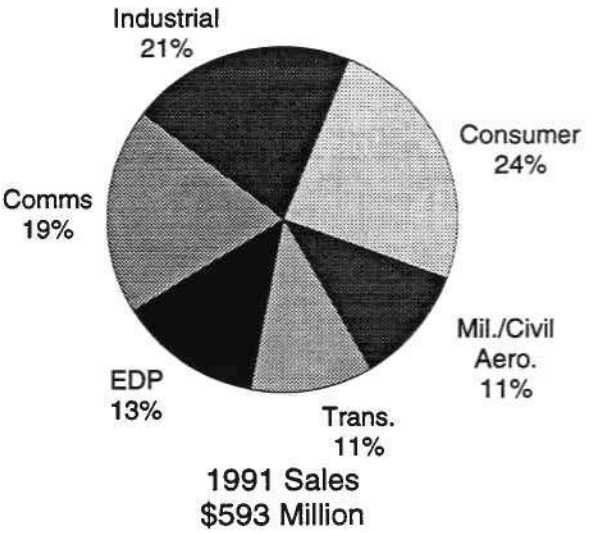
TEMIC's strongest growth will be in the transportation segment, which will account for a fifth of its semiconductor sales worldwide. In addition to the influence of its parent company Daimler-Benz, synergies within the TEMIC group also exist (for example, the Automotive Equipment division).

One of the reasons behind the consolidation by Daimler-Benz of its component operations will be related to the combined losses some of the individual companies are currently making. These losses are estimated at about $60 million for 1992, but the new company expects to be profitable by 1996.

The grouping of the companies may also be related to Daimler-Benz attempting to focus more on its core business, and keep peripheral business separate. The concern for the new company could be cultural differences between the members. This has shown to be an important consideration in the success or failure of other larger multinational mergers. The most successful have been those which have exhibited a strong strategic direction.

Mike Glennon
David Moorhouse
Mike Williams

FIGURE 2
TEMIC Semiconductor Group
Sales by End Application



Source: Dataquest (November 1992 Estimates)

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Research Newsletter

WHITE GOODS MANUFACTURING IN EUROPE

INTRODUCTION

Dataquest defines the white goods manufacturing industry in Europe to include five segments namely: cooking appliances (grills, hobs and ranges); microwave ovens (including fitted oven units); refrigerators and freezers (or combinations); dishwashers; and laundry appliances (washing machines and drying machines). Overall during 1991 the largest segment was refrigeration equipment representing 31 percent of the overall white goods unit production, closely followed by cooking appliances at 29 percent, laundry appliances at 18 percent, microwave ovens at 16 percent, and dishwashers the remainder at 6 percent.

This newsletter is a summary of the results obtained from an extensive research of white goods production in Europe. It provides an insight to developments in the industry and the emerging potential for electronics in the white goods equipment sector. Our research covered 80 percent of total unit production for white goods equipment in Europe and provides an estimate of semiconductor purchasing volume for this application.

METHODOLOGY

Dataquest conducted a research survey during the first six months of this year to assess and analyse the level of white goods equipment production in Europe. We contacted a total of 66 company locations, each company with responsibility for one or several other locations.

We also collated data from the various trade associations in Europe including FEI (Fachverband der Elektro-und Elektronik Industrie) in Austria; SB (Statistisches Bundesamt) in Germany; ANIE (Associazione Nazionale Industrie Elettrotecniche ed Elettroniche) in Italy; and AMDEA (Association of Manufacturers of Domestic Electrical Appliances) in the United Kingdom.

For each appliance segment we derived a total European production estimate by utilizing data from trade associations and industry associations. We also qualified this data with the results of the research survey. The further analysis by company was derived from research material gathered over the last financial year.

SUMMARY OF 1991 EUROPEAN PRODUCTION

Total European white goods production for 1991 is estimated at 48.9 million units. This is divided into segments as shown in Table 1.

Refrigeration Appliances

With 15 million units produced in 1991, refrigeration appliances account for the largest proportion of white goods produced in Europe. Our research sample accounted for 75 percent of total European unit production. The bigger white goods companies dominate this segment (Figure 1).

TABLE 1
White Goods Production by Segment, 1991 (Millions of Units)

Segment	Units (M)
Fridge/Freezers	15.0
Cooking Appliances	14.0
Laundry	8.8
Microwave Ovens	7.8
Dishwashers	3.3
Total Production	48.9

Source: Dataquest (July 1992 Estimates)

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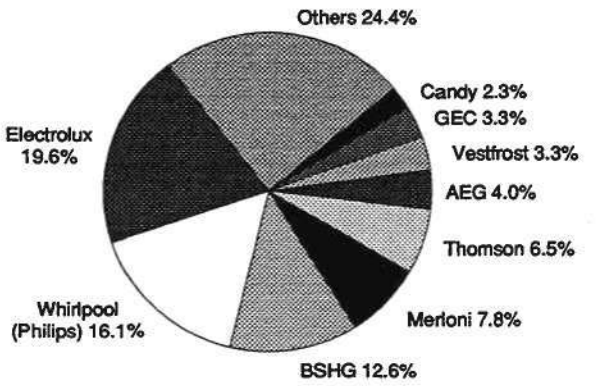
FIGURE 1
Refrigeration Appliances Manufacturing* in Europe



* Includes fridges, freezers and combos
Source: Dataquest (July 1992 Estimates)

Nearly 50 percent of refrigeration appliances are produced by only three companies:

- Electrolux, 19.6 percent
- Whirlpool (Philips), 16.1 percent
- BSHG (Bosch-Siemens Hausgeräte GmbH), 12.6 percent

More than 40 percent of refrigeration appliances production is made in Italy.

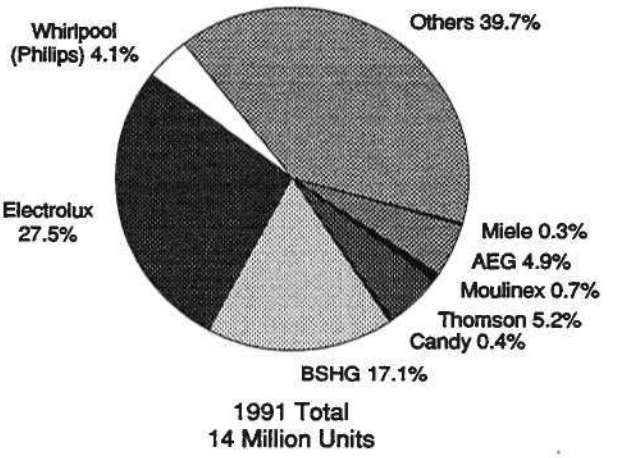
Cooking Appliances

For this segment, total European production of cooking appliances amounted to 14 million units during 1991. The industry is supported by a large number of companies. This is largely due to the fact that capital investment for building factories in this segment is much smaller compared with other white goods product segments. Electrolux and BSHG emerge as the major players in this area (Figure 2).

Laundry Appliances

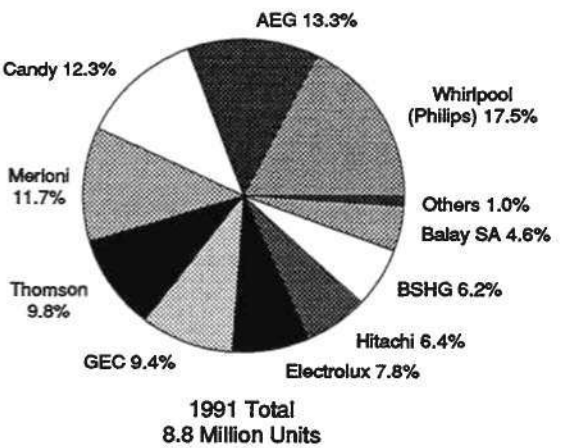
Laundry appliance production is shared 60 percent between five companies: Whirlpool (Philips), AEG Hausgeräte, Candy, Merloni, and Thomson (Figure 3). In total, there are 11 major companies manufacturing laundry appliances in Europe. Our research sample indicates that we covered 99 percent of overall European production in this segment. The end equipment market is not fully saturated here as we believe a potential gap still exists in the dryer market. Statistics from European trade associations indicate that only 20 percent of all European households have tumble dryers.

FIGURE 2
Cooking Appliances Manufacturing* in Europe



* Includes grills, hobs and ranges
Source: Dataquest (July 1992 Estimates)

FIGURE 3
Laundry Appliances Manufacturing* in Europe



*Includes washers, dryers and combos
Source: Dataquest (July 1992 Estimates)

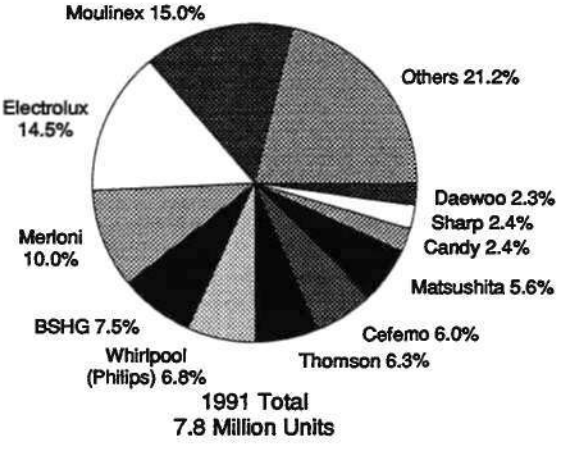
Microwave Ovens

Moulinex, the French electronic appliance manufacturer is the leading manufacturer in this segment and accounts for 15 percent of European production (Figure 4). On average, French households own more microwave ovens than the European average. An estimated 34 percent of French people own microwave ovens, whereas the average European rate is 20 percent. The second leading manufacturer in Europe is Electrolux. Microwaves are still considered relatively new products in the white goods industry and there is plenty of room for new players. BSHG and Miele are the only two major German companies in this area. Most of the UK production of this product comes from its Japanese transplants.

Dishwashers

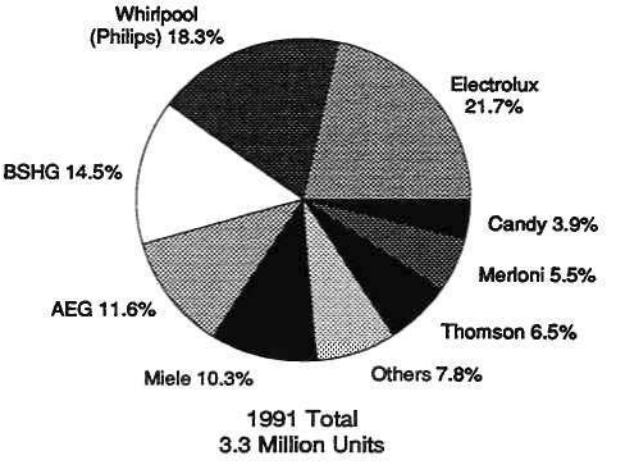
Dishwashers are still a relatively new product in the European market. In this product area only five companies dominate with more than 75 percent of total European dishwasher production (Figure 5). These companies can be divided into two distinct groups. The first group is made up of two of the big three, Electrolux and Whirlpool (Philips), each contributing about 20 percent of the market production; and the second group is largely the major German companies (BSHG, AEG Hausgeräte and Miele), which combined control nearly 40 percent of European production. This segment has the strongest growth potential as European trade statistics show only 20 percent of European households have dishwashers, highlighting the big gap compared with 50 percent of households in the United States owning dishwashers.

FIGURE 4
Microwave Oven Manufacturing* in Europe



*Includes fitted ovens
Source: Dataquest (July 1992 Estimates)

FIGURE 5
Dishwasher Manufacturing in Europe



Source: Dataquest (July 1992 Estimates)

MAJOR PLAYERS

Electrolux, Whirlpool (the former Philips white goods division), and BSHG contribute an estimated 42 percent of overall European white goods manufacturing. In broader terms, however, the white goods producer base is largely shared between 15 significant companies; these in turn control an estimated total of 250 individual factories dotted over most European countries (Table 2).

The divergence in the spread of the major manufacturers is largely attributed to the special characteristics of the industry (including, for instance, varied eating, cooking, and washing habits) throughout Europe. Owing to the high costs of transporting bulky and heavy white goods equipment, the net result subsequently has been a large number of factories, with differently designed products specially to cater for each region. For example, the temperatures at which clothes are commonly washed in Spain, France and Germany vary widely; also microwaves have turntables in France and United Kingdom but not in Germany. In summary, the diversities are reflected in the number of manufacturers.

TABLE 2
Estimates 1991 Unit Production
(Thousands of Units)

Company	Dishwashers	Cooking Appliances	Microwave Ovens	Refrigeration Appliances	Laundry Appliances	Total
Electrolux	715	3,853	1,157	2,942	623	9,290
BSHG	480	2,398	598	1,895	490	5,861
Whirlpool (Philips)	603	579	543	2,416	1,389	5,530
Thomson Electromenager	214	734	500	975	780	3,203
Merloni	180	-	800	1,170	930	3,080
AEG	382	685	-	593	1,061	2,721
Candy	130	50	190	350	975	1,695
Miele	340	40	105	-	843	1,328
Moulinex	-	100	1,200	-	-	1,300
GEC	-	-	-	500	750	1,250
Balay SA	54	85	170	-	367	676
Hoover	48	-	-	-	510	558
Vestfrost	-	-	-	500	-	500
Cefemo	-	-	480	-	-	480
Matsushita	-	-	450	-	-	450
Goldstar	-	-	250	-	-	250
SA des Usines de Rosieres	-	170	40	-	-	210
Sharp	-	-	190	-	-	190
Daewoo Electronics	-	-	180	-	-	180
Sanyo	-	-	130	-	-	130
Samsung Electronics	-	-	100	-	-	100
Others	154	5,306	717	3,659	82	9,918
Total Production in Europe	3,300	14,000	7,800	15,000	8,800	48,900

Source: Dataquest (July 1992 Estimates)

We found, though, that the manufacturing base for cooker hobs is much more fragmented as essentially there is no major feature with this type of equipment (particularly gas) that could influence its end market. However, the industry is undergoing constant change due to several large takeover bids; for example, Electrolux has acquired Zanussi, Whirlpool has acquired Philips, and Candy has acquired MAYC and MEM (see the section on major white goods companies). Dataquest believes that this trend may mean the fragmented European white goods industry could ultimately consolidate to a few major companies as is the case in the United States and in Japan.

The major players by segment in 1991 are summarized in Table 3. Clearly, Electrolux and Whirlpool (Philips) are the top two major European manufacturers overall. There is increasing industry speculation that the European white goods market is about to see some changes. German manufacturers are believed to be considering some form of merger to reduce their high costs of materials procurement.

Far Eastern companies do not feature in these rankings, but we would not discount any major investments by the end of this year, as there is clearly sufficient room in this area for a new player to revitalize the European industry. Philips sold its white goods division to the US company Whirlpool last year and we believe that at least one more such major investment is possible from a Far Eastern company like Matsushita, or another US company.

TABLE 3
Major Players by Segment in 1991

Segment	Company
Fridge/Freezers	1. Electrolux
	2. Whirlpool (Philips)
	3. BSHG
Cooking Appliances	1. Electrolux
	2. BSHG
	3. Thomson Electromenager
Laundry	1. Whirlpool (Philips)
	2. AEG Hausgeräte
	3. Candy
Microwave/Ovens	1. Moulinex
	2. Electrolux
	3. Merloni
Dishwashers	1. Electrolux
	2. Whirlpool (Philips)
	3. BSHG

Source: Dataquest (July 1992 Estimates)

EUROPEAN MANUFACTURING PROFILE

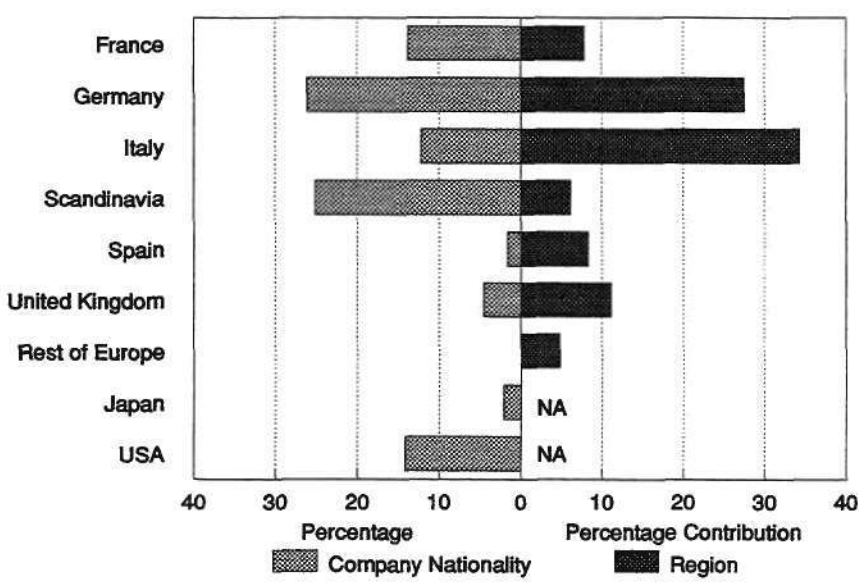
The underlying nature of the European manufacturing industry is the contrast between each country's white goods production and the proportion of European production by country of origin.

Figure 6 shows that most companies do not produce solely in their country of origin. The reasons behind the spread location of white goods plants are largely to do with the cost of freight and transport of finished goods to the markets.

The right hand side of the figure shows each country's production of white goods in Europe, and on the left hand side is European production of white goods by each company's nationality. This illustrates the profile of European white goods manufacturing, showing the larger companies have a wider spread of manufacturing activity compared with, for example, potentially large German companies, which have a significant impact only in Germany but much less importance across Europe.

A pattern that emerges from our research shows that a large proportion of companies have been attracted to countries such as Italy, Spain and the United Kingdom for a number of reasons. The attraction to Italy and Spain is largely attributed to cheap labor costs. In the United Kingdom, however, lower taxes and government incentives for inward investments have affected this pattern.

FIGURE 6
White Goods Production in Europe, 1991 by Country Nationality and Region



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

As a result, Far Eastern (particularly Japanese) manufacturers have been attracted to the United Kingdom and in recent years, there has been an influx of Japanese companies including Daewoo, Hitachi, Matsushita, Toshiba and Sanyo.

Owing to climatic conditions, Italy itself has always been a strong producer of refrigeration and laundry equipment and has now developed a large local industry. Many of these Italian factories were bought by companies such as Electrolux which have, through a series of acquisitions, gained a foothold in Italy. The Spanish industry has largely been involved in manufacturing cooking appliances and laundry equipment.

While the Scandinavian white goods company Electrolux produces only 25 percent of its total European production in Scandinavia, German white goods companies tend to produce nearly all their products from their own local factories. Thus, German brands have less of a market presence outside of Germany compared with other major companies like Electrolux, Whirlpool (Philips), and so on. Although there is significant Scandinavian control in this industry, with Scandinavian white goods manufacturing well dispersed among other European countries. The experience and flexibility gained by these companies allow them to be more competitive in the European marketplace.

MAJOR WHITE GOODS COMPANIES

Table 4 shows manufacturing activity in Europe by white goods manufacturers.

TABLE 4
European White Goods Manufacturing Activity

Company	Board Assembly	Board Test	Assembly/Complete Manufacture	Source if Using Subassembled Components (optional)
Balay SA			✓	Spain and France
AEG Hausgeräte			✓	
BSHG			✓	
Braun	✓	✓	✓	
Candy			✓	Italy
Cefemo	✓	✓	✓	USA (some parts)
Daewoo				
Electrolux	✓	✓	✓	Italy
Goldstar			✓	
GEC	✓	✓	✓	
Hitachi				Japan
Hoover	✓	✓	✓	France (some parts)
Matsushita			✓	
Merloni	✓	✓	✓	Italy, Germany
Miele	✓	✓	✓	
Philips			✓	
SA des Usines de Rosieres	✓	✓	✓	
Samsung			✓	Korea
Sharp			✓	Japan
Sanyo			✓	
Moulinex	✓	✓		France
Toshiba	✓	✓		
Vestfrost			✓	Various countries
Whirlpool (Philips)			✓	

Source: Dataquest (July 1992)

Electrolux

Although Electrolux is a Swedish company, the majority of its manufacturing base is outside Sweden. Household appliances account for more than half of the Electrolux group's total sales.

A large number of acquisitions mainly during the second half of the 1980s has enabled Electrolux to attain a leading position in the white goods markets throughout the world. At the beginning of the 1990s Electrolux initiated a restructuring program which led to the closing down of 10 large plants as well as personnel reductions of about 15,000. The number of employees is 136,000, with nearly 47,500 employed for the European market.

Demand in most of the Electrolux product areas has been substantially lower in 1991 despite a substantial final-quarter improvement. However, Electrolux is still the European leader in the white goods market with 19 percent of market share. The Swedish multinational launched a new $100 million pan-European marketing campaign to promote its range of white goods to the upper mass market.

Electrolux owns the Zanussi, Tricity, Bendix, Juno, Zanker, Frigidaire, Corbero, Domar and Lehel brand names. Electrolux is opting to maintain local brands alongside its pan-European ones. Electrolux has 40 European plant locations.

BSHG

BSHG (Bosch-Siemens Hausgeräte GmbH) is the second-biggest European producer of white goods in unit production terms. This company is jointly owned by Siemens AG and Robert Bosch GmbH (both German electronics companies), with the share capital divided equally. Within the European manufacturing industry, BSHG contributes 12 percent of overall white goods production (in units) with its product range of refrigeration equipment, laundry equipment and dishwashers.

BSHG owns Pitsos SA in Athens, as well as Balay SA in Zaragoza and the Safel Group in Pamplona (both Spain). All of BSHG's white goods production comes from its 7 plants in Germany.

Whirlpool (Philips)

Whirlpool, which is the largest US white goods producer, entered the European market through its acquisition of the white goods division of Philips. Whirlpool's European goal is to create flexible factories producing a large number of units in small differentiated batches. Whirlpool is spending heavily to establish its own name in Europe because under the terms of its acquisition, it may only use the Philips brand name until 1998. To establish its own brand in Europe it has added $110 million to Whirlpool International's existing advertising budget and launched a pan-European marketing campaign.

Whirlpool has entered the Eastern European white goods market by creating a wholly owned Hungarian subsidiary to sell and service its products.

With 11.3 percent of the European white goods market, Whirlpool (Philips) is the third leading producer in Europe. Two new European sales units have been created, one for the upmarket Bauknecht brand; the other for dual-branded Whirlpool (Philips) products, plus the Ignis and Laden brands.

Thomson Electromenager (TEM)

Thomson is fourth in the European white goods manufacturer league with 6.6 percent of the European production. It has a strong image in France and holds a big slice of the French white goods market, nearly 30 percent. It is trying to become more involved in the European market.

Thomson owns Brandt, Vedette, Thumor and Saute, as well as having 50 percent of de Dietrich. Industry sources believe that TEM may be up for sale by the Thomson Group to help finance its electronics sector; a potential buyer could be General Electric of the United States.

Merloni

Merloni holds fifth place in the European white goods manufacturer base with 6.3 percent of total European unit production. The company has expanded rapidly in recent years through acquisitions. In previous years, it suffered from overcapacity in this industry and was burdened by its heavy borrowing used to finance its growth.

Merloni owns companies such as Ariston, Indesit and Colston. It is a family-owned company (like many others in Italy). Merloni holds more than 10 percent of total European production including the following products: microwave ovens, refrigeration appliances, and laundry appliances. The company's product portfolio does not include any cooking appliances.

AEG Hausgeräte

Dataquest estimates AEG Hausgeräte manufactures 5.8 percent of total output of the European white goods manufacturing industry. AEG Hausgeräte is a subsidiary of Germany's Daimler-Benz group and has been contemplating closer cooperation with either the Swedish giant Electrolux or with German white goods producer BSHG in recent years. This has been accelerated by recent financial problems, particularly from its AEG Olympia Office subsidiary.

AEG's white goods operations account for about a fifth of its total sales. AEG's business portfolio includes rail, electricity and automation equipment.

Candy

Candy is the seventh-largest producer of white goods in Europe, and produces 3.5 percent of the European white goods. The company and its subsidiaries are planning to spearhead a major push throughout Europe and to strengthen its position in white goods market. It owns two Spanish domestic appliance makers, MAYC and MEM. Like Merloni, Candy is a privately owned Italian white goods company.

Candy produces mainly laundry appliances and holds more than 11 percent of the European production, making it the third-largest European supplier in this segment.

Miele

Miele, the German white goods manufacturer, is the eighth-largest producer of white goods in Europe. It holds 2.8 percent of the European market, and produces white goods for the upper end of the market.

Miele mainly specializes in the manufacture of dishwashers and laundry appliances, and has nearly 10 percent contribution to overall European production in both of these product segments. Miele has carved itself into the high-end segment of the European market. In Germany, Miele products extend from laundry equipment through to vacuum cleaners.

ESTIMATED 1991 SEMICONDUCTOR PROCUREMENT

Of the 22 companies surveyed, 12 revealed significant levels of semiconductor procurement. Their combined spend totalled $18 million in 1991. We estimate these 12 companies account for 36 percent of total European white goods production. These companies indicated that they planned to increase their semiconductor purchases to $22 million this year.

Although semiconductors are not commonly used in most kitchen appliances, the high end of the white goods market is supplied with sophisticated cooking appliances that use microcontrollers for various cooking methods. Laundry appliances are also beginning to use more electronics in programming. Microcontroller ICs are used to program wash cycles in relation to different load weights. The algorithms are endless and there is enough room for fuzzy logic implementation in this area. Microwave oven chip sets are believed to be shipped from Far Eastern suppliers, but some optoelectronic and sensor parts are procured locally.

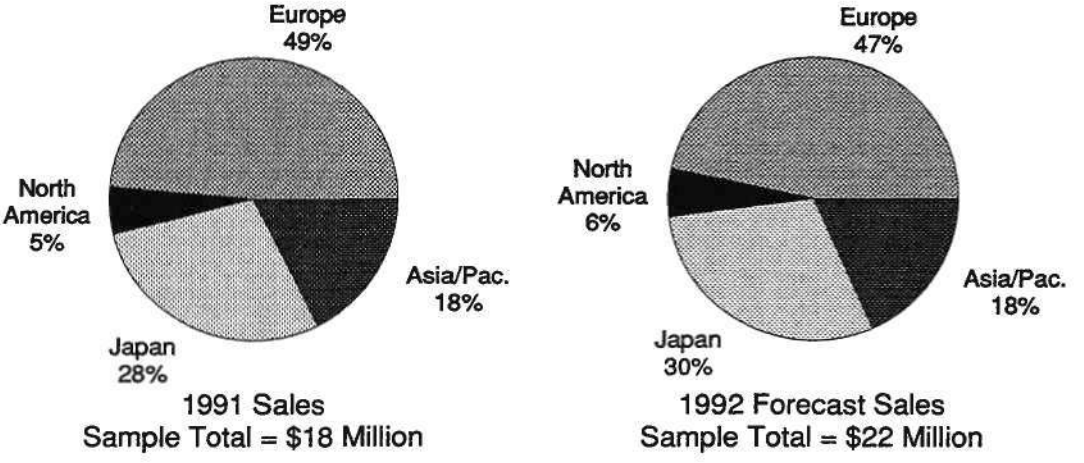
Figure 7 shows the percentage of semiconductor sales by semiconductor vendor country of origin. Far Eastern manufacturers supply nearly half of the industry's requirement, and our research shows that this trend is likely to intensify this year. Dataquest believes that Far Eastern semiconductor vendors have more products to cater for this industry than US or European vendors. Already this leadership is clear in the microwave oven business, and we believe also in rice cookers and other cooking and laundry appliances.

WHITE GOODS PRODUCTION OUTLOOK FOR 1992

This year, production of white goods in Europe is forecast to increase by 5.9 percent to 51.5 million units, from 48.9 million in 1991. The underlying trend is that while laundry appliances seem to have reached maturity and near market saturation, dishwasher appliances and microwave appliances still have sufficient room for market growth.

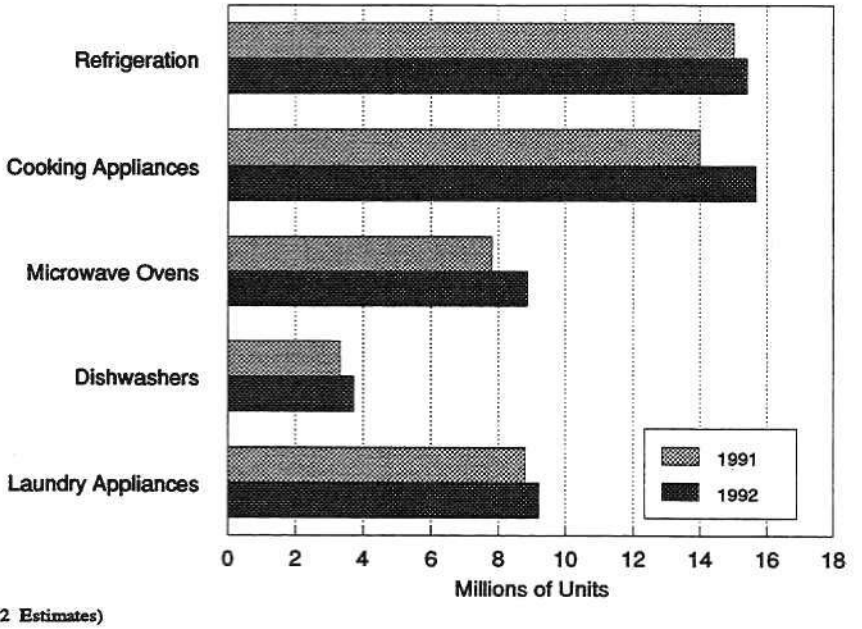
Figure 8 shows the 1991 and 1992 production forecast of white goods by equipment type. Dishwasher production clearly accounts for the smallest white goods segment in Europe, but it is one of the fastest-growing segments, as it still has ample room before it reaches maturity in Europe.

FIGURE 7
White Goods Semiconductor Sales by Semiconductor Vendor Country of Origin



Source: Dataquest (July 1992 Estimates)

FIGURE 8
European White Goods Production and Forecast by Type of Equipment



Source: Dataquest (July 1992 Estimates)

CONCLUSION

The future of the European white goods industry is likely to form similar characteristics to those of both the United States and Japan, where a small number of major companies dominate the local industry. The removal of trade barriers among EC member countries has accelerated the consolidation process. Since the mid-1980s, many European white goods manufacturers have embarked on mergers and acquisitions as a means of strengthening their local bases. Electrolux is one such company which has been through this process very fastidiously. Whirlpool has also emerged as a leading force in the European white goods industry with its acquisition of the Philips consumer division. What remains for these industry leaders is to devise a winning formula to survive the borderless European markets.

The real question, though, is whether their products need innovation or whether the industry should be innovated. Innovation will bring a standardized product for the European markets but an industrial innovation may result in the closure of more plants along with the construction of hyper-factories. Many other issues surround the culture of design and manufacture in each country. These issues are now being reviewed and most companies have began devising their strategy for the new European markets. The biggest issue facing most appliance manufacturers remains whether they will start designing standardized products for the single market. The white goods industry is moving into a new era with increasingly high-technology applications. Companies that survive will be the ones that have the right solution to cater for the newly formed EC markets.

Market barriers are disappearing, not only in Europe but also globally. Design functions will become more sophisticated as electronics technology employed for these products begins to increase. Far Eastern companies have not yet entered all segments of European white goods manufacturing. Although we acknowledge that Japanese companies have some capacity for microwave production, we believe they will need to further increase their capacity to meet local market demands. Dataquest believes that the leading Japanese white goods manufacturers (such as Matsushita, Toshiba or Hitachi) will begin to seek local partners or acquire an existing player to gain entry in this region.

Mike Williams
Jean-Louis Fréart

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Research *Newsletter*

VIDEOPHONES

This is the fourth of four newsletters giving reports on Dataquest's eleventh annual semiconductor conference. The conference took place between June 3 and 5 at the Jurys Hotel, Dublin, Ireland. It was chaired by Bipin Parmar, Director of the European Semiconductor Group (ESG) at Dataquest. This speech by Jeffrey Goldberg, an Industry Analyst with Dataquest's European Document Management Group, was given during the session entitled "Emerging Applications and Technologies." The full text is reproduced here for the benefit of those clients who could not attend the conference. Copies of the slides shown follow the text.

Today TV, cinema and video dominate the media. They give us colorful, moving images to try to convince us to buy washing powder while politicians try to convince us to vote for them.

Yet, the main means of business communications is the telephone, which only uses sound and, if you are lucky, fax, which uses only still, black-and-white images. Today we are going to look at how the telecoms companies are trying to put moving images down a phone system made only for sending audio across the world.

SLIDE 1—WHAT IS VIDEOTELEPHONY?

But first, what is videotelephony? For the sake of simplicity we are going to divide it into three categories:

- Videophones
- PC videophones
- Videoconferencing

Videoconferencing is happening now: a room set up for videoconferencing or a floor-standing machine. These typically use proprietary protocols linked sometimes by private lines.

At the other end of the spectrum are videophones, which are very much like an ordinary phone but with a camera and a screen so that you can see the person on the other end.

In between these are PC videophones that are add-in boards to a personal computer which with a camera allow a PC to be a videophone. The person at the other end is shown in a small window overlaying the current task. The addition of a PC allows a great deal of flexibility such as the sending of spreadsheets and the ability to see more than one caller simultaneously,

Today we can't cover every sector of the market so we are going to concentrate on the high-volume end of the market rather than the high-cost, low-volume, videoconferencing end.

SLIDE 2—WHO WANTS IT?

So who wants it? Videophones are an easy sell. As I am speaking, you are concerned both with the sound coming out of my mouth and the nonverbal communication such as a raised eyebrow or a ruffle of the hair. Indeed, research tells us that over 60 percent of the message comes through nonverbal means.

Everyone knows what a phone is. Everyone knows how to use it. We even have a universal symbol for one. The phone is a familiar object to everyone in Europe. And everyone knows of the problems with a telephone. You cannot see the person at the other end. Video is an obvious extension. This is probably best summed up by the adverts AT&T have in the United States where two doting grandparents are shown gazing longingly at the screen of a videophone watching their young grandchildren. It is this sort of parental pressure that will sell videophones.

But it is not only residential users who will buy such a product as there are clear cost savings

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for business users. No longer will you have to fly to the United States for a meeting if you can see the people on the videophone or videoconferencing device. This has been the main selling point for videoconferencing and anyone who has used it will vouch that it is better than taking the red-eye across the United States.

SLIDE 3—TECHNOLOGY

So if everyone wants it why doesn't it exist today? The problem is bandwidth. An audio signal for the phone takes 3 kHz of bandwidth whereas a TV picture takes 6 MHz. That means a difference of several orders of magnitude. And the problem is that the phone companies have a whole infrastructure devoted to taking 3 kHz around the world. So you need to squeeze 6 MHz into 3 kHz—no easy task. The usual way to do this is to compress the image in some way. Typically, this would involve only sending the changes in the picture and slowing down the refresh rate to only send the changes when they are needed.

SLIDE 4—STANDARDS

But there is another reason why the videophone revolution has not happened—standards. In the telecoms industry these are incredibly important, after all nobody is going to buy a phone if they cannot speak to anyone? So for the videophone to succeed a worldwide standard must be in place. The CCITT, the telecoms standards body, took a long time to have a standard in this area partly because of immaturity and partly because of the huge technical task.

It eventually did it in 1991 when most of the videophone standards were ratified. The most important one, and the one you are likely to hear of most, is the one related to video compression: H.261 sometimes called Px64. Unfortunately, already companies have come up with better compression algorithms that give better pictures over the same bandwidth.

SLIDE 5—ANALOG VERSUS DIGITAL

The other problem with H.261 is that it requires a digital connection to the phone system—ISDN for those who know. This is not what most people have; instead, they have an analog connection to the phone system or PSTN. ISDN is not in widespread use across the world because most people cannot get hold of it. In telecoms terms the coverage is small.

The cost of ISDN is high too, both in equipment and line rental terms. In the United Kingdom, ISDN is about four times more expensive than the PSTN in terms of initial line connection and rental charges. The call costs, except for some international calls, are the same. The equipment costs are much more expensive, for example an analog phone will cost about $1,000 to $1,500, while the current ISDN videophones cost $5,000 to $7,000.

SLIDE 6—QUALITY

So if few people could get ISDN and it cost a huge amount more, why did the CCITT and others push for it. Well, it is to do with quality:

- VGA (640 pixels by 480 lines), a standard computer screen display
- CIF (352 pixels by 288 lines), typical videoconferencing display
- QCIF (176 pixels by 144 lines), typical digital videophone display
- Analog (128 pixels by 96 lines), typical analog videophone

Doesn't the analog videophone look terrible?

SLIDE 7—A VIDEOPHONE IS ...

So what is inside a videophone? Your face is filmed by a CCD camera whose output is then fed into an A/D which goes into the video CODEC. This compresses the picture and sends it to the line interface. A similar thing happens to the audio. These are combined and sent as sounds down an analog line via a modem, while they are kept separate when sent through an ISDN line interface.

At the other end the line interface or modem receives the sounds from the line and parcels it to the codes. The video CODEC decompresses the image and sends it to a color LCD screen if it is a videophone or becomes an overlay into VGA memory for a PC videophone. The audio gets decompressed and comes out of a speaker. An MCU controls the videophone and grabs user input.

The only new part of the videophone from a semiconductor view is the CODEC, so we will look a bit further into that.

SLIDE 8—H.261 VIDEO CODEC

To give you an idea of what the encoding does, here is a list of the six stages of video encoding:

- Discrete cosine transform (DCT)—is where a frame is subdivided into blocks of 8 × 8 pixels and converted into values that represent the spatial frequencies.
- Motion estimation and compensation—is where adjacent frames are compared to identify moving patterns. These movements are transmitted as displacements of pixel blocks between frames, as opposed to fully reconstructing each block in each frame.
- Quantization—is the technique used to represent the DCT values as a small number of discrete integer values. This minimizes the amount of data that must be transmitted to describe them.
- Loop filtering—is a simple, low-pass digital filter that removes unwanted edges which are a byproduct of interframe compression.
- Variable length coding/decoding—is the process of converting the quantized DCT coefficients into a serial bit stream.
- Error correction—a BCH error correction is used with the serial bit stream to permit detection and correction of errors on reception by the receiving videophone.

SLIDE 9—IMPLEMENTATION OF VIDEO CODEC

The current videophones typically implement the CODEC using 16-bit DSPs such as Texas Instrument's 320C30 or the Motorola 56 family. This is because the standards were still flexible at the time of design and companies still want to update their proprietary algorithms.

But videophones need to be cheap and using DSPs will always give as low a cost as hardwired ICs for this task. We are already seeing this happen as companies such as LSI Logic bring out chip sets to support videotelephony.

As well as these core chips, a number of other peripheral chips are also required, such as 2 Mbits of memory and at least 256K of fast FIFO plus the usual array of glue logic.

SLIDE 10—KEY PLAYERS

Who are the key players in the video telephony game? As a typical example of a Japanese company, I am taking Hitachi. All Japanese electronics companies that have some telecoms interests have programs on videophones. Some still in the labs and some outside. Hitachi is one of those which have launched a videophone in Japan, perhaps the best to date, and has met with some success. It also has the display and camera technology to be a major player in the videophone market in the years to come.

BT, the UK PTO, has been one of the major companies behind most of the videotelephony standards. It participates in all areas from infrastructure, research, through to designing the videophone. It has two major alliances, with IBM for PC videophones over ISDN, and GEC-Marconi on analog videophones.

GEC-Marconi has used its defense expertise and is trying to turn it into a commercial advantage. One of the areas it sees as fruitful is image compression, since it has much expertise in DSPs and so on. It is providing these for the analog videophones shown by BT at the Ideal Home Exhibition and Amstrad (the UK consumer electronics company). It also has several agreements with other, as yet unannounced companies and PTOs.

The AT&T analog videophone in contrast comes from chips developed by Compression Labs Incorporated (CLI) in partnership with ITT. CLI is one of the kings of the videoconferencing arena with PictureTel (which we will discuss later). CLI gets most of its current income from the high end of the videoconferencing arena from its Rembrandt range. It has also penetrated the PC videophone arena with its Cameo product for the Apple Macintosh.

PictureTel, in contrast, dominates the low end of the videoconferencing arena. It has a five-year agreement with Intel on videophone, conferencing and DVI chip sets. PictureTel is providing the compression technology; it has also supplied AT&T with products: the low-end videoconferencing product and probably a PC add-in card. The major reason AT&T took this over CLI is PictureTel's adherence to standards. PictureTel has also allied itself with several other PTOs and large companies of which the most important from the European viewpoint is the alliance with Siemens to produce a videophone matched to Siemens PBXs.

Finally the daddy of them all—AT&T. It produced its first videophone way back in 1964 and

has been passionately in favor of them ever since. It is the first PTO to launch an analog videophone and to have the ability to coerce the market into buying them. It has the structure, research and product design of BT but also the silicon technology that BT has not.

SLIDE 11—DATAQUEST VIEW OF THE VIDEOPHONE MARKET

What do we think of the videophone market? I come from a facsimile background and am one of the industry analysts at Dataquest who covers it. It is interesting to see the contrasts between facsimiles. Let me explain. Back in the early 1980s the Group 3 fax standard that we know and love became ratified. Previously the cost was too high and the quality too low for people to want to buy a fax in big numbers. It was only when the first Group 3 machines appeared in 1984 that fax started to get moving. Yet it took Europe until 1988 to 1989 to really take off in terms of volume and revenue.

In the videophone market we are in a similar position. The standard was agreed last year and the first machines have started to appear which match the standard and can communicate with each other. However, there is still the problem of multiple standards since the analog videophones have not got a standard—the AT&T one cannot talk to the Amstrad one, for example. None of the digital videophones can speak to the analog videophones. So in some ways the position is worse than fax in the early 1980s.

We believe that the screen display on the analog videophones is unacceptable to most consumers and the cost too high. Even if you buy one videophone on the assumption that the person at the other end already has one, then it is still 10 times the cost of an ordinary phone, even at the most generous of estimates. We therefore believe that the analog videophone will not take off in the short term and indeed that is our view of the whole videophone market.

However, when it does take off, as it surely will, there will be strong growth from the sorts of factors mentioned early. For example, from parental pressure of mothers wanting to look at children, grandparents at grandchildren and friends and families split across the world. In this increasing global village, we are becoming more aware of communications and video is a powerful form that people will surely want.

But we don't believe it will be soon. The ISDN infrastructure, quality of picture and costs of equipment will limit the market until the latter half of this century. We believe videophones will happen in the 1995 to 2000 time frame. This might seem strange to some, but I have learnt that the telecoms industry moves far slower than the PC industry.

There is, however, a potential vast market out there. There are about 260 million handsets in Europe connected to the phone system; if only 10 percent of these get transferred into a videophone then that is 26 million, or over five times the installed base of facsimile machines across Europe.

I leave you with this thought: potentially, the videophone market is a vast one, and it is up to you to exploit it.

Jeffrey Goldberg

WHAT IS VIDEO TELEPHONY?

- Videophones
- PC Videophones
- Videoconferencing

WHO WANTS IT?

- 60 percent of message = nonverbal
- Phone familiar object
- Video obvious extension
- Clear cost savings

TECHNOLOGY

- Why does it not exist today?
- Bandwidth, Bandwidth...
- Image compression

STANDARDS

- Why important?
- CCITT H.261
- Problems...

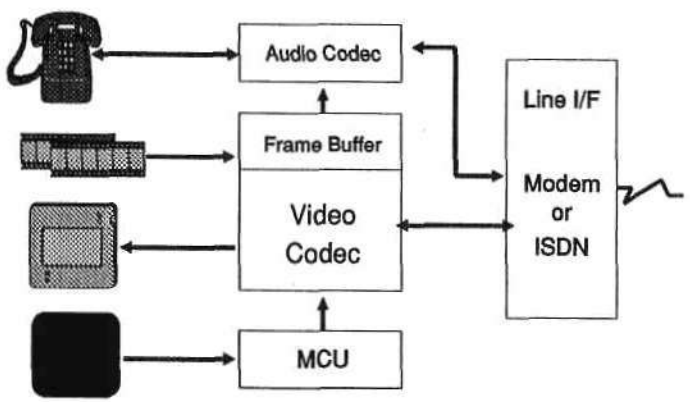
ANALOG VERSUS DIGITAL

- ISDN or PSTN
- Coverage
- Cost
- Quality

QUALITY

- VGA (640 pixels by 480 lines)
- CIF (352 pixels by 288 lines)
- QCIF (176 pixels by 144 lines)
- Analog (128 pixels by 96 lines)

A VIDEOPHONE IS...



H.261 VIDEO CODEC

- DCT
- Motion estimation and compensation
- Quantization
- Loop filtering
- Variable length coding/decoding

IMPLEMENTATION OF VIDEO CODEC

- 16-bit DSPs (TI 320C30)
- Hardwired ICs
- Peripheral chips also required

KEY PLAYERS

- Hitachi
- BT (and partners)
- CLI/IIT
- PictureTel/Intel
- GEC-Marconi (and partners)
- AT&T

DATAQUEST VIEW OF THE VIDEOPHONE MARKET

- Similar to facsimile
- Slow to start until price/quality acceptable
- Strong growth
- 1995-2000 time frame
- Potential of vast market

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Research Newsletter

PERSONAL COMMUNICATIONS

This is the third of four newsletters giving reports on Dataquest's eleventh annual semiconductor conference. The conference took place between June 3 and 5 at the Jurys Hotel, Dublin, Ireland. It was chaired by Bipin Parmar, Director of the European Semiconductor Group (ESG) at Dataquest. This speech by Dean Eyers, an Industry Analyst with Dataquest's European Telecommunications Group, was given during the session entitled "Emerging Applications and Technologies." The full text is reproduced here for the benefit of those clients who could not attend the conference. Copies of the slides shown follow the text.

Personal communications is expected to represent one of the greatest opportunities for the semiconductor industry over the next few years. I will cover four main topics. During my presentation I will show that, while technology plays a key role in determining the future of this market, there are a number of other factors over which manufacturers have less control. Firstly, I will talk about analog cellular in Europe; and secondly, digital cellular or GSM, which is the next big opportunity in this field. This leads on to an assessment of the GSM-derived DCS 1800 standard, the proposed technology for PCN. Finally, I will discuss our view of digital cordless telephony—CT2 and DECT.

SLIDE 1—ANALOG CELLULAR SYSTEMS, IMPLEMENTATION BY COUNTRY

The market is fragmented with several different standards in operation and launch dates ranging from late 1981 to early 1990. The most successful standards are NMT-450, NMT-900 and TACS-900. This patchwork of systems represents not one market for analog cellular but several. While creating certain problems for marketeers, this also provides an opportunity to analyse the factors in the development of cellular markets through comparison of growth patterns against varying national conditions and offerings.

SLIDE 2—PENETRATION BY MAJOR COUNTRY BY YEAR

This chart shows cellular penetration per thousand inhabitants after a given number of years in operation. As you can see, rates of adoption have varied considerably in these countries.

SLIDE 3—KEY FACTORS IN CELLULAR MARKETS

What factors have created such variance? It will be no surprise to learn that cost and perceived benefits determine the rate of uptake of individual cellular offerings. Cost, in this case, is a combination of equipment price and ongoing cost of use.

Factors influencing benefits include the geographical coverage of a service: capacity, the number of users which can be supported in a given area; features and quality of service; and availability of certain equipment types and their features, for example hand portables and innate potential as defined by a country's demographic profile and current economic conditions.

SLIDES 4, 5 AND 6—EUROPEAN CELLULAR SUBSCRIPTION FEES, CALL CHARGES AND END-USER PRICES

These three additional charts show how the three main elements of the cellular package prices vary across Europe. As you will see, individual operators have taken differing approaches to marketing their services.

ESAM Newsletters 1992-6

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SLIDE 7—ANALOG CELLULAR MARKET TRENDS

Looking briefly at market trends, 90 percent of cellular subscriptions are still supported by the user's business. Slowdown created by the recession in many markets has been offset partly by growth on second analog networks in others. Capacity is still available on many systems and recently, Scandinavian operators have introduced new tariff packages aimed at attracting individual rather than business users.

Within terminal markets the trend towards hand portables continues to gain momentum, having become the largest sector in a number of countries. The major players in analog cellular are generally those whose distribution channels and product portfolios cover the whole of Europe. Many of the small cellular specialists, set up in the early 1980s, have been acquired by larger companies eager to strengthen their technology base and product portfolios. On the other hand, a number of new entrants have emerged in the last couple of years, mainly from the Far East.

SLIDE 8—EUROPEAN ANALOG CELLULAR SHIPMENTS

Just to illustrate a couple of these points, this chart shows our historical and forecast analysis of the split between larger units and hand portables in the analog cellular market. From a very low base, hand portables had reached nearly 46 percent of the market during 1991 and are forecast to grow to over 69 percent of the market in 1995.

SLIDE 9—EUROPEAN CELLULAR TELEPHONE MARKET

Of the top five players, only NEC does not cover the major technologies and territories. Rather, it has focused on the largest single market, TACS equipment. However, NEC has this year re-entered the NMT-900 market, starting in Sweden. Note in this slide the relatively small shares of European telecoms giants, Alcatel and Siemens; and also the absence of certain Japanese suppliers active in the US market, particularly Uniden, Toshiba and Fujitsu.

SLIDE 10—ANALOG CELLULAR LIMITATIONS

Limitations on the development of analog cellular relate to the previously discussed factors and are closely interlinked. The limited amount of spectrum made available to analog cellular operators ultimately restricts the capacity on their networks.

As I said earlier, this is not one market but several. With limited economies of scale, margins must be higher—a factor reflected in the prices for both terminals and infrastructure. With a high cost per subscriber, subsequent tariffs limit the market to those for whom the cost can be justified by measurable business benefits.

While spare capacity may be available nationally, congestion occurs more rapidly around urban areas. All of this adds up to volumes which are not sufficient to justify the cost of involvement for some potential manufacturers.

SLIDE 11—REASONS FOR GSM

Many of these issues were taken into account in the development of the pan-European digital cellular standard—GSM. The support of the European Commission guaranteed a directive to national governments to make adequate spectrum available. A common standard across Europe has the benefits of providing greater economies of scale, allowing a common type-approval process, and enabling roaming across the whole of Europe.

In choosing and developing a digital standard, particular attention was paid to ensuring that GSM gained advantages over its analog precursors in terms of spectral efficiency, more sophisticated services and greater transmission security. Ultimately it is hoped that this cooperative development will benefit the region, both in terms of the standard's exportability and through the advantages it provides to users.

SLIDES 12 AND 13—KEY FACTORS FOR GSM, PRICING

How will GSM fare in the European market? Pricing will be a key issue and one factor is that components will be more expensive. Suppliers to this market must also repay the heavy cost of research and development.

On the positive side, however, the volumes *are* potentially much greater than for individual analog cellular standards, which in turn will attract greater competition. So, while in most countries

GSM terminals will initially cost more than analog alternatives, significant erosion will occur once volume growth begins.

For the first time in most countries there will be competition to provide cellular services. Those operating analog networks must guard their existing investment. New operators wish to achieve fast growth gaining maximum market share and returns within a few years of launch. Air time retailers will also come into existence in Germany and France at least. As in the United Kingdom, the signs are that equipment subsidies will form a key weapon in their armouries.

Competition is already greater for the supply of infrastructure, as the radio specialists which dominated the analog market have been joined by others such as Alcatel, Philips, and to a greater extent than before, Siemens. AT&T, Northern Telecom and other non-European companies have also signalled their intent to enter this market.

Combining these factors with GSM's innately higher spectral efficiency will ultimately lead to a lower cost per subscriber. Competition will lead to a drop in cellular tariffs, or in the package price, through terminal subsidization.

SLIDE 14—KEY FACTORS FOR GSM

Coverage in most countries will initially be limited. In time, national coverage will match that of analog, and international roaming will broaden users' horizons. We do not foresee capacity as a limiting factor for GSM in the first few years; and this will prove beneficial from the standpoint of improved service reliability, which will be complemented by digital-quality speech. Ultimately more sophisticated services will be available, with innovative product differentiation in both terminal and service sectors being stimulated by competition. That, at least, is the theory.

SLIDE 15—DELAYS IN GSM

Anyone who has followed GSM will know that there have been delays in development, which have led to problems for manufacturers trying to meet the specifications—not least for the company chosen to supply type-approval testing sets. Reduced interim specifications have been agreed in order to expedite the commercial availability of terminals, culminating in May's decision to allow self-certification on the final few test specifications. Questions have been asked regarding the commitment of existing analog operations to developing interim GSM products and helping to meet any subsequent lists of retrofitting. Realizing the innate potential for GSM depends largely on the support the technology receives from manufacturers and operators.

SLIDE 16—GSM MARKET PROSPECTS

There are still uncertainties about the future of the market. Nevertheless, Dataquest takes the view that GSM has slipped rather than fallen. Commercial services will start in a number of countries in the next few months. We expect to see significant growth beginning next year led by Germany and France.

Competition will be fierce. Dataquest expects to see a second wave of manufacturers entering the market starting in 1993, and including a number of new players. These will focus on the hand portable sector which, after the launch of first products towards the end of this year, will increasingly dominate the market. We expect GSM terminal shipments to overtake combined analog around 1994 to 1995, representing a $2.3 billion market by 1995.

SLIDE 17—EUROPEAN CELLULAR SHIPMENTS

In unit terms, we expect to see GSM shipments rising to just over 1.8 million by 1995. Do bear in mind, however, that the pattern will vary greatly by country, and that many of the factors impacting development come under direct control of operators and regulators. A change in strategy could adversely impact market potential. This is more likely to be an issue during the early part of the forecast.

SLIDES 18 AND 19—DCS 1800 IN EUROPE

Up until now I have focused on giving Dataquest's view of the development of GSM against a background of existing services. The next step is to look at how future technologies will develop. Because of its links with GSM, the obvious place to start is with DCS 1800.

The concept of personal communications networks was first put forward by the UK government in early 1989. The concept was of a microcellular, mass-market service in which the phone number would be associated with a person rather than a place with a single handset, on which it would be possible to make and receive calls anywhere.

Operators would compete both with cellular services and with BT for a sector of the residential market. Three licenses were issued in December 1989 with a view to launching in 1992.

Basing the underlying technology on GSM was aimed at generating support throughout Europe. The spectrum around 1.8 GHz is far less congested than at 900 MHz—allowing much greater traffic densities to be supported.

A number of industry observers, Dataquest included, have come to question whether DCS 1800 can actually provide a basis for true personal communications services. In the United Kingdom two of the three licensees have combined their operations, following consortia members dropping out. A license to operate DCS 1800–based services will be issued in Europe. However, this is seen more as an opportunity to gain access to cellular users than to compete for PSTN services.

DCS is very similar to a GSM. Its main benefit is additional capacity, and hence, eventually, of lower cost per subscriber. The main disadvantage is that maximum cell size is limited, demanding a high level of investment to achieve adequate geographical coverage. Operators need deep pockets and to be able to take a long-term view on their investment. There are also doubts over how many countries will have competing operators with licenses for domestic services. This will be a matter of national importance, setting a precedent for the future of state-owned utilities in any given country.

In virtually every case in Europe, the PTO will be one of the operators of GSM services. Will DCS 1800 be stimulated by PTO adoption? Well maybe, but for what reason? To compete with their own fixed services? The investments and running costs would certainly be lower than for a private operator, but so would the returns.

One factor which may help to speed acceptance of this technology is that radio-based communications become more competitive with copper alternatives in lower population densities. Some Western PTOs are looking to take advantage of such economies in rural areas. Of course, wireless communications are most competitive with fixed alternatives when the latter is not already in place. Already one can see the advantages of wireless communications at work in parts of Eastern Europe, where analog cellular technologies are being used to provide reliable communications for a limited number of users. DCS 1800 will certainly be considered in these countries as they plan to modernize their networks.

In Western Europe, however, the current emphasis is upon widening the scope and accessibility of mobile communications offerings. Partly for this reason, Dataquest sees the window of opportunity for DCS falling mainly in the late 1990s, when capacity is again an issue but when further technologies may have arisen to challenge its suitability to provide true personal communications networks [PCNs].

SLIDE 20—DIGITAL CORDLESS TELEPHONY

Another area of development is digital cordless telephony. Analog cordless telephones have been with us for some time, but have mainly been confined to the residential environment. Two main digital cordless standards have been developed—the official digital European cordless telephony standard, DECT, and CT2.

Three main applications exist for digital cordless telephony:

- In the office
- On the back of cordless PBX platforms (providing access to the public network via public base stations or telepoints—sometimes referred to as the portable payphone scenario)
- In the home (as with analog cordless units)

Possible future developments may also see digital cordless standards modified for use in the local loop, or integrated into future PCN services.

SLIDE 21—TELEPOINT STATUS IN EUROPE

Of these applications, the earliest to be put to the commercial test was telepoint. In early 1989, the United Kingdom's DTI licensed four operators. And, later that year, three launched services, using proprietary CT2 standards. The exercise failed. By late 1991 the three had all suspended services, never having gained more than a few thousand subscribers between them.

In Dataquest's view, this was not a valid test of telepoint's potential. The operators launched too early, using what was not yet a fully developed technology, and suffered adverse publicity. Base station rollout and marketing of the service were both limited in anticipation of upgrading to the increasingly delayed CAI standard. Tariffs and

equipment prices were unrealistically high given the one-way nature of the service and alternatives available within the United Kingdom.

The failure of telepoint in the United Kingdom was predictable. This does not mean, however, that telepoint will always fail. The service launched in Singapore earlier this year is gaining tremendous support. Last month, CAI-based services were launched on consecutive days by the Dutch PTT and by Hutchison Telecom—the fourth license holder in the United Kingdom. France Telecom will follow later this year. Other European PTOs are watching closely and more announcements may be made soon.

There is no doubt that a national PTO, viewing telepoint as an opportunity to generate traffic on the PSTN, is in a better position to stimulate growth and ensure success than a private operator. Growth in the cordless PBX sector would boost telepoint services by creating a pool of potential subscribers already with handsets.

While in theory either DECT or CT2 could form the platform for telepoint systems, the latter has always been developed with this sector as a primary application, and units will be priced competitively with DECT's for some time. There is still a window of opportunity for CT2 to succeed in this sector.

SLIDE 22—CORDLESS PBX ENVIRONMENT

Both DECT and CT2 supporters have great hopes of the potential for their products within the office systems environment. In order for such aims to be realized, digital cordless products must meet the general price/performance requirements within this fiercely competitive sector.

While there is certainly a great deal of interest in the benefits which mobility within the office would bring, the value and cost of digital cordless will be weighed up, in the context of other requirements, by professional telecoms managers. Such users will be aware of both current and future options, and in some countries recent developments in analog cordless systems will also be considered.

Dataquest sees digital cordless developing as a niche within the business telephone market. Just as a limited number of individuals within an organization require top-of-the-range featurephones, telecoms managers will limit the purchase of digital cordless units to those with a genuine need for mobility. In setting the options available, standards and type-approval authorities will still play a key role in deciding the future of the market. An example was given last month when the DTI cast doubt over the implementation of DECT in the United Kingdom because of possible interference with DCS 1800.

Factors other than those strictly relating to competitiveness in the cordless PBX environment may also play a part. The success of telepoint within a country may impact a telecoms manager's choice of technology.

On the supply side, work on DECT-based cordless LANs or the similarity between DECT and the Japanese digital cordless standard, may prove long-term advantages over CT2.

SLIDE 23—EUROPEAN DIGITAL CORDLESS TELEPHONY (TECHNOLOGY APPLICATIONS TRENDS)

The development of the market for digital cordless technology will initially be determined by the interaction between the two key applications of office systems and telepoint services.

In some countries, telepoint may provide a differentiator for those choosing between competing technologies for cordless PBX systems. In others the office market may determine whether telepoint services are launched at all. The influence of national telecoms administrations in adopting standards will continue to be a major factor.

Towards the latter half of this decade, Dataquest expects to see digital cordless prices reduced to levels competitive within the residential cordless market. The terminal market will generally be dominated by specialist suppliers, working partly in conjunction with office systems vendors. Leading companies in the development of CT2 technology are Motorola, GPT, Shaye and Orbitel. Ericsson leads the DECT camp for the time being, with Philips, Dancall and Olivetti promising to be early players.

SLIDE 24—PERSONAL COMMUNICATIONS IN EUROPE

In the course of this presentation, I have briefly covered four major technology groups within European personal communications which exist or are under development today. What lessons can we draw from such an assessment about the potential for true, mass-market personal communications in Europe?

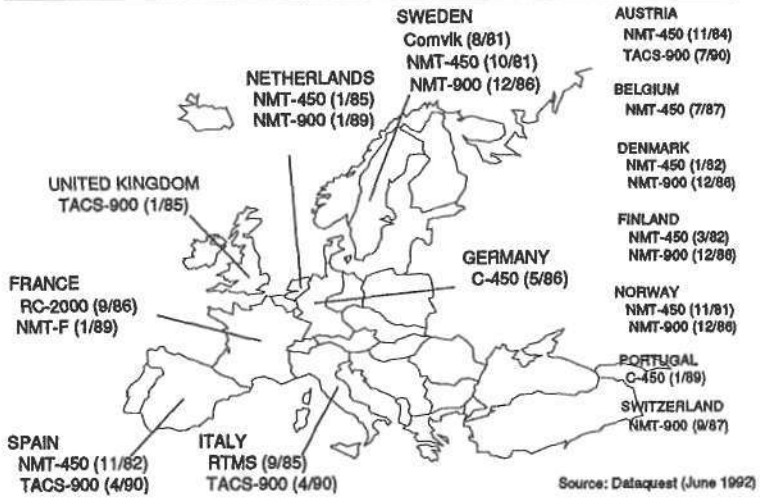
Well, for one thing, a pan-European market would provide economies of scale and subsequent equipment prices which would greatly heighten the chances of success on a mass-market basis. As we have seen, however, there are a number of technologies which could provide some of the applications of a true PCN without any single one having the advantage across all applications.

Indeed, the very concept of one technology meeting all needs is greatly under question. It seems far more likely at this stage that true PCN services will ultimately be provided by not one technology but a combination. This in itself poses a question over the current tendency of most national telecoms administrators to issue single standard licenses to private operators, while allowing PTOs access to all technologies.

There may be further technologies on the horizon which will also play a part in the development of PCNs in Europe. One thing, which can be said with some certainty, is that despite the technological, economic and political complexities of this market, Europe is still setting the pace for the rest to follow in the world of personal communications. Technologies developed here will gain success throughout many other parts of the world.

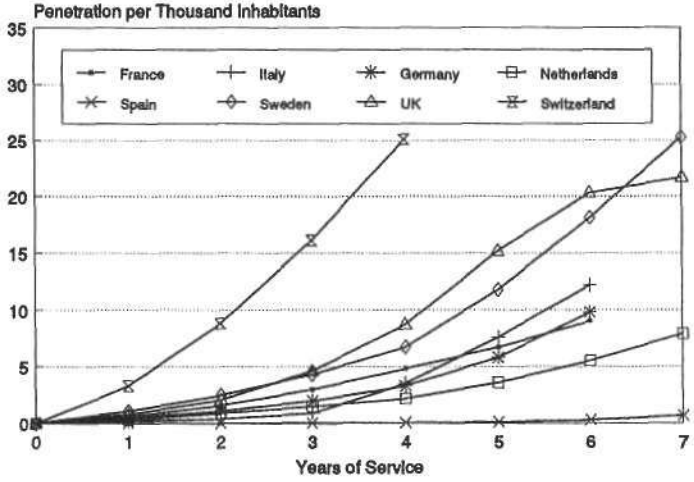
Dean Eyers

ANALOG CELLULAR SYSTEMS
IMPLEMENTATION BY COUNTRY



Source: Dataquest (June 1992)

PENETRATION BY MAJOR COUNTRY BY YEAR

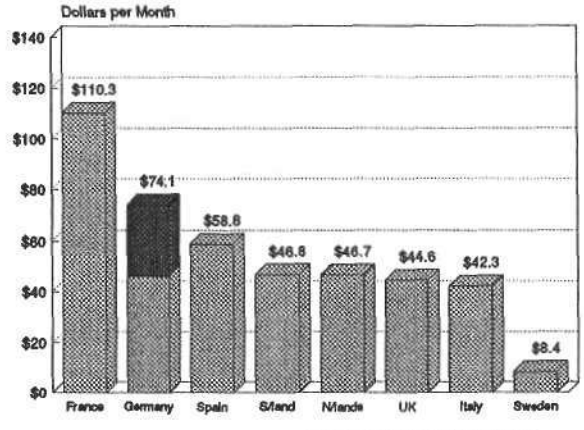


Source: Dataquest (June 1992 Estimates)

KEY FACTORS IN CELLULAR MARKETS

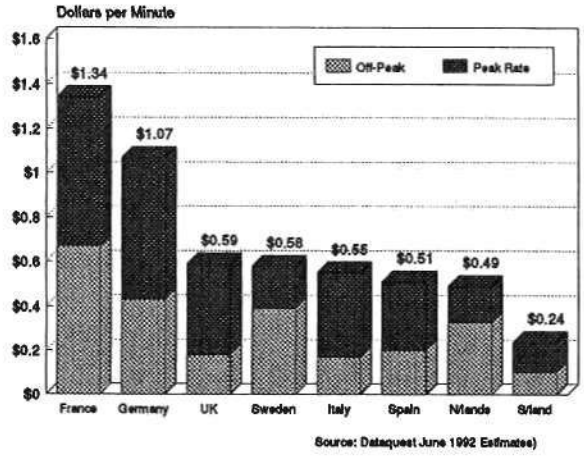
- Pricing
  - Equipment
  - Tariffs
- Coverage
- Capacity
- Service/quality
- Equipment features/availability
- Demographics/economics

EUROPEAN CELLULAR SUBSCRIPTION FEES



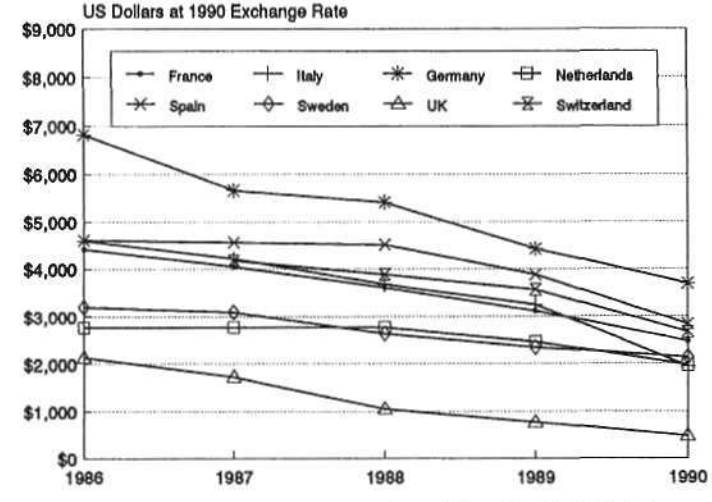
Source: Dataquest (June 1992 Estimates)

EUROPEAN CELLULAR CALL CHARGES



Source: Dataquest June 1992 Estimates)

CELLULAR TELEPHONES - END-USER PRICES

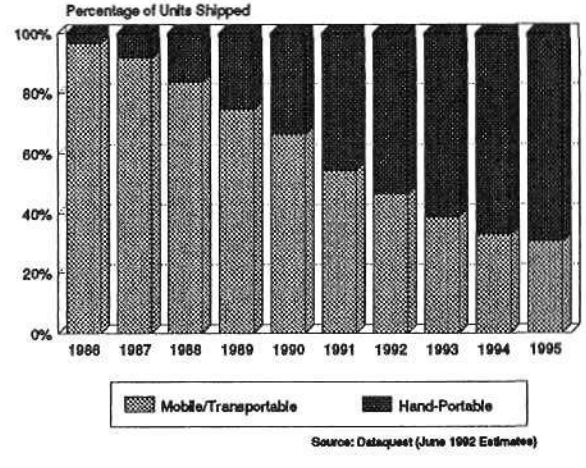


Source: Dataquest (June 1992 Estimates)

ANALOG CELLULAR MARKET TRENDS

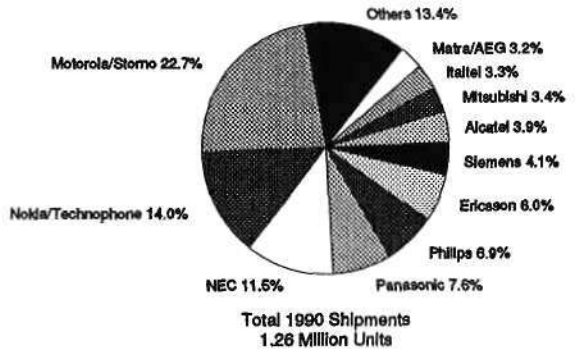
- Still predominantly business market
- Recession leading to slowdown
- Interim analog networks supporting growth
- Capacity available on many systems
- New tariff packages in Nordic countries
- Strongest growth in hand-portable sector
- Major players cover Europe
- Some new entrants

EUROPEAN ANALOG CELLULAR SHIPMENTS



Source: Dataquest (June 1992 Estimates)

EUROPEAN CELLULAR TELEPHONE MARKET



Source: Dataquest (June 1992 Estimates)

ANALOG CELLULAR LIMITATIONS

- Spectrum availability limits capacity
- Economies of scale for infrastructure and terminal suppliers limited by fragmented market
- Tariffs and terminal prices relatively high
- Scope for further growth is generally limited to business users
- Congestion in areas of high user density
- Potential new competitors deterred from entry

REASONS FOR GSM

- Realization of spectrum limitation
- Harmonized system in all CEPT countries
- Digital technology
- Gives Europe a leading edge

KEY FACTORS FOR GSM - PRICING

Handsets

- Components more expensive
- Heavy cost of research & development
- Economies of scale potentially greater
- Greater competition

Initially higher price than analog, significant erosion once critical market size attained

KEY FACTORS FOR GSM - PRICING

Service Tariffs

- Competing operators
  - Existing operators want smooth migration
  - New operators want fast growth, max. ROI
- Service providers in major territories
- Greater competition for infrastructure supply
- Innately higher spectrum efficiency
- Ultimately, lower cost per subscriber

Tariffs/package price to drop with competition

KEY FACTORS FOR GSM

Coverage - Initially limited compared to analog

Capacity - More spectrum available - EC directive
- More spectrum efficient

Quality - Better speech quality, more reliable

Features - More sophisticated services available
- Product differentiation stimulated by competition

DELAYS IN GSM

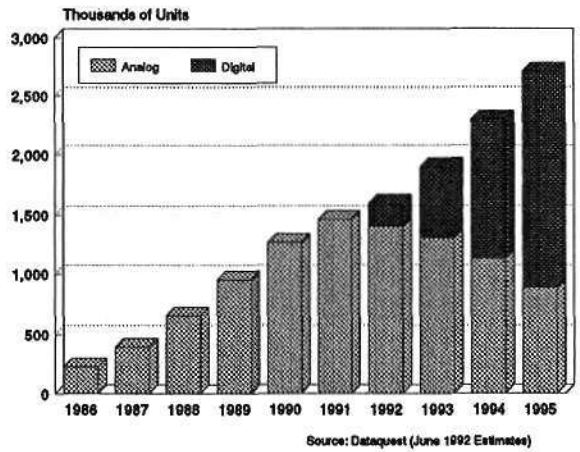
- Specifications set late, incomplete
  - Still changing
  - Some features delayed until phase 2
  - Ongoing problems with type approval
- Operators still have capacity on analog networks
- Intercountry roaming arrangements to be agreed
- Second operators licensed late, more to come

Market development largely dependent on level of support from operators and manufacturers

GSM - MARKET PROSPECTS

- GSM has slipped but not fallen
- Growth will begin in earnest next year, driven by majors with unexploited potential - Germany and France
- Competition will be fierce - expect second wave of terminal suppliers during 1993
- GSM terminal shipments to overtake combined analog in 1994/5
- Terminal market to grow to $2.3 billion by 1995

EUROPEAN CELLULAR SHIPMENTS



DCS 1800 IN EUROPE

- PCN concepts of UK's DTI
- GSM specification at 1.8 GHz
- Microcellular applications
- Three licenses in UK - down to two
- License to be issued in Germany

DCS 1800 IN EUROPE

- Main advantage over GSM is extra capacity
- Disadvantage is network investment
- PSTN competition demands political will and long-term investment
- Possible application in underdeveloped territories
- Western Europe - focus is mobility

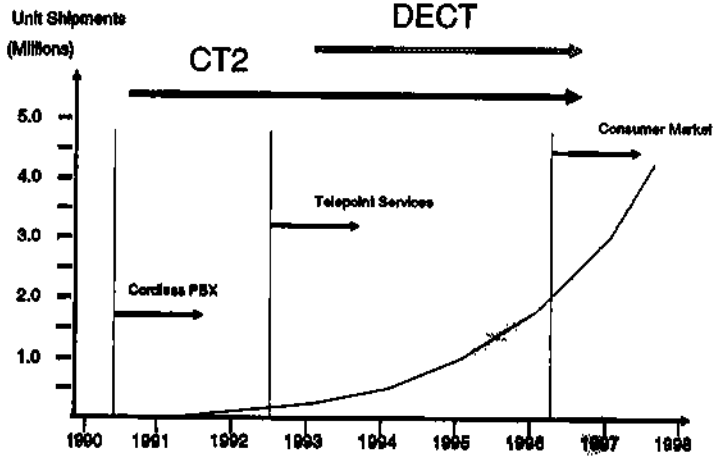
DIGITAL CORDLESS TELEPHONY

- Two major standards:
  - DECT
  - CT2/CAI
- Three major applications:
  - Office System - cordless PBX platform
  - Telepoint - portable PSTN access service
  - Residential - home base station
- Possible future applications:
  - Local loop - Telepoint to the home
  - Personal communications network

TELEPOINT STATUS IN EUROPE

- UK failure - not a valid test
- Services to launch this year in France, Netherlands and UK - others watching
- Success will depend on positioning and operator support in national market
- Critical mass of business terminals would provide major boost
- CT2 still has window of opportunity

EUROPEAN DIGITAL CORDLESS TELEPHONY (TECHNOLOGY APPLICATION TRENDS)



Source: Datag[illegible]

CORDLESS PBX ENVIRONMENT

- Products must meet general price/feature criteria
- Competition between standards and with analog cordless alternative
- Standards/approvals bodies play key role
- Telepoint may be a differentiator
- Related technologies may influence market

PERSONAL COMMUNICATIONS IN EUROPE

- A pan-European market
- Technologies in competition
- A realistic dream?
- Leading the world

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Research Newsletter

END-USER STRATEGIC TRENDS

This is the second of four newsletters giving reports on Dataquest's eleventh annual semiconductor conference. The conference took place between June 3 and 5 at the Jurys Hotel, Dublin, Ireland. It was chaired by Bipin Parmar, Director of the European Semiconductor Group (ESG) at Dataquest. This speech by Bipin Parmar was given during the session entitled "Dataquest's Forecasts and Analysis." The full text is reproduced here for the benefit of those clients who could not attend the conference. Copies of the slides shown follow the text.

In this speech I plan to walk you through some of the issues that are affecting your customers and how that will affect you.

SLIDE 1—END-USER STRATEGIC TRENDS

My agenda is to address trends in technology, standards, and the impact of confused marketing channels. At previous conferences we have emphasized the importance of understanding not only the end users of semiconductors, but also their customers in order to position for the future.

The electronics industry increasingly represents a very large part of many economies. In the United States it employs more people than the automotive and steel industries together. Yet the electronics industry has a long way to go before it matures fully. There are, however, segments within our total industry which are maturing faster than others. It will be very difficult to present issues and trends covering the entire electronics industry in such a short speech; therefore, I want to focus on the segment which today represents the largest market for semiconductors.

SLIDE 2—WORLDWIDE SEMICONDUCTOR CONSUMPTION

The EDP or computer sector is the largest consumer of semiconductors worldwide. This industry is going through a very turbulent period. Issues facing this sector are similar to the ones that the semiconductor industry is quite used to, such as diminishing product life cycles, near commodity market conditions with severe open competition. The huge improvements in price/performance in microprocessor and memory technology is forcing some of the players in this industry into a fight for survival. Let me expand on this further.

SLIDE 3—WORLDWIDE COMPUTER SYSTEMS

This chart shows that starting in 1987, mainframe, midrange and PC factory revenues were on a par at roughly $22 billion. The availability of reasonably low-cost semiconductor technology has revolutionized the PC industry. The PC industry is now roughly twice as big as the mainframe or the midrange industry. Notice how the mainframe revenue rose steadily until 1990 and then suddenly started to nose-dive in 1991. Please also note how the midrange market remains almost flat, even with the launch of new platforms like the AS/400. There is another rising star which we will have to start giving serious attention to. I am, of course, referring to revenue from workstations.

We forecast that by 1996 workstation revenues will be higher than either the mainframe or the midrange. So what does this all mean? When you have such a big transformation taking place, I believe the winners in this market will be different from those of today. In other words, your customer base is going to be transformed in the coming decade. So who are these top customers today?

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Dataquest's estimate of the top 10 semiconductor users in Europe is as follows:

1. IBM
2. Siemens
3. Philips
4. Bosch
5. Alcatel
6. Olivetti
7. Grundig
8. Nokia
9. Matsushita
10. Ericsson

Clients of Dataquest's application services should refer to their binders for the top 50 accounts in Europe where actual dollar estimates are also provided. We routinely survey these companies in order to assess their inventories and buying patterns. As I said earlier, we use this information as an input to our forecasting model.

I now want to assert that this list will look totally different in five years' time, which means you will have to be careful that you not only back the right companies, but also continuously reassess your strategic partnering and major accounts programs. Of course, Dataquest will be carrying out more in-depth studies on this subject in the future.

In the time available today, I want to examine the fortune of the top player in this sector, namely IBM. As many of you are already aware of its problems, let me focus on the reasons behind some of them.

SLIDE 4—IBM MARKET SHARE OF COMPUTER SYSTEMS

The biggest problem for IBM is to maintain its market share in total computer systems. I expect that it will have to pull out of a few more sectors of the market and outsource more manufacturing. For example, it has pulled out of the printer and PBX business. It is quite ironic when you consider that it was IBM which revolutionized the computer industry by launching the IBM personal computer. This, as we all know, was cloned by the whole industry. As a matter of fact we now know that IBM originally intended the PCs to be used by private users at home; it did not envisage the PCs having a massive uptake in the business community at the expense of mainframe revenue. What we see here is the inability of large organizations to compete with themselves. While the whole world was eating their lunch, the corporation was heavily focused on its proprietary mainframes, which were increasingly becoming outdated. Popular democracy at end-user level meant that all white-collar workers had access to low-cost distributed computing on their desks. So declining market share also has its impact on the bottom line.

SLIDE 5—IBM NET EARNINGS

As a matter of fact, we think that the IBM PC division is a major contributor to these problems in the company, and by now you should have heard of how IBM is going to market its own clones with a new company called ICPI Ltd. By the way, nobody knows what ICPI stands for, but I believe it should be called IBM Clone Peddlers International.

Well the picture is very clear here for IBM. From 1986 to the end of this year, IBM will have reduced its worldwide work force by more than 80,000 employees, and eliminated 94,000 staff positions and 11,000 management functions. The company now claims that it is transforming itself into better focused, independent units. Each unit will have a faster pace and will be in charge of its own destiny. For example, the personal systems business has been segregated into more than a dozen businesses, and some will compete against each other. IBM has also created an OEM division which will sell components in the merchant market. So watch out. Your biggest customer might also be a potential competitor or a source of cheap technology transfers. Some claim that the problems are IBM's own making, but I want to show you that these problems are inherent in the whole computer industry.

SLIDE 6—1991 SELECTED COMPANIES' PROFIT MARGINS

Companies in similar businesses are also going through such pains. If the computer industry was as good at inventing profits as it is at inventing jargon like open systems, ACE and UNIX International, the whole industry would be in better shape. In contrast, companies involved in telecommunications are returning respectable margins except when they don't stick to their core business. Nokia's ill fortunes are due to its defunct PC

division (which has been sold now) and its consumer business. I have selected an unusual company in this list. Remember those "boom and bust" video games industries in the early 1980s? Well, Nintendo declared a profit of over $660 million, even bigger than Philips. Video games use similar components as the PC but not the most powerful processors and latest memories.

Part of the profit problem is related to the overall manufacturing costs, and it is claimed that the current 14 percent tariff on semiconductor imports does not help. Well as you heard earlier, memory prices are quite cheap in Europe and most of Intel's processors don't carry any duties. As a matter of fact, quite a large number of PC manufacturers import motherboards without the processor or the memory, which in turn affects the semiconductor market in Europe. So who are these top PC manufacturers in Europe?

SLIDE 7—TOP PC MANUFACTURERS

We have produced a special report* which lists both the screwdriver plants and the partial screwdriver plants. There is no such thing as a true manufacturer nowadays, as these companies use a combination of all three. The report gives our estimates of the quantity produced by different types of processor platform as well as detailed semiconductor content analysis of the popular PCs. Many of our clients are using this report as an independent measure of their penetration into these accounts and also for addressing new sets of customers. It is also used for hedging their position in case some of these producers do not fare well in their own marketplace. So how are some of these producers faring in the different markets across Europe?

SLIDE 8—UNIT PC MARKET SHARE

As you can see, with the exception of France, IBM is no longer a top player in Europe. And notice Commodore, the ex–video games company taking the top spot in the United Kingdom and Germany. Also note Atari, coming up in the list. For a while, a very unusual company called Vobis had the number-one spot in the German market. So this is further proof that the traditional leaders in the industry are being replaced by younger, more innovative firms, which are borrowing their lessons from the mature consumer industry.

We don't expect this ranking to remain static either, as the battle for winning the most appropriate marketing channels will determine the winners and losers.

SLIDE 9—CHANNELS

This shows the various channels used today to supply PCs to end users. Yes, it looks more complex than the latest RISC processors.

I don't intend to describe each of the channels and overlaps that exist. The message here is that it is a jungle out there. One of the reasons that PC vendors have thin margins is that they are supporting so many marketing channels, which are squeezing their margins, or in some cases, as I will show you, stealing their lunch.

So what, you might say! Well, understanding and capitalizing on this confusion could lead *you*, the semiconductor vendor, into some very profitable and exciting new business. With the exception of some value-added resellers, the rest don't provide much value to the ultimate end users. Remember the 1990s will be the decade of 3Cs which is cooperation, competition and coexisting with your own customers. So semiconductor vendors should outsmart their traditional OEMs. Let me show you one example of this.

SLIDE 10—1Mx9 SIMM (MEMORY MODULE)

Those of you who have purchased memory modules for your PCs would have been astounded by how much you have to pay for 1M9 SIMM module. It is almost criminal. Today it varies between $230 to $350 depending on where you purchase it from. But when you check the *DQ Monday* prices that a PC OEM pays to the semiconductor vendor, roughly $30, you see there are a lot of parasites in the market, which rightly do not deserve to exist. The semiconductor industry is sometimes its own worst enemy by being very loyal to its traditional OEMs. So if you want to bypass some of these channels, and sell directly to value-added resellers, would you know where to find these people? Well don't panic.

* Note: *European PC Manufacturing and Semiconductor Demand* available from Dataquest's marketing department.

SLIDE 11—NEW CUSTOMERS

Dataquest has produced a special report* on the top 500 resellers in Europe. Sorry, I am not trying to be a salesman here, but it is our duty to provide you with the right information in order for you to be in a competitive and profitable business.

We believe there are roughly 30 to 40 million end users in Europe and they are getting tired of having to replace their whole PCs just to get extra performance. They would instead prefer to buy simple add-ons which stretch the life cycle of their initial investment.

Some PC vendors are already supplying models which could easily be upgraded. The new PC card standard and the popularity of flash memory will further enhance this process. So I believe that the semiconductor vendors will see a whole set of new customer who will help end users to enhance their products with add-on graphics, modems, fax and networking facilities. One word of caution, though; this business could easily become similar to the video games cartridge business, with whole operating systems and application packages made available from your local retail store at knockdown prices.

I would now like to turn to some technology, price/performance and standard issues which I believe will also have a major impact on the PC industry.

SLIDE 12—DOWNSIZING

I don't know how many of you actually use notebook PCs. They are the hottest item on the market currently. Well, I have a notebook PC and I use it when I am away from my office for mundane tasks like word processing and simple spreadsheets. After a while, my eyes get very tired as the screen is too small, not to mention the keyboard. So to summarize, I use it for entering data. I don't really use the 386 processing power which is made available to me. So I believe the notebook is all right for those 30 million Europeans who are used to desktop PCs, but you see there are 70 million other potential customers out there who do not use PCs at all today. The industry will have to find these new customers, and I believe we in the semiconductor industry will have to play a large part in this. Let me explain my thinking.

* Note: *Top 500 European Microcomputer Resellers* available through Dataquest's marketing department.

SLIDE 13—EMULATION OF FUNCTION

If you look at the functions that most people carry out, especially managers of businesses, projects and departments, diaries and time organizers play an important role in the lives of business people. Also, the majority of us are quicker at writing than typing. So we believe the advantages of palmtop PCs and pen-based PCs will give another jump start to the whole industry. The 70 million potential users need low-cost solutions. Although the PC cards seem to be very expensive today, it will provide a lower cost of entry and ownership of information. Let me explain why.

SLIDE 14—THE COST OF USING INFORMATION

Although the good old floppy seems to be very cheap, it requires a notebook with a disk drive, which makes notebooks heavier, power-hungry and hence expensive. On the other hand, a palmtop with PC card provides a lower cost of ownership, as you can see from the slide. A palmtop does not need expensive high-speed processors and memories either. The basic function that people want is storing and retrieving daily information like telephone numbers and business records.

SLIDE 15—PC CARDS

The only way the industry can move forward is if semiconductor vendors start shipping volume PC cards via alternative channels directly to the end users, otherwise the various channels' margins will make these solutions not viable.

In other words, the semiconductor industry will have to learn a whole new set of tricks, like brand awareness and recognition, mass merchandising and maybe even advertising on TV. So you might want to start recruiting people from the consumer industry, which also has its own set of problems, some of which I will discuss later.

The PC card and its sister smart cards will also transform the way in which telecommunications companies address the explosion of wireless and digital communications.

SLIDE 16—GOING WIRELESS

The advance in voice and picture compression technology will increasingly blur the picture between computer and telecoms products. Already computer companies are taking a distinct interest in

the consumer electronics business. The reason for this is that towards the end of this decade, the consumerization of the telecoms industry will be even more severe than in the PC industry. It will make the PC industry look like a picnic. Once the standards for digital communications have been set, you cannot enhance it with higher-performance chips, like in the PC industry. The only way is to keep reducing costs. But don't worry, we in the semiconductor industry are quite used to that. I am not sure whether the telecoms vendors know what cost really is.

We expect that like suppliers of PC chip sets today, there will be a host of chip set vendors for GSM, videophone and personal fax. The PC OEMs are looking at embedding these functions with the advent of the single-chip PC in order to provide differentiation to their products. So if the PC vendors start taking the lunch away from the telecoms vendors, what will the telecoms vendors do? There are two distinct directions they can go in: one is to get into the service business; the other is to make an alliance with consumer electronics.

SLIDE 17—CONSUMER ELECTRONICS

So, if both the computer and telecoms industries are forced to move towards the consumers electronics scene, what is currently happening to the dominant players in the market, namely the Japanese companies?

SLIDE 18—1990 TO 1991 CONSUMER PROFIT DECLINES

The recession in the major economies of the world is having an impact on the leading consumer electronics companies, as in the computer industry. Profit margins in consumer electronics have dropped considerably since last year, as this chart shows. Sony declared a net loss this year in its consumer division and, in combination with this reduced profit, its source of virtually interest-free capital is drying up. Japanese companies used to access cheap capital issuing bonds and securities. The major customers of these bonds and securities were the Japanese banks, which became very rich (on paper at least).

SLIDE 19—TOP FIVE BANKS

As you see, the top four banks in the world are now Japanese. Having said that, the squeeze for better returns on this investment is coming very rapidly, as they have to increase their capital ratio in line with the world standard from the Bank of International Settlements. The Japanese need to do this in order to continue operating in the global markets. Also, the valuation of the securities were mostly based on property assets. When the property price balloon burst, most companies' total assets had to be revalued.

The situation is further exacerbated by the high losses these banks have declared on their paper securities, some of it due to "bad loans" to property companies. Now Japanese companies face $9,635 million in losses (Table 1).

So what does this mean? Will the Japanese companies slow down a little? Let us not delude ourselves. Japan's corporation squeeze for better profits will make the Japanese more aggressive in the marketplace with value-added products like videophones and personal faxes. The playing field will be more levelled, so there are tremendous opportunities for the European telecoms vendors to strike alliances with the Japanese.

We believe that these companies will reduce the number of products that they design and modify continuously, in order to get more efficiency out of their scarce R&D centers. In the past it was not unusual for a Japanese company to develop 10 new competing TV models in parallel to see which will best suit the market. We also believe that the higher interest rates and squeeze on profits will slow down the massive foreign investments abroad. So the Japanese will be looking for local partners, and telecoms vendors in Europe are reasonably cash rich. It will be some time before you see another Japanese fab in Europe.

Some Japanese companies which have diversified will return to their core business where they can muster better returns on their scarce capital.

TABLE 1
Bank Losses on Securities

Bank	Loss ($M)
Sanawa Bank	$1,077
Industrial Bank of Japan	$732
Fuji Bank	$716
Sumitomo Bank	$655
Tokai Bank	$629
Sakura Bank	$586
Diawa Bank	$540
Dai-Ichi	$535

Source: Financial Times

For example, Toshiba is closing down its audio division and merging it with its video divisions. You might also, for the first time, see consolidation in the three major plug-compatible computer companies—NEC, Fujitsu and Hitachi—where one of them might give up. Already there is a degree of inter-cooperation taking place. So what about the European companies' positions?

I was recently talking to some Japanese stock analysts who were visiting German banks. When I asked them which bank, they said Siemens and Diamler-Benz.

SLIDE 20—EUROPEAN ZIABATSUS

Although Siemens and Diamler-Benz do not participate in retail banking, their assets portfolio is almost similar to a normal bank with increasing investments in turnkey projects involving construction, maintenance and services contacts. With all the recent acquisitions that these companies have done recently, we are seeing the birth of the European "ziabatsus."

For those of you who have been sceptical about the health of European-owned companies, please think again. These companies have strong balance sheets and liquidity to gobble up many computer or telecoms companies around the world. So, let me conclude my presentation by summarizing the strategies that major OEMs in the computer and telecoms industries might follow.

SLIDE 21—STRATEGIES FOR OEMS

Possible strategies for OEMs include:

- Outsource manufacturing
- Concentrate on channels/mail order/mass merchandisers
- Provide application-specific PCs, PBX, telephones
- Retrench to core activities
- Software and professional services

As I showed you, the 1990s will be the decade for the battle of marketing channels. OEMs will increasingly outsource more and more activities to subcontractors. They will do this in order to concentrate their firepower into winning marketing channels and mastering their core activities. They will be looking to survive by providing application-specific products to suit different vertical markets. They will increase their investments in software and professional services. The service business is very profitable and it is difficult for services to become a commodity item as they involve manpower at point of delivery. There are some lessons to be learned from this trend for the semiconductor industry.

SEMICONDUCTOR VENDORS' STRATEGIES

Strategies for semiconductor vendors can be summed up as:

- Continuously monitor customers' strategic directions
- High growth areas may not return the best margins
- Create new organizations to address/develop new customers
- Subcontract for customer product development
- Enter the service business: training, consultancy, standards setting

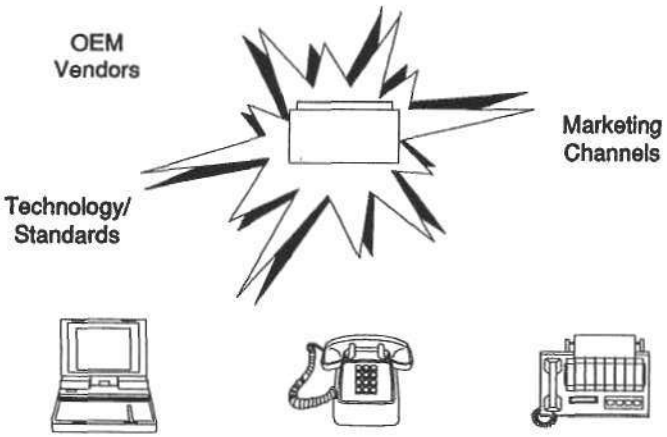
Those vendors who fail to grasp the strategic trends of their major customers will be left empty-handed. The increasing consumerization of the PCs and wireless products will result in high growth but very low margins as the industry repeats the lessons learned in the PC chip set business.

Opportunities exist for semiconductor vendors to develop a whole new set of customers by delivering shrink-wrapped solutions to end-user needs via alternative channels, even if this means competing with your own customer. The customer, by the way, will increasingly compete with its suppliers in any case. As major OEMs look to outsource more activities and more and more intellectual value is added on the chip sets, be prepared to offer your valuable R&D resources to your customer.

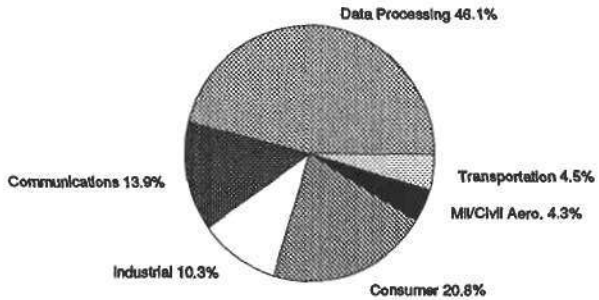
Those of you who have attended any standards committees such as FDDI, MPEG, JPEG or GSM will see that there are more semiconductor companies represented than OEMs, so strategic partnering with OEMs can allow these costs to be shared. As the complexity and size of semiconductor devices grow, new opportunities will be created for semiconductor vendors to offer their OEM customers consultancy and training services, which could return higher margins.

Bipin Parmar

END-USER STRATEGIC TRENDS

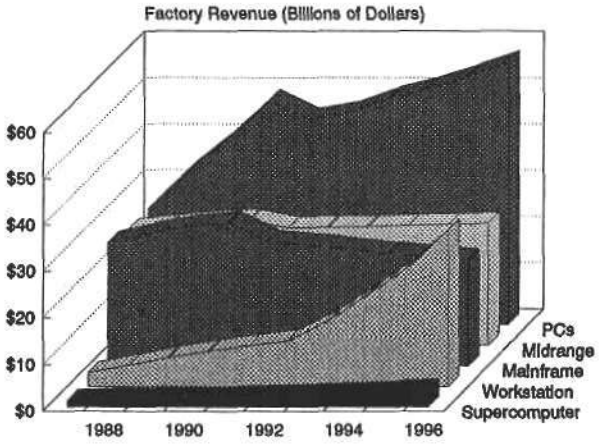


WORLDWIDE SEMICONDUCTOR CONSUMPTION BY APPLICATION SEGMENT



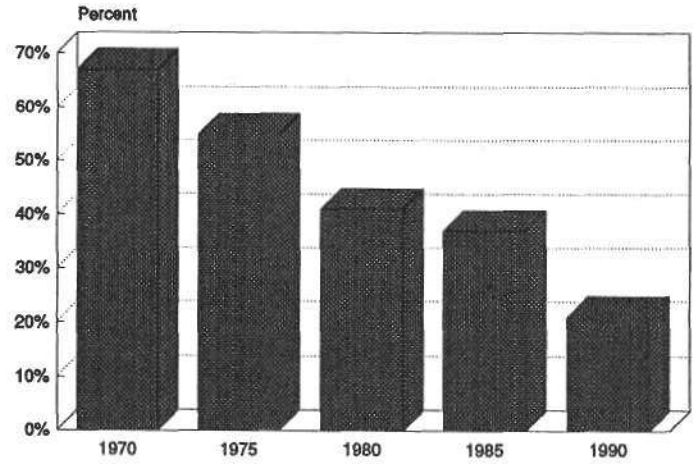
Source: Dataquest (June 1992 Estimates)

WORLDWIDE COMPUTER SYSTEMS PRODUCT SEGMENTATION



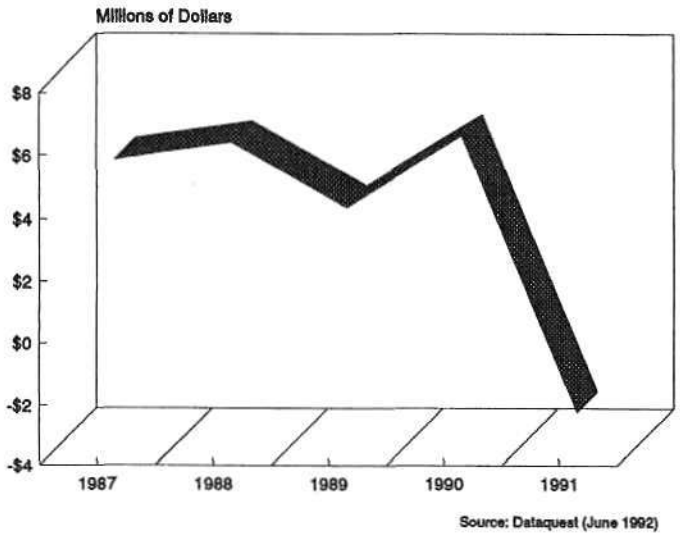
Source: Dataquest (June 1992 Estimates)

IBM MARKET SHARE OF COMPUTER SYSTEMS WORLDWIDE



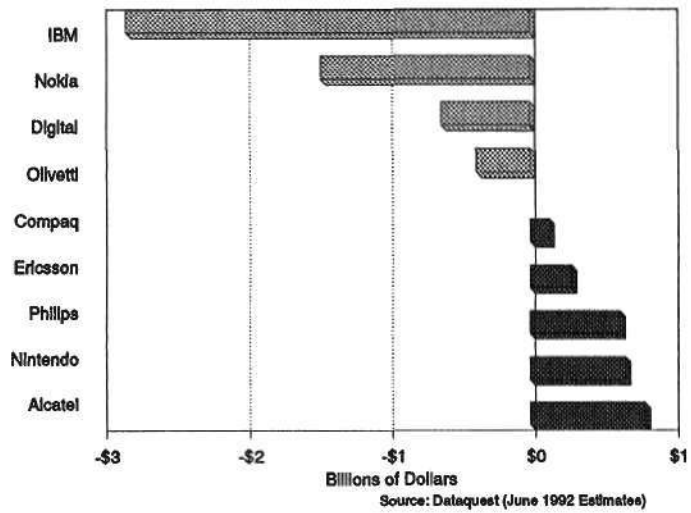
Source: Dataquest (June 1992 Estimates)

IBM NET EARNINGS



Source: Dataquest (June 1992)

1991 SELECTED COMPANIES PROFIT MARGINS



Source: Dataquest (June 1992 Estimates)

TOP SEMICONDUCTOR USERS IN EUROPE

1. IBM
2. Siemens
3. Philips
4. Bosch
5. Alcatel
6. Olivetti
7. Grundig
8. Nokia
9. Matsushita
10. Ericsson

Top 50 are available in your ESAM binders

UNIT PC MARKET SHARE BY MAIN MARKETS

United Kingdom

1. Commodore
2. IBM
3. Compaq
4. Atari
5. Apple

GERMANY

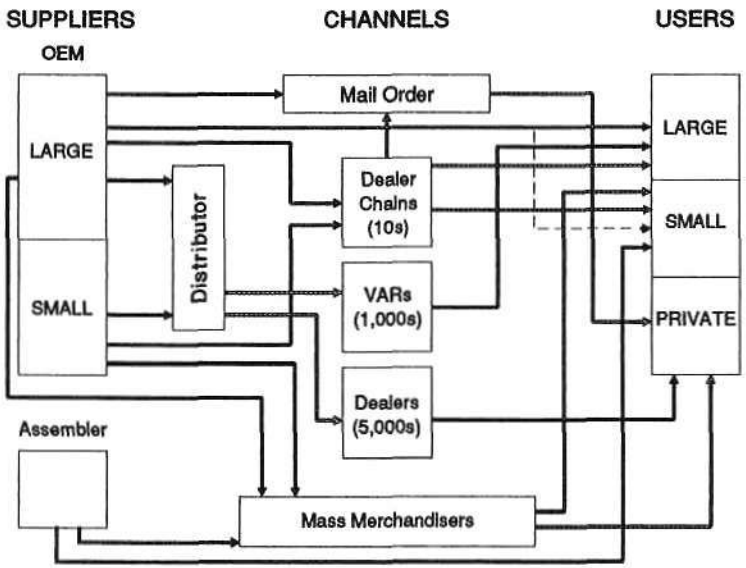
1. Commodore
2. Vobis
3. IBM
4. Atari
5. Siemens Nixdorf

FRANCE

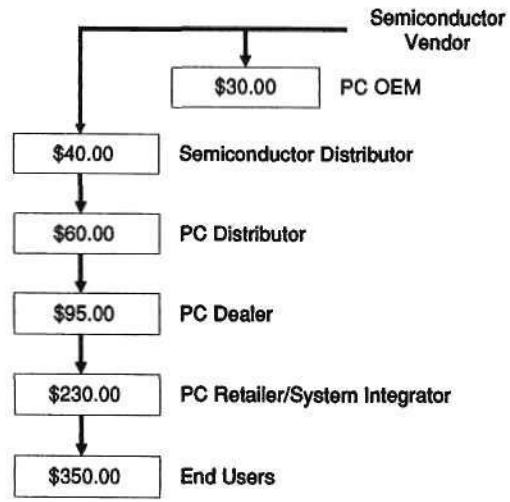
1. IBM
2. Apple
3. Compaq
4. Commodore
5. Atari

ITALY

1. Olivetti
2. IBM
3. Commodore
4. Apple
5. Zenith Data Systems



1Mbx9 SIMM (MEMORY MODULE)



THE BIRTH OF A NEW SET OF CUSTOMERS

UK

1. Computercenter
2. Dixons
3. Centre File
4. Specialist Computers
5. Businessland UK

GERMANY

1. Component Computer Gruppe
2. Computerland Deutschland
3. Taylorix
4. House of Computers
5. Metro

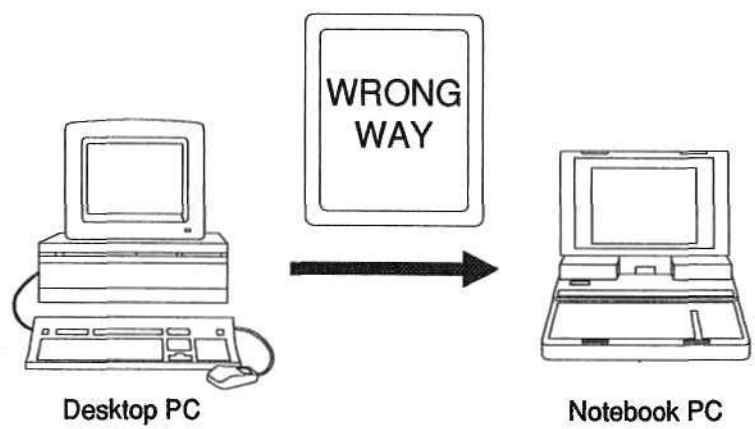
FRANCE

1. Agena
2. ISTA
3. Random
4. Asystel Conseil et Service
5. ECS Diffusion

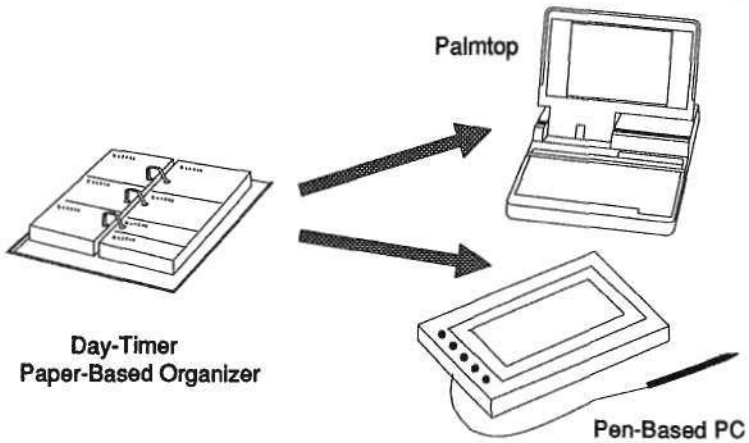
ITALY

1. Metos
2. Asystel Sirio
3. TC Sistema
4. Winline
5. Systex Informatica

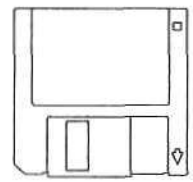
DOWNSIZING



EMULATION OF FUNCTION



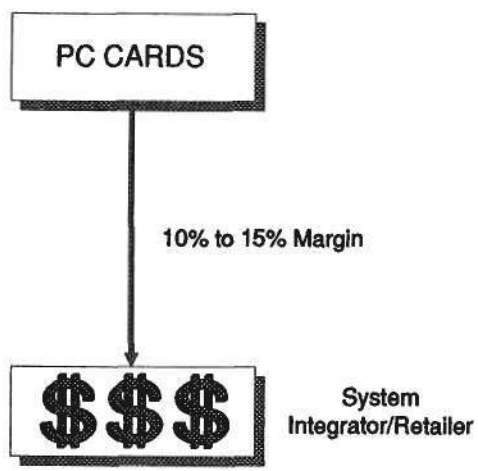
THE COST OF USING INFORMATION



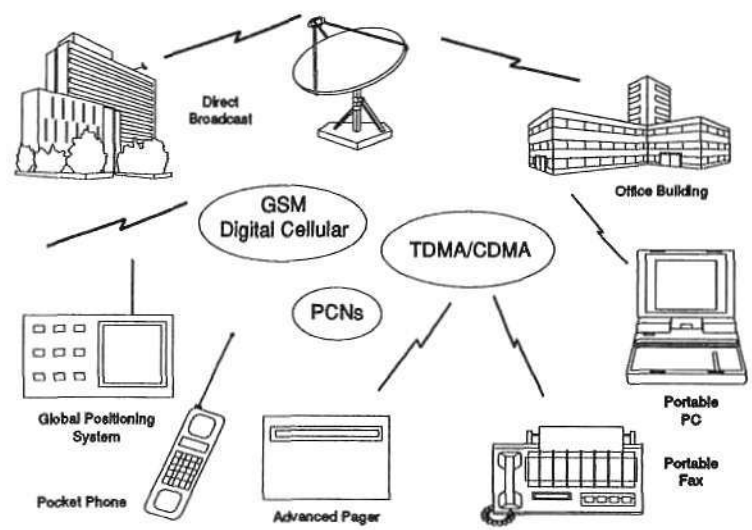
	Cost		Cost
Floppy:	$1	Memory Card:	$300
Notebook:	$3,000	Palmtop:	$600
Total	$3,001	Total	$900

The Floppy Is More Expensive!

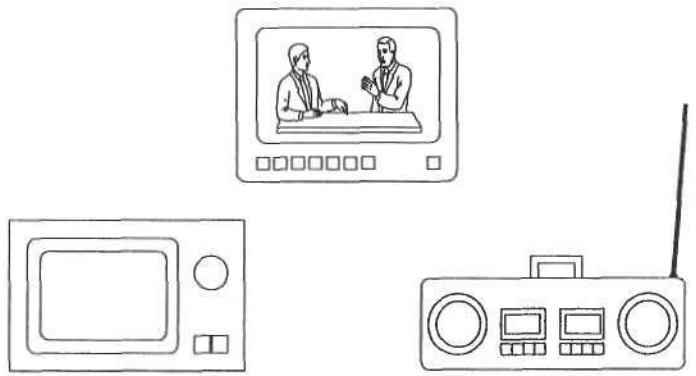
PC CARDS



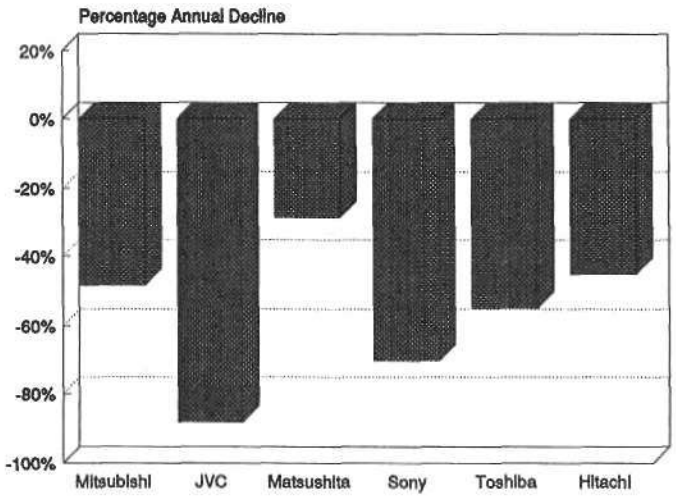
GOING WIRELESS (AND DIGITAL)



CONSUMER ELECTRONICS



1990-1991 CONSUMER PROFIT DECLINES



Source: Yomiuri-Shimbun

TOP 5 BANKS

(by Capital)

1980	1990
1. Crédit Agricole (France)	1. Somitomo (Japan)
2. National Westminster (UK)	2. Dai-Ichi Kangyo (Japan)
3. Barclays (UK)	3. Fuji (Japan)
4. Bank America (US)	4. Sanawa (Japan)
5. Citicorp (US)	5. Union Bank of Switzerland (Switz.)

Source: The Banker

THE BIRTH OF EUROPEAN ZIABATSU/KEIRETSU

(Banks/Industrial/Electronics/Construction/Services)

Daimler-Benz

Siemens

Alcatel

Thomson

Bosch

Philips

France Telecom

POSSIBLE STRATEGIES FOR OEMs

- Outsource manufacturing
- Concentrate on channels/mail order/mass merchandisers
- Application-specific PCs, PBX, telephones
- Retrench to core activities
- Software and professional services

Dataquest
a company of
The Dun & Bradstreet Corporation

Research *Newsletter*

SEMICONDUCTOR FORECAST AND MARKET SHARE ANALYSIS

This is the first of four newsletters giving reports on Dataquest's eleventh annual semiconductor conference. The conference took place between June 3 and 5 at the Jurys Hotel, Dublin, Ireland. It was chaired by Bipin Parmar, Director of the European Semiconductor Group (ESG) at Dataquest. The first speech *Semiconductor Market Forecast and Market Share Analysis* was given during the session entitled "Dataquest's Forecasts and Analysis" by Jim Eastlake, Senior Industry Analyst and Manager of ESG, Mike Glennon, Senior Industry Analyst, ESG and Byron Harding, Industry Analyst, ESG.

The full text of this speech is reproduced here for the benefit of those clients who could not attend the conference. Copies of the slides shown follow the text.

INTRODUCTION

Jim Eastlake

We are going to analyse the European semiconductor market, beginning with a review of our 1991 market share, and then talking about products and applications. Next, we will perform some vendor analysis to understand the possible direction of market shares. We will also look at that impact the product and applications trends will have on the regional markets. And finally, we will discuss world markets.

MARKET SHARES

Slide 1—Preliminary European Market Share Rankings 1991

Let us begin our analysis by looking at 1991 in order to establish a base to look forward from. Here we see our preliminary estimate of the European semiconductor market share. While the big three European companies continued to hold the top spots, the headlines went to Intel which grew its European sales by 22 percent. This growth occurred through a substantial increase in microprocessor revenue as the PC migrated from the lower-priced 80286 to the more expensive 80386 products, and the 80486 established itself.

As Intel controls 60 percent of the European microprocessor (MPU) market, it is easy to understand why MPU was the strongest market in Europe, and indeed worldwide last year. Though I must note here that it was not alone, not surprisingly AMD more than doubled its European microprocessor sales. A review of the behavior of the various semiconductor product and applications markets last year provides a valuable guide to the reason behind the company's performance.

With the consumer market plagued with inventory problems, and the industrial market depressed by economic conditions, the discrete, microcontroller and analog markets achieved little growth. This we see reflected in the flat sales of Philips, SGS-Thomson, Motorola, and National Semiconductor.

In the EDP segment there were a few bright spots, but overall, a slowing PC market and continued restructuring among the big customers in Europe led to slow demand. This resulted in continued price erosion particularly in memory. We see this reflected in the sales of Siemens, Texas Instruments, Toshiba, and NEC, which rely on memory for a significant proportion of their revenue. Of the strong memory players, only Hitachi achieved significant growth doing very well in value-added memory modules. I would like to point out here that 7 of these top 10 vendors lost share of the European market—European, US and Japanese companies alike.

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Slide 2—Preliminary European Market Share by Supplier Base Region

Here we see the European market share by vendor base. After a rare turn of events in 1990, when European and US companies gained share of the European market, 1991 saw a return to the more familiar pattern of the last decade. That time saw the combined sales of Japanese and now Korean companies (more specifically Samsung) gaining share at the expense of the European and North American companies.

The point I am making is: a company's market share depends on how well the product and applications markets in which it operates perform, particularly in the short term. However, in the longer term this alone does not determine market share performance. One major factor is that as new companies enter a market, they take share from the bigger, more established companies. This is balanced by the fact that the big companies with huge resources can "out-invest" their competition if they apply their strengths wisely and leverage their better developed routes to market.

I shall return to this theme in a little while to look at events over the next five years. But, in order to do this we must introduce and justify our thinking on the direction of product and applications markets.

PRODUCTS

Mike Glennon

Slide 3—Market Product Share

I can analyse the European semiconductor market from three viewpoints. For products I shall examine the current status of the market; for applications I shall look forward and see which applications are likely to provide future demand for products, and for countries I shall see the impact of these trends on the regional markets. So, what do we expect to happen in these areas?

Let us turn first to products. Those products which are the most representative of the semiconductor market are memory, microcomponents and logic. These products represent over half of the semiconductor market in Europe.

The analog product segment is also significant, but while in 1991 it was larger than each of these categories, its expected growth is lower than for the others.

Slide 4—European Semiconductor Market

Here we have Dataquest's short-term and long-term growth forecasts for the products. It is clear that they show good growth, both in the short and the long term. First I shall look at the microcomponent market.

Looking at events over the past year, microcomponents have enjoyed high growth, in fact for the past two years, and this will continue for at least the next year. The major use of microprocessors is in personal computers, and the trend over the past 12 months has been towards 486-based PCs, and away from the 386.

Slide 5—European PC Shipments

While the upturn in 486 PCs is slight, it is significant, and the downturn in 386 products is very marked. This slide shows the consumption of PCs in Europe, but the shift in emphasis is also reflected in PC production. The 486 is higher in price than its 386 equivalent, so this move to higher performance increases the dollar value of the market.

Slide 6—Products, Microcomponent

In microcontrollers, growth has been slow. The weak consumer market mentioned by Jim earlier has reduced the consumption of these products. In addition, delays in the approval of GSM handsets, due to a bottleneck in testing of devices, has put back volume production of the phones, and hence the volume consumption of the high-value DSP controllers which are used in the handsets.

ISDN equipment is also a heavy user of DSP and microcontrollers, and the persistent delay in the volume use of the service has given a long-term postponement to consumption.

In the automotive industry, economic conditions across Europe have slowed new car sales, and hence the microcontrollers which are placed in them. However, the growing semiconductor content in automotive applications is offsetting this, and the market is still growing, albeit slowly. The peripherals market stalled in the past year.

Many component prices have declined severely. Maths coprocessors experienced dramatic price cuts, partly because of competition, and the PC chip set market is very competitive now and has

many suppliers. Price pressure is very high in this area, resulting in low growth for the market.

Looking now to the future, the microprocessor market, especially in PC applications, is becoming more competitive as alternative sources appear. The size of the PC market has ensured companies are prepared to risk lengthy and costly litigation in order to gain a share of this lucrative market. However, it may not remain as lucrative for them. Intel's response to this frontal attack by a variety of companies has been to try to move the majority of the consumers upmarket to a well-protected area. The rise in 486 shipments indicates that it is succeeding. While the other suppliers are battling for a smaller share of a declining market, Intel has the high-end market to itself again. However, the effect of competition on processor prices has been noticeable.

Slide 7—Intel 386SX Pricing

The price in Europe of the 16-MHz 386SX processor, shown as the lines on this graph, has been relatively stable since December 1990. Prior to this, the high prices were related to shortages in supply, as the long lead times, shown as the bars, indicate. This decline in lead times may be due to the onset of competition in this market, which is reducing prices slightly, in spite of increases in lead time.

The result is the narrowing of the gap between the low-volume price and the high-volume price. There is now very little difference between them.

These price falls are small, as the only real competitor was AMD, but the arrival of more suppliers narrows the scope for differentiation, and lower prices become more tempting.

Slide 8—Products, Microcomponent

The other noticeable feature of the processor market, is the application of consumer marketing, in the form of brand image. We are now encouraged to buy a PC with "Intel Inside," even if we are not sure what it is. This is a reflection of a maturing market.

The RISC arena has been a little unsteady for the past year. There have been many announcements of new products which provide a major improvement in performance. However, many of these products have been delayed, with the consequential effect on their consumption.

The ACE consortium was to have provided a stimulus to the use of RISC and in particular the MIPS processor. However, the departure of many key members of the consortium, such as Digital and Compaq, has weakened it considerably, so the outlook is less optimistic. Europe's contribution to the RISC market has been subdued.

While the raging battle between SPARC and MIPS and Hewlett-Packard and IBM has received much attention in the press, a company called ARM has been quietly shipping its products, with very little fuss. Considering there are four SPARC suppliers, and five MIPS suppliers, ARM—until now only using VLSI Technology as its manufacturer—has maintained a creditable success in the top five installed base products. ARM has taken the unique approach of using RISC techniques to reduce die size and power consumption, rather than to deliver the ultimate performance.

At the same time, Europe's alternative processor, the Transputer, has been endorsed by IBM, for use in its disk drives—the serial link on the device giving the greatest benefit for IBM's application.

I just mentioned that the microperipheral market stalled last year, but one specific microperipheral deserves a more detailed analysis, mainly because of its impact on the semiconductor market. I am of course referring to memory.

PRODUCTS—MEMORY

Byron Harding

Slide 9—1M DRAM Production in Europe

The memory market in Europe, and the industry supplying it, have seen some important changes since our last conference. I shall summarize these changes and their effect on the European market. To begin with, I will look at production of DRAM in Europe.

Siemens is the leader in the production of the 1M DRAM, followed at some distance by NEC and Motorola. Demand for the 1M has already peaked, so it is not surprising to see local production declining rapidly.

Slide 10—1M DRAM Production vs Demand in Europe

Total European production compared with demand indicates that a significant proportion of the market is being met by imports. Leading

importers of the 1M are Samsung and Texas Instruments.

Slide 11—4M DRAM Production in Europe

4M DRAM production is beginning to ramp up, following the wave of investment in new European plants by the companies shown in the slide.

Mitsubishi and Hitachi are the most conservative in their production schedules, and my estimates for Texas Instruments only covers phase 1 of their fab plan. Of course, all these estimates are subject to changing market conditions and strategies.

Semiconductor companies around the world have pushed out their fab construction plans in reaction to the weakness in the world semiconductor market.

Fab plans in Japan have been affected more severely by this slowdown than fabs in Europe. In fact, the strategic importance of having a fab in Europe has probably saved these plants from more severe cutbacks.

Slide 12—4M DRAM Production vs Demand in Europe

A comparison of 4M production versus demand indicates that at least 30 percent of 4M DRAM will still be imported by 1995. This is even before taking into account exports from these plants to other world markets, and the use of these fabs to run other product lines. Nonetheless, Europe *will* become more independent in its supply of DRAM and other memory modules.

The question I raise is: can the European market provide an adequate return on investment? One indicator of this is the market price for memory.

Slide 13—Worldwide Market Prices, 1M (256Kx4) DRAM

This slide shows booking prices for 1M DRAM over the last nine months in five major world markets. These are the United States, Japan, Korea, Taiwan, and Hong Kong.

Europe is placed in perspective with these markets, and in a reasonably competitive position.

Slide 14—Worldwide Market Prices, 4M (4Mx1) DRAM

In the case of the 4M DRAM, there has been some price movement in Japan, making it the cheapest market overall. This is a continuing problem of overcapacity.

Europe fits firmly above price levels in the United States, Japan, and South Korea. This relatively high position is not entirely unrelated to certain trade controls, which I shall discuss later.

Slide 15—Worldwide Market Prices, Slow 1M (128Kx8) SRAM

The Japanese market price for the 1M slow SRAM has followed almost the same trend as the 4M DRAM. Again, overcapacity is to blame, pulling the price down below all other markets—except Europe.

In January this year, the 1M SRAM benefited from complete duty suspension, marked by the star in the slide. I believe that the sudden downward plunge in the price is mainly related to this suspension, and not just a result of ongoing price erosion.

This being the case, it clearly demonstrates the effect the tariff has on the market, and the likely consequence of its removal on other products.

[Dataquest has produced a reference report entitled *EC Semiconductor Tariffs and Related Issues: a Guide for Suppliers and Buyers,* which can be obtained by contacting Dataquest's marketing department.]

Slide 16—Worldwide Market Prices, 1M (128Kx8) EPROM

This is the case of 1M EPROM, which has hit rock-bottom prices in the Korean market. Cutthroat competition between US and European suppliers has driven the price down to a ridiculous $2.5.

Including European price trends shows that Europe is the next-cheapest market after Korea. Again, it is US and European suppliers that have driven the price down, not Japanese or Korean.

These slides demonstrate that Europe is world competitive in memory prices, and a reasonable return on investment for putting expensive DRAM fabs in Europe is not likely to be gained by selling the output from these fabs in Europe alone. Another solution is to run non-memory product lines in these fabs, for which profits are higher.

Slide 17—EC Antidumping Action in Memory

This is a summary of EC antidumping action in the semiconductor field. But what is the effect of such measures on market prices?

As a case study, I will show you for the first time our estimates for Japanese DRAM reference prices compared with market prices.

Slide 18—Estimated EC DRAM Reference Price vs European Market Price, 256K DRAM

This the 256K DRAM. There is hardly any correlation between reference price and market price for this product.

The Japanese have moved out of this market and the major share is now held by Samsung, which is not bound by reference prices yet.

Slide 19—Estimated EC DRAM Reference Price vs European Market Price, 1M DRAM

The correlation is stronger for the 1M DRAM. However, as the Japanese are moving out of this market too, the correlation is being lost again. Samsung and Siemens are now leading suppliers for this part.

Slide 20—Estimated EC DRAM Reference Price vs European Market Price, 4M DRAM

The closest link is found in the 4M DRAM, as products made in Japanese fabs still have the largest share of the market.

But with European production coming on line and strong imports coming from South Korea, this link will soon be lost, and a free market will prevail.

And so, on to our forecast for the European memory market.

Slide 21—European MOS Memory Consumption

Overall demand for memory in Europe in terms of megabits is expected to grow by 50 percent per annum out to 1995.

But there is a slowdown in this growth rate in the longer term. Although PC and workstation manufacturers are increasing their production base in Europe, we do not foresee any major new applications to sustain historical growth rates.

One exception is flash memory. It is getting implemented in many existing and emerging applications. The success of flash memory has been helped by a worldwide standard on memory cards, the PCMCIA standard, which continues to evolve beyond its original charter for information storage.

Slide 22—European MOS Memory Price/Mbit

But the main differentiator in the memory market is cost, and this slide shows that flash memory suppliers, particularly Intel, are addressing this issue seriously. The market potential that flash memory presents has not gone amiss among those who envy Intel's 80 percent market share.

Slides 23 and 24—Flash Memory Product Announcements

This is a summary of some of those companies' plans, all the way from Intel through to TSMC. This is a market to watch over the next few years, as these companies start competing against each other for slices of Intel's market share.

PRODUCTS—LOGIC

Mike Glennon

The outlook is also for a respectable growth over the next five years, comparable to microcomponent and memory.

ASIC has been the strongest contributor to the logic market, but now a wider range of VLSI standard products is encroaching upon ASIC's domain.

Slide 25—Product Cycle Times

ASICs are often used early in a piece of equipment's life cycle, where standard products cannot provide the flexibility in the application.

As the equipment becomes more mainstream, and the volume increases, standard products take over from the ASICs.

These standard products are being developed earlier in the product life cycle, and this is compressing the early period in a product's life when ASICs are the preferred solution.

Many of these VLSI products are supplied by ASIC companies, as they attempt to break out of the ASIC market. The profitability of these products is high, despite the competition.

The price of a gate array may be low, but the price can rise significantly when it is sold as part of a SPARC chip set for example. The design expertise is being leveraged through the higher-priced silicon, raising the profitability of the product line.

Slide 26—Products, Logic

However, the factors which forced down prices in the ASIC market will also apply to these chip set markets.

There is only a limited number of high-volume applications, and many of these have already been identified by these ASIC companies. The PC chip set has had its day. The next application is now GSM, and already suppliers are fighting for these chip set sockets.

Image and data compression, high-definition TV, and cordless communications are other areas where we expect to see severe competition in the longer term.

No surprises are forecast for the general-purpose logic market, and it will maintain its steady level. The emphasis will move away from bipolar products towards CMOS and BiCMOS. The semiconductor market owes much to general-purpose logic, and there is still much to be learned from this market.

Finally, while bipolar is clearly showing a decline in logic, a place still exists in the highest-speed applications. These include very high-performance products such as digital testers or supercomputers.

APPLICATIONS

Slide 27—European Semiconductor Market, Applications Share

Moving on now to applications, I shall look at EDP, communications, and consumer. As you can see, these represent about two-thirds of the market.

Slide 28—European Semiconductor Market

Here is the short- and long-term forecast for these applications. You can see from this that:

- Data processing shows the highest long-term growth.
- Perhaps surprisingly, communications shows the lowest of the three.

I shall explain the reasons behind this in the next few minutes.

Slide 29—Applications, EDP

Looking in more detail at EDP applications, manufacture of PC products is returning to Europe again, reversing the transfer of production to the Far East. The lack of control of production at these large distances, in a fast-moving market, has added to the cost of manufacture.

The total cost of delivering a product to a customer is now considered; offshore manufacture is not necessarily cheaper in this overall equation. PC manufacture is not alone in this, and other areas of manufacture, such as some consumer and telecoms products, are also being brought back to Europe.

In addition to PC manufacture, workstation and mainframe manufacture is likely to increase, following the transfer of some production to Europe. Companies such as Bull and Olivetti are expected to increase their purchase of semiconductors, following a moratorium in purchasing to reduce inventories. These, however, are short-term changes. In the long term, multimedia-related products will be the driver for electronic data processing. Windows and other software will make significant demands on processor performance and memory needs.

Image management will also stimulate demand for peripheral chips; for image compression and decompression, and also network interface products. The complexity of these components is so high, they must be developed in multichip solutions. So, the outlook for multimedia applications is good, as the silicon demands are quite high at the moment.

However, there are many suppliers which are developing chip sets for this market now, while the high growth is still some time away. When the market does begin to take off, several suppliers will be ready to jump in at a moment's notice. The final result will be severe competition on price.

Slide 30—Applications, Communications

Communications is another major applications area in Europe, and is indeed Europe's greatest strength. However, the high long-term growth for the communications market is now past its peak, and we can expect lower growth in the long term. Much of the high growth is related to the digitization of communications within Europe, but this is nearing completion. But Eastern Europe still requires a digital infrastructure to be built, and the introduction of second operators into many countries will add to exchange and switch sales. The GSM network is still being built, but much of this work will be also completed in the near term. The market with the highest potential growth is cordless communications, although this does not require the same level of infrastructure.

So the potential decline in internal consumption of infrastructure products must now be balanced by exports of European telecoms products. Typically this would include exchange manufacture and mobile handsets. The outlook for the communications sector of the semiconductor market is therefore related in the long term to the health of the world's communications market, as the export of equipment is dependent on the competitiveness of Europe's telecoms hardware suppliers.

These companies should maintain some success, however, as the world's top telecoms hardware manufacturers are European.

Slide 31—Applications, Consumer

In the consumer market, while the short-term demand has been weak, the longer-term outlook is much better. Fear of recession has slowed consumption of consumer products, and many suppliers built products in time for an expected boom, related to this year's Olympics, but this has yet to materialize, resulting in large inventories. There were some signs of a mini-boom in countries such as Austria and Switzerland prior to the Winter Olympics, but the summer boom is yet to come.

In the longer term, the outlook is better. Digital audio equipment will give consumers something new to spend their money on, when confidence returns to the market. Multimedia products provide another outlet for spending.

The negative factor is incompatiblity between vendors' formats, in both digital audio markets and multimedia. This may provide a brake on early take-up of the devices, until a clear winner is seen.

HDTV is a long time away, and the standards battle is yet to be finished. Resistance from both suppliers and consumers may hinder the success of this product, in spite of efforts by the European Commission:

- The Commission is trying to enforce a standard.
- But the suppliers have yet to be satisfied.

The consumer as yet can only see an expensive TV, with little benefit in improved resolution.

I have shown you how we expect the market to behave for both products and applications, and this clearly will have an impact on how the semiconductor companies will perform over this period.

VENDOR ANALYSIS

Jim Eastlake

Earlier, I established the principle that the behavior of product and applications markets affect company market share, though I acknowledged that there were other factors.

Well, I am now going to take the applications and product forecast that Mike and Byron have just presented and use them to do some portfolio analysis to see how market shares may evolve over the next five years.

Slide 32—European Product Split

This is a listing of the major product markets from bipolar digital, through MOS memory, micro, logic, and so on. On this we can plot the percentage share that each represents of the total European market.

So, bipolar digital represents 4 percent of the European market, MOS memory 20 percent and so on. The "average" line plots these shares giving an average for the European market. Note that analog, memory and micro represent the three largest markets. Though MOS logic and discretes are quite sizable too.

Take the long-range product forecasts and see which product categories contribute the most growth in dollars, or ECU, to the European market over the next five years. We can now plot what we call the "growth contribution" that a particular product area will make.

As you saw, we believe memory and micro will contribute most of the value of the growth to

the European market, followed by logic and then analog. Note that discretes, opto. and bipolar products contribute little or nothing to Europe's growth.

So far then, the slide tells us that while analog is the biggest market in Europe, its growth contribution is somewhat less that MOS memory and micro, which by 1996 will be substantially bigger markets than the other five product areas.

Slide 33—European Applications Split

To cut a long story short, we can do a similar analysis with applications markets. Here we see the percentage share that the six applications markets show and the markets' growth contributions. The conclusion is that data processing is Europe's largest applications market though communications, industrial and consumer are quite substantial. Also, over the next five years, we believe data processing will contribute nearly 35 percent of the value of Europe's semiconductor market growth. The nearest other market will be communications which will contribute about 20 percent.

So, here we have a quantitative analysis technique based on size of current market and a market's growth contribution for products and applications. I am now going to use it to see if we can draw some conclusions about what US, European and Japanese companies' share of the European market will be like in five years' time.

In order to do this I am going to take the aggregated European sales in 1991 of the three big US, European and Japanese companies to look at how their combined market share may evolve. So, I have combined the European revenues of Philips, Siemens and SGS-Thomson; Motorola, Intel and Texas Instruments; and Toshiba, NEC and Hitachi. I have then calculated what percentage of the combined sales of these three groups is by product and applications market. Let us begin with the position of three European companies.

Slide 34—Top Three European Companies' Analysis, Product Split

This slide plots the top three companies' combined product portfolios on the share/contribution graph. The bars show the percentage of their total European sales, which fall into each of the main product markets. You can see that their combined sales are heavily weighted towards analog and discrete products which represent over half the business; whereas memories and microcomponents, the main contributors to growth, represent a relatively small part of combined business. Let us look at their combined position in applications.

Slide 35—Top Three European Companies' Analysis, Applications Split

Again, the bars show the percentage of the three companies' combined European revenues which fall into the major applications markets. The analysis shows that nearly 35 percent fall into consumer, when consumer represents only 18 percent of the European market. Sales in industrial and transportation are pretty much at market average. But, the percentage of their business, which falls in the two key growth segments of data processing and communications, is notably below average.

So we can conclude that the big European companies have dominance over the slower growth product and applications markets. With this in mind it becomes clear why the three companies have made certain strategic moves:

- Siemens has committed itself so heavily to DRAM, and has taken a license for MIPS RISC technology.
- Pasquale Pistorio [of SGS-Thomson] has voiced the need to enter the DRAM business; why he acquired Inmos to strengthen SGS-Thomson's micro and SRAM businesses; and why he is showing an interest in X86 processors.
- Philips has stayed in the PC business, and taken the license to Sun's SPARC, though it clearly needs to increase its presence in memories.

Slides 36 and 37—Top Three European Companies, Product and Applications Split

These are independent companies, So, their individual details differ considerably. In order to illustrate this I have included the next two slides in the conference binder which illustrate the individual products and applications portfolio details of the three. You can see for example, Siemens' significant sales in memories, and Philips' dominance in the consumer segment.

Slide 38—Top Three US Companies' Analysis, European Product Split

Now let us move on to look at North America. The combined product sales of the "big three" is shown here. It is certainly very different to the European companies' picture.

Nearly half of US companies sales to Europe fall into microcomponents: over twice the market average. By contrast, the combined portfolio of the three falls significantly below the market average in memory, logic, analog, discretes and optocomponents.

Companies with more than twice the market average share in a product tend to lose share with time. So, with such a presence in micros it seems highly likely that their combined market share will come under pressure. Though micros is one of the two big growth contributors.

Now we will look at how US companies' applications pan out.

Slide 39—Top Three US Companies' Analysis, European Applications Split

Well, not surprisingly with such a focus on microcomponents, an above-average percentage of their sales in Europe are into data processing applications. What this comparison reveals is a gap in the consumer segment.

So, among the major growth contributors in Europe, the three US companies are probably too heavily biased towards microcomponents, and data processing. In order to improve their likelihood of maintaining market share, they should strengthen their presence in memories, MOS logic and analog, and focus on consumer. To this end we have seen:

- Motorola develop a relationship with Toshiba over memory technology and products. It became involved with a number of companies in the field of consumer such as Philips, with which it is developing multimedia products.
- Intel perform pioneering work with flash memory, enter the DRAM business again through reselling Korean products, and develop its own DVI multimedia algorithm and product offerings.
- Texas Instruments blazes a trail of manufacturing and technology joint ventures in memories with its competitors, customers and even governments. It announced a re-emphasis on its consumer division, and is one of the most active participants worldwide in the various HDTV projects.

Slides 40 and 41—Top Three US Companies' Analysis, European Product and Applications Split

Again, US companies' individual details differ greatly. In order for you to study them in detail I have included these next two slides.

Slide 42—Top Three Japanese Companies' Analysis, European Product Split

Now to the big three Japanese. Well, no prizes for guessing which product area represents the biggest portion of their businessmemories. Again, like the North Americans, the share of total sales that their biggest product area represents of their total European business is over twice the market average for that product. Unlike the North Americans, a big portion of their sales comes from the other high growth area, microcomponents.

Other than memories and micros, a study of the rest of their product profile reveals that their presence in bipolar, analog and discretes is well below the European average. This profile has left them vulnerable. With the flat memories business of the past couple of years they have found it difficult to maintain share, and profits have been under pressure. Let us look at their applications profile.

Slide 43—Top Three Japanese Companies' Analysis, European Applications Split

Here we see an interesting picture. Their combined sales reveal an applications profile that maps the European market very closely. The emphasis is clearly towards data processing and is memory-dependent, but unlike the North Americans they have a good deal of business in the consumer segment.

The conclusion I would draw is that Japanese companies' product portfolios *are* too memory-dependent in Europe. But knowing the products and technologies they offer in Japan, they have the ability to boost their European presence in the other

areas quite considerably. Their weakness is in microcomponents, more specifically microprocessors and microperipheral chip sets.

To this end we have seen Toshiba, NEC and Hitachi make a number of moves over recent years to rectify this. Most significant for me is the way in which they have embraced RISC. I see this as a possible route for them to break the North American hold over this area. The irony of the situation is that it is the North Americans who have given them the RISC technology.

Slides 44 and 45—Top Three Japanese Companies' Analysis, European Product and Applications Split

Again no one company is the same and I have yet again enclosed the individual companies' details in the conference binders for your reference.

I have shown how the evolution of product and applications markets have an effect on market share. To a lesser extent, the behavior of country markets can also play a role in determining vendor performance. So, next, we would like to give you our analysis of the main country markets in Europe.

REGIONS

Mike Glennon

We have now seen how we expect the markets for products and applications to behave, and examined the expected impact of these trends on the semiconductor companies which operate in the European market.

There now remains the regional analysis of the market, where we can see what we expect to happen at the country level.

Slide 46—European Semiconductor Market, Regional Share

For this I will again focus on three representative regions:

- Germany
- United Kingdom and Eire
- France

As you can see, these three countries represent over two-thirds of Europe's semiconductor consumption.

Slide 47—European Semiconductor Market, Consumption Forecast

Again, this is Dataquest's forecast for the regions. From this you can see that we forecast the United Kingdom and Eire to have the highest growth of the three, and France to have the lowest. So now I shall look at the reasoning behind this forecast.

Slide 48—Countries, Germany

Turning first to Germany, the region's short-term outlook is poor, but the longer-term outlook is more positive. The cost of unification has had a big impact on the GDP growth, as we said it would at this conference last year. Higher wage demands are increasing costs and interest rates, giving Germans less money to spend on consumer goods. The result is some growth in consumer inventories, and a cutback in production. In addition to this, some consumer production is moving out of the region to areas such as Austria, which has stronger links into Eastern Europe.

The electronic content of cars is increasing, and this is compensating for the short-term decline in new car sales. Exports of cars, in particular to the United States, are growing again, so this sector will improve. To balance these negative factors, longer-term growth looks good. The telecoms business is strong, and the country's manufacturers benefit by being close to Eastern Europe.

Industrial production is also strong, and stable, and does not suffer the same swings in demand as consumer or EDP segments. PC manufacture is also rising, and this is a high-growth area. The longer-term outlook is therefore good, partly due to the size of the country, and the high demand as a result of this. The level of equipment manufacturing investment in Germany by foreign companies has not been massive; but big enough to have an impact on production in the region.

Slide 49—Countries, United Kingdom and Eire

The UK and Eire region also shows high growth, related very strongly to the presence of foreign companies which have invested in manufacturing in the region. However, the result of this foreign investment is that the design wins for

the product are in the home market. The short-term outlook is for a recovery, following two weak years. This is related to the expected recovery in consumer consumption, and the knock-on effect on consumer equipment production. The growth in the manufacture of PCs is also contributing to the short-term recovery.

Presenting the conference here in Dublin means Eire should receive a special mention. The Irish market is a major contributor to the UK and Eire region. The location of manufacturers such as Apple, Digital and others means the market here is tied strongly to the PC market in Europe. We foresee this market to continue to show high growth, as the introduction of more advanced PC and workstation products stimulates EDP demand in Europe. The UK and Eire region has been particularly successful in courting foreign investment, perhaps the most successful region in Europe. This is a result of a continued policy throughout the 1980s.

Slide 50—Countries, France

Finally, France. The country is in a poor state of health, with some key French manufacturers in the process of transferring some manufacturing outside Europe to regions with low labor costs. This is at a time when many other countries are attracting manufacturing back to the home region.

But the telecoms business in France is good, and the country is benefiting from the telecoms market boom. The longer-term outlook is not so good, however, as the telecoms manufacturing business is moving past its growth peak.

The factor which is most likely to have an impact on semiconductor consumption is equipment manufacturing. The government appears to have made little effort to attract foreign manufacturers. Some local manufacturers are now transferring production overseas, and there are few new ones to replace them. The French semiconductor market may suffer as a result.

So I have shown you our expectations of performance both in the short term and the long term for the key areas of: products, applications and regions. But how will the European region as a whole perform when compared with the other worldwide regions?

Slide 51—Worldwide Semiconductor Forecast, Actual Market Share by World Region

This is Dataquest's latest forecast for the world regions, out to 1995. Europe lost its position as the world's second-largest semiconductor market as long ago as 1980. The United States lost its leading position in 1985. If the picture is not clear, the next slide shows the underlying trend.

Slide 52—Worldwide Semiconductor Forecast, Market Share Trend by World Region

From this slide you can see that Western Europe is in danger of becoming the smallest semiconductor market in the world, as the growth in the Asia/Pacific region outstrips that in Europe. The transfer of equipment production to that region is reducing the equipment production in Europe, and hence the semiconductor consumption.

If this is the case, Europe may lose its high technology to other regions, as the worldwide semiconductor suppliers focus their attention in areas where much of the world's manufacturing is located. If this occurs, European equipment manufacturers may not have access to the latest technology, and will therefore lose a competitive edge for their equipment.

GLOBAL INVESTMENTS

Jim Eastlake

Slide 53—Investment

I would like to finish this market analysis with a few observations on the global investment environment.

Between 1986 and 1991 worldwide capital spending on semiconductor plant and equipment grew from $5.1 billion to $14.4 billion. We attribute this incredible surge to a capital investment boom in Japan fuelled by cheap money, and spurred on by a double-digit growth in the worldwide PC market. This has left the industry with significant excess capacity that is going to take time to work off. There are several signs which point to this:

- IC prices are flat or declining, particularly memory products.

- The profits announced by particularly the big Japanese corporations have slimmed.
- The level of foundry activity is increasing, which suggests that some companies are scrambling to sell excess wafer fab capacity in order to attain higher utilization.
- The rate of closure of older fabs is picking up and the speed with which new lines are being brought forward has slowed.

Slide 54—Delayed 200 mm Fab Plans in Japan

This slide shows the number of 200 mm mainly memory fab projects that have been delayed or scrapped recently in Japan. There are 12 here but outside Japan there are even more. Byron already indicated that Europe has not escaped.

Slide 55—Worldwide Forecast of Production, Capital Spending and Wafer Fab Equipment

Against this background we do not expect the current levels of capital spending to be maintained. This table summarizes our latest projection for semiconductor production, capital spending and fab equipment revenues.

You will see that we expect global capital spending to shrink by 3 percent this year and that wafer fab equipment sales will decline by 8 percent. The projected growth of 14 percent in the value of semiconductor production may then seem contradictory, but this is possible because of the excess capacity. In the longer term, we forecast the compound annual growth rates for capital spending and fab equipment as being only single-digit across the period 1990 to 1995. This is to be compared with the solidly double-digit growth through the 1980s.

Slide 56—Investment

What do we consider to be the implications of the end of this Japanese-led boom.

Firstly we can expect Japanese semiconductor companies to slow down their plans for foreign investment. There are clear signs of this happening now. Secondly, we see a slowdown in the flow of capital from Japan. The migration of Japanese equipment and materials companies set to follow their customers abroad will slow. This will result in fewer acquisitions and investments abroad which in turn will cut off a vital flow of investment to, in particular, US companies, given the importance Japanese capital has played in funding start-ups. Thirdly, Japanese companies will increasingly move away from commodity products towards offerings with added higher value; as a result, chip design and manufacturing flexibility will grow in importance. Finally, there is the spectre of increased trade friction.

The silver lining to this dark cloud rests on the simple fact that the increasing use of semiconductors across a bewildering array of applications will continue at a steady pace. Several new areas promise to kick the industry back into high gear over the next four or five years. We have mentioned some already. But, we must be vigilant for there is a clear analogy with market conditions of the past, if capacity is cut back too far at the wrong time.

Slide 57—Summary

We explained how we believe memory reference prices will be less influential in the future as production in Europe increases. We then indicated that we see semiconductor demand from the communications segment in Europe starting to slow, as the digitization of exchanges nears completion. Germany is experiencing a short-term slowdown as the cost of unification slows economic growth. But as the country recovers, we will see the semiconductor market improve within the window of this forecast.

I indicated that, *combined*, the big three Japanese companies seem best positioned in Europe's product and applications markets to maintain or grow market share over the next five years. And finally, the current overcapacity in the industry is going to take time to work off with the inevitable consequences on prices.

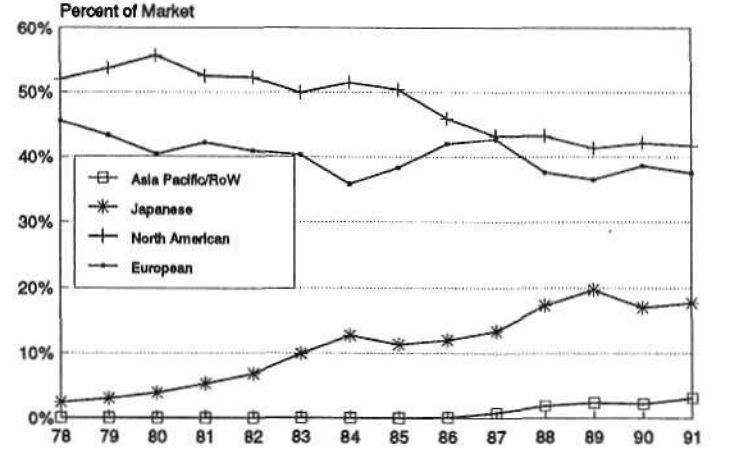
PRELIMINARY EUROPEAN MARKET SHARE RANKINGS 1991

(Millions of US Dollars)

1990 Rank	1991 Rank	Name	1991 Revenue	91/90 % Growth
1	1	Philips	$1,172	1.5
2	2	Siemens	958	-0.6
3	3	SGS-Thomson	887	-2.3
4	4	Motorola	770	0.7
6	5	Intel	760	22.2
5	6	Texas Instruments	629	-1.3
7	7	Toshiba	509	3.9
8	8	NEC	452	8.4
9	9	National Semiconductor	408	0.0
10	10	Hitachi	318	16.5

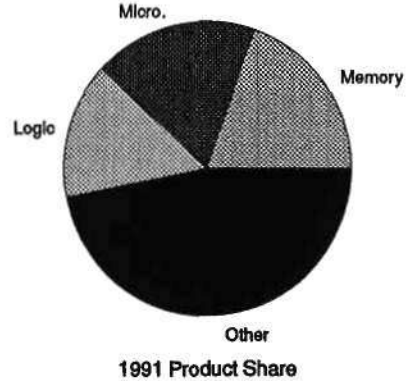
Source: Dataquest (June 1992 Estimates)

PRELIMINARY EUROPEAN MARKET SHARE BY SUPPLIER BASE REGION



Source: Dataquest (June 1992 Estimates)

EUROPEAN SEMICONDUCTOR MARKET PRODUCT SHARE



1991 Product Share

EUROPEAN SEMICONDUCTOR MARKET

(Millions of ECU)

	1991	1992	% AGR	1996	% CAGR
MOS					
Memory	1,787	2,000	11.9	3,584	14.9
Microcomponent	1,701	1,929	13.4	3,167	13.2
Logic	1,366	1,463	7.1	2,455	12.4

Source: Dataquest (June 1992 Estimates)

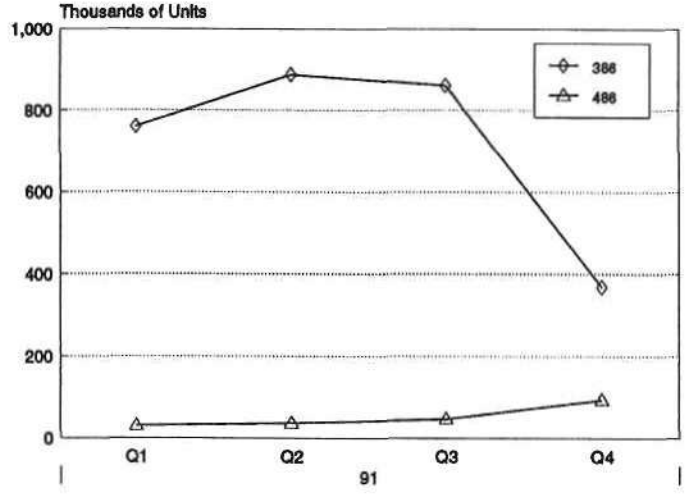
PRODUCTS - MICROCOMPONENT

- Microprocessor strengthened
  - Processor mix moved upmarket
- Microcontroller
  - Weak consumer market
  - GSM delays for DSP products
  - ISDN slower than expected
  - Transport segment slow
- Microperipheral
  - Significant price declines
  - Stronger competition than anticipated

PRODUCTS - MICROCOMPONENT

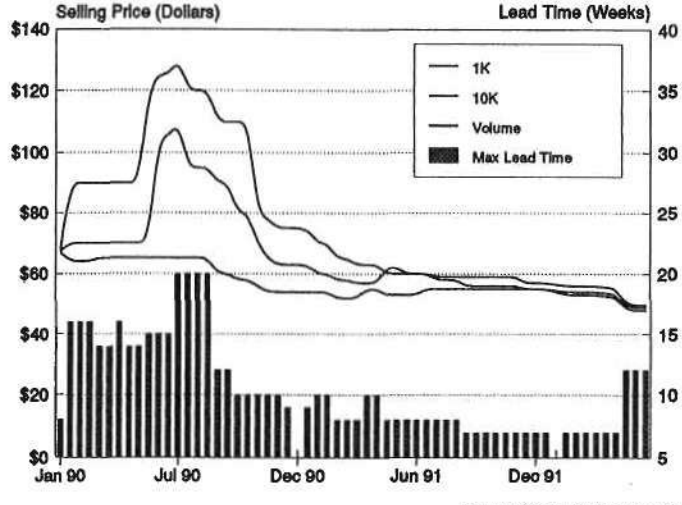
- Competition enters microprocessors
  - AMD, Chips & Tech, Cyrix, Texas, ST
  - Intel responding well
  - Consumer marketing comes to processors
- RISC
  - Step improvement in performance
  - ACE consortium weakening
  - ARM achieving success
  - IBM endorsing the transputer

EUROPEAN PC SHIPMENTS



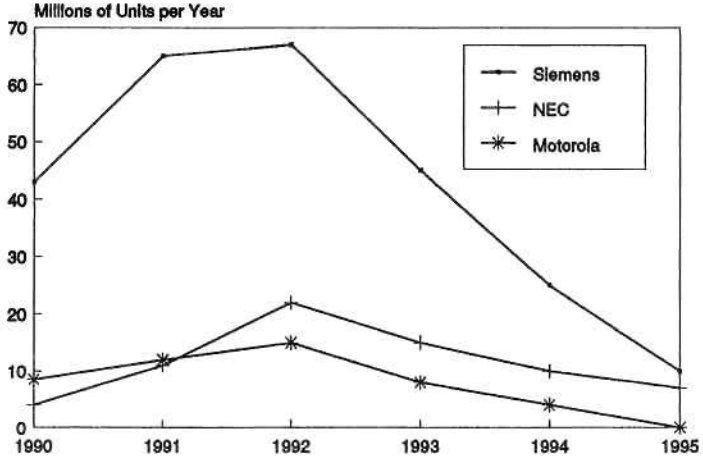
Source: Dataquest (June 1992 Estimates)

INTEL 386SX PRICING



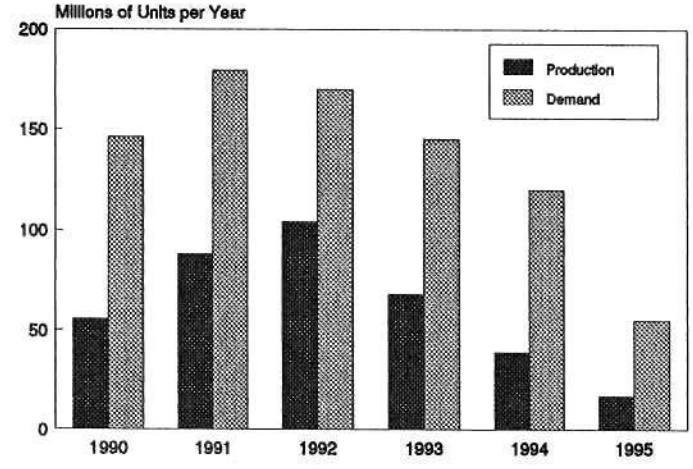
Source: Dataquest (June 1992 Estimates)

1M DRAM PRODUCTION IN EUROPE (PROJECTION)



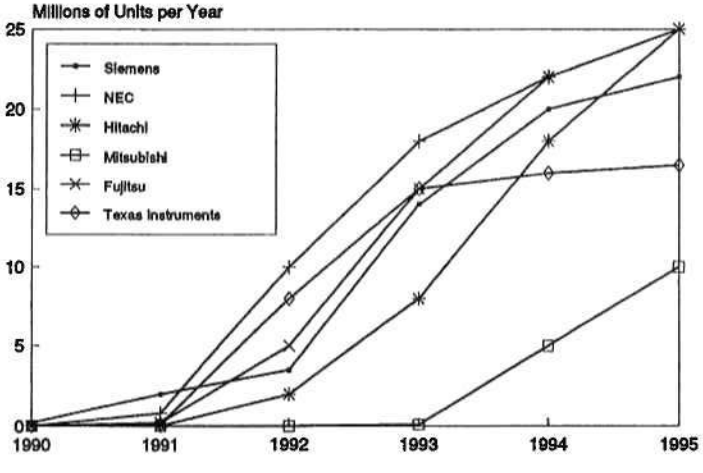
Source: Dataquest (June 1992 Estimates)

1M DRAM PRODUCTION vs DEMAND IN EUROPE (PROJECTION)



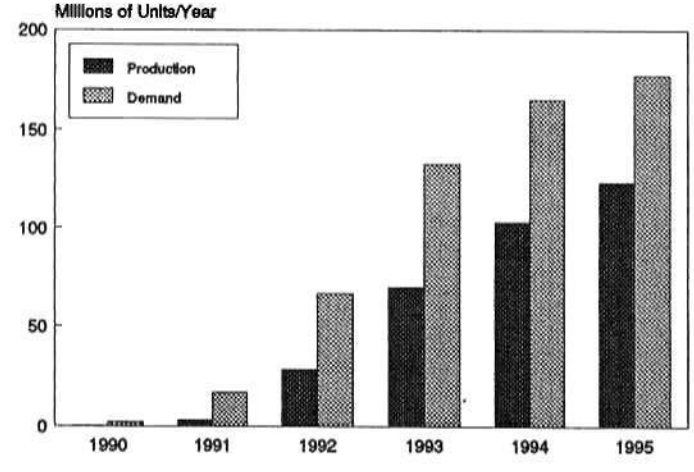
Source: Dataquest (June 1992 Estimates)

4M DRAM PRODUCTION IN EUROPE (PROJECTION)



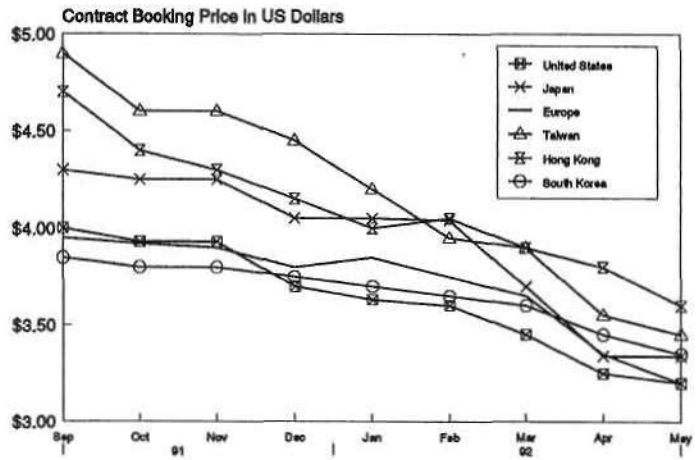
Source: Dataquest (June 1992 Estimates)

4M DRAM PRODUCTION vs DEMAND IN EUROPE (PROJECTION)



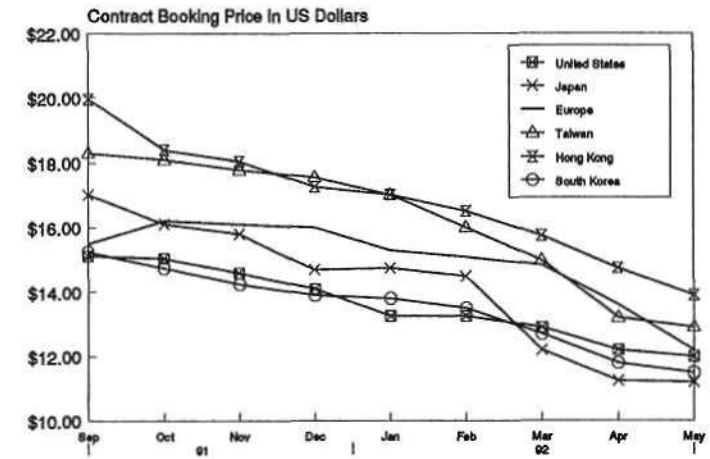
Source: Dataquest (June 1992 Estimates)

WORLDWIDE MARKET PRICES
1M (256Kx4) DRAM



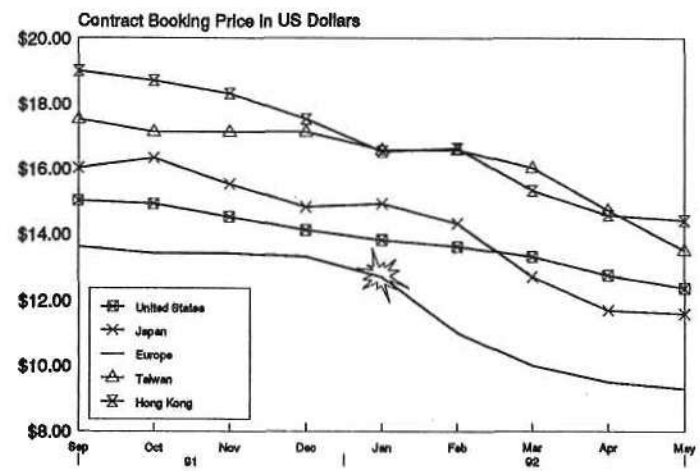
Source: Dataquest (June 1992 Estimates)

WORLDWIDE MARKET PRICES
4M (4Mx1) DRAM



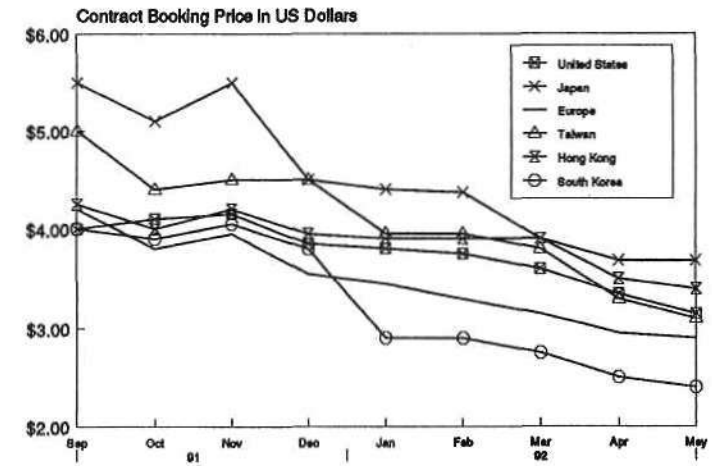
Source: Dataquest (June 1992 Estimates)

WORLDWIDE MARKET PRICES
SLOW 1M (128Kx8) SRAM



Source: Dataquest (June 1992 Estimates)

WORLDWIDE MARKET PRICES
1M (128Kx8) EPROM



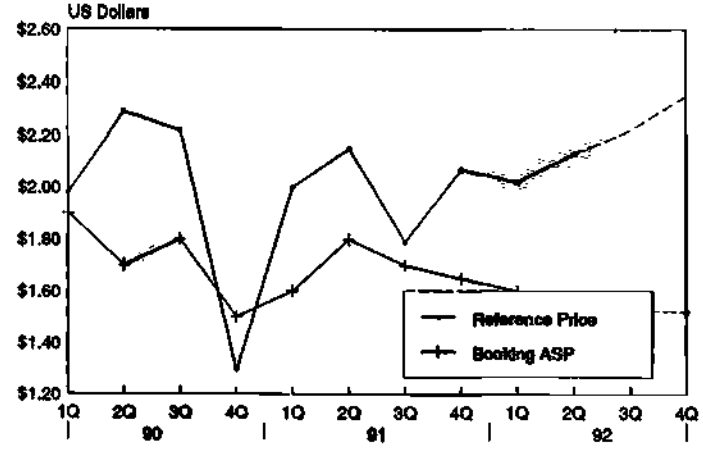
Source: Dataquest (June 1992 Estimates)

EC ANTIDUMPING ACTION IN MEMORY

Japanese DRAMs:	Imposed January 1990
Japanese EPROMs:	Imposed March 1991
S Korean DRAMs:	Verdict expected In June 1992

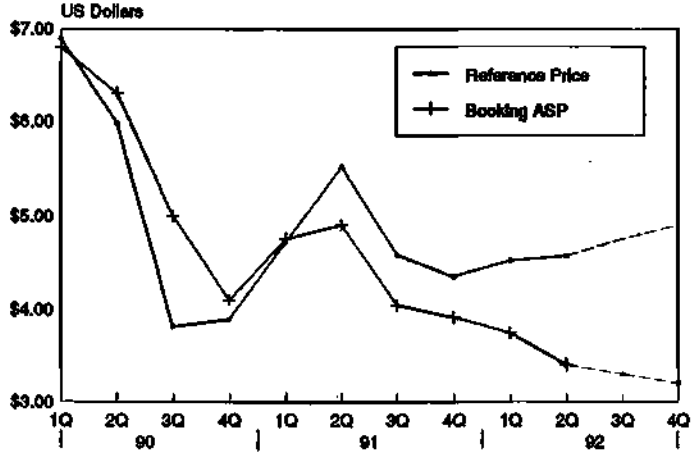
SRAMs next?

ESTIMATED EC DRAM REFERENCE PRICE vs EUROPEAN MARKET PRICE, 256K DRAM



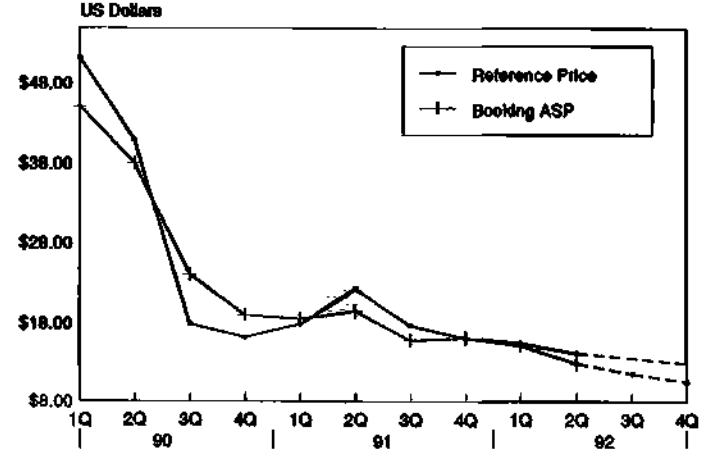
Source: Dataquest (June 1992)

ESTIMATED EC DRAM REFERENCE PRICE vs EUROPEAN MARKET PRICE, 1M DRAM



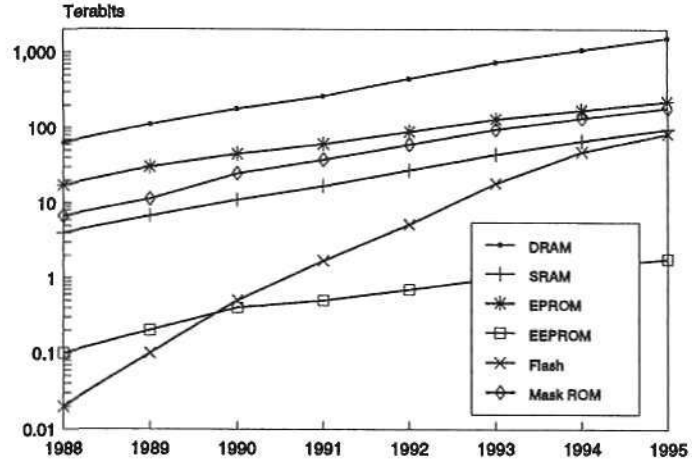
Source: Dataquest (June 1992)

ESTIMATED EC DRAM REFERENCE PRICE versus EUROPEAN MARKET PRICE, 4M DRAM



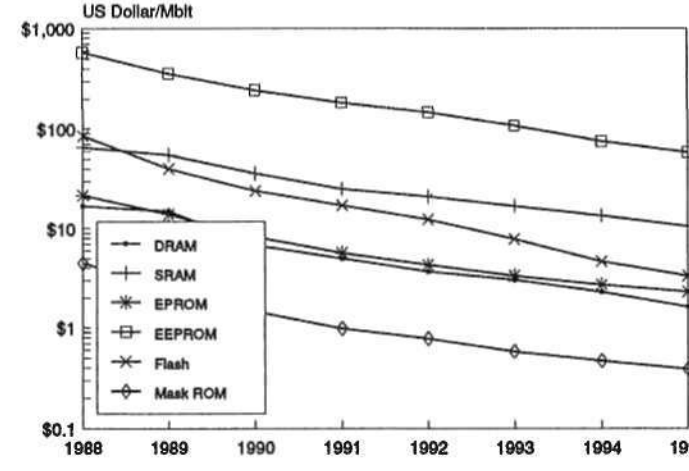
Source: Dataquest (June 1992)

EUROPEAN MOS MEMORY CONSUMPTION
(BIT SHIPMENTS)



Source: Dataquest (June 1992 Estimates)

EUROPEAN MOS MEMORY PRICE/MBIT
(AVERAGED ACROSS ALL DENSITIES)



Source: Dataquest (June 1992 Estimates)

FLASH MEMORY PRODUCT ANNOUNCEMENTS

	1M	2M	4M	8M	16M
Intel	4/89	6/90	1/92	4/92	4/93
AMD	9/90	4/91		1/93	9/93
Toshiba	11/90		9/91		6/93
Hitachi	9/90		3/92		
Atmel	9/90				
Samsung				3/93	
SGS-Thomson	1/92		9/93		3/93
WSI					
SEEQ	6/89		6/93		
Mitsubishi	9/90		1/93		8/93
Catalyst	3/91				

Source: Dataquest (June 1992 Estimates)

FLASH MEMORY PRODUCT ANNOUNCEMENTS

	1M	2M	4M	8M	16M
NEC	1/91		3/92		6/93
Fujitsu	1/93		6/93		12/93
Texas Inst.	1/91		1/93		1/95
NMB				1/95	1/95
Cypress	9/92		3/93		9/93
Sharp				1/95	3/95
Vitelic			9/93		
Hualon			9/93		
Macronix					9/95
Oki			3/93		3/94
TSMC				3/93	1/94

Source: Dataquest (June 1992 Estimates)

PRODUCTS - LOGIC

- Emphasis moving to standard products - ASIC is the loser here
- Fierce competition in GSM, HDTV, data compression, will axe chip prices
- General-purpose logic will move to CMOS and BiCMOS
- Bipolar still has a place in high-speed applications

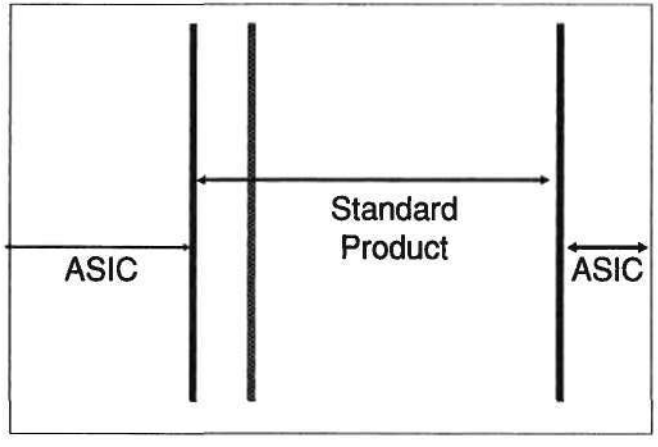
EUROPEAN SEMICONDUCTOR MARKET

(Millions of ECU)

	1991	1992	% AGR	1996	% CAGR
EDP	2,594	2,837	9.4	4,392	11.1
Communications	2,123	2,240	5.5	3,225	8.7
Consumer	1,613	1,695	5.1	2,581	9.7

Source: Dataquest (June 1992 Estimates)

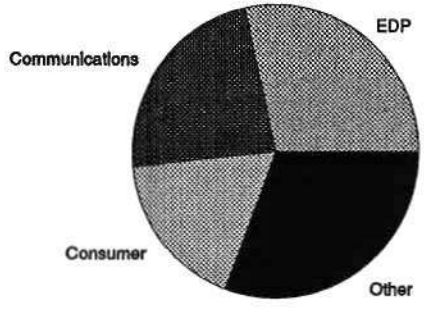
PRODUCT CYCLE TIMES



Product Lifetime

Source: Dataquest (June 1992 Estimates)

EUROPEAN SEMICONDUCTOR MARKET APPLICATIONS SHARE



1991 Applications Share

Source: Dataquest (June 1992 Estimates)

APPLICATIONS - EDP

- High growth again
  - PC manufacture returns to Europe
- Mainframe and workstation manufacture in France and Italy rises
- Longer-term multimedia will be the application driver

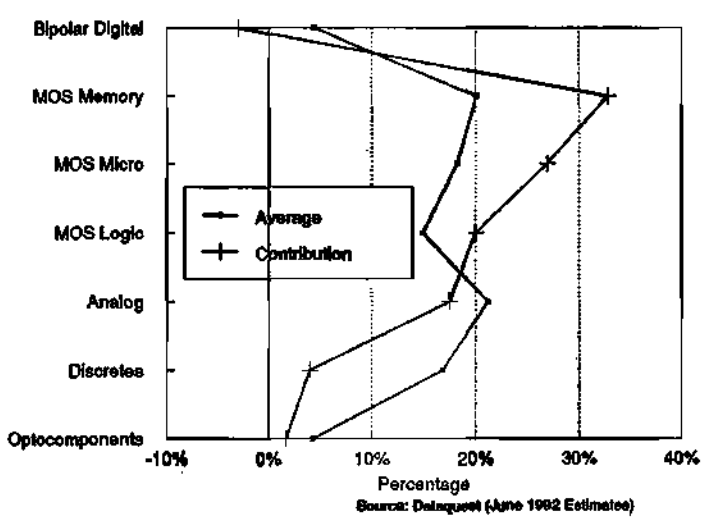
APPLICATIONS - CONSUMER

- Short-term demand weak
  - Threat of recession in most countries
  - Excess inventory of all consumer goods
  - Olympics may not help
- Longer-term outlook is better
  - DCC and minidisk to stimulate demand
  - Consumer multimedia
  - HDTV: let's wait and see

APPLICATIONS - COMMUNICATIONS

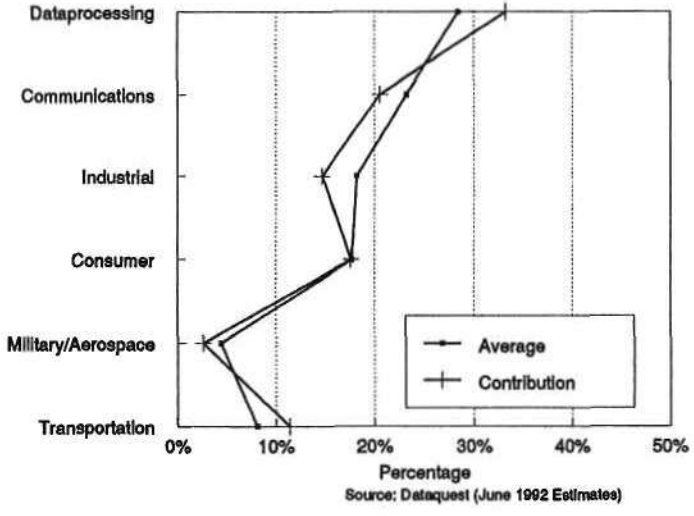
- Europe's greatest strength
- Internal consumption:
  - Digital communications
  - Mobile and cordless
  - Infrastructure in East Europe
- External exports:
  - Exchanges
  - Mobile handsets
- World's top hardware suppliers are European

PORTFOLIO ANALYSIS
EUROPEAN PRODUCT SPLIT



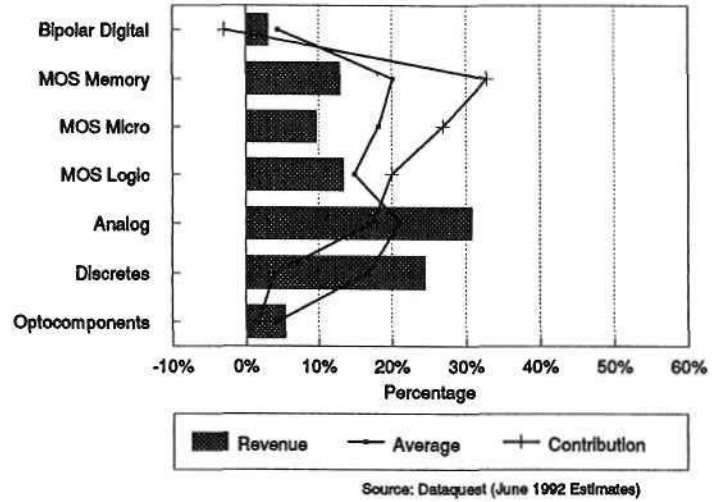
Source: Dataquest (June 1992 Estimates)

PORTFOLIO ANALYSIS
EUROPEAN APPLICATIONS SPLIT



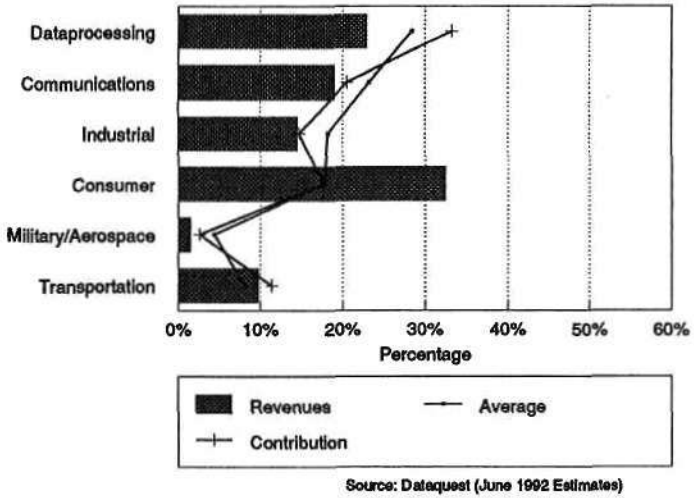
Source: Dataquest (June 1992 Estimates)

TOP THREE EUROPEAN COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



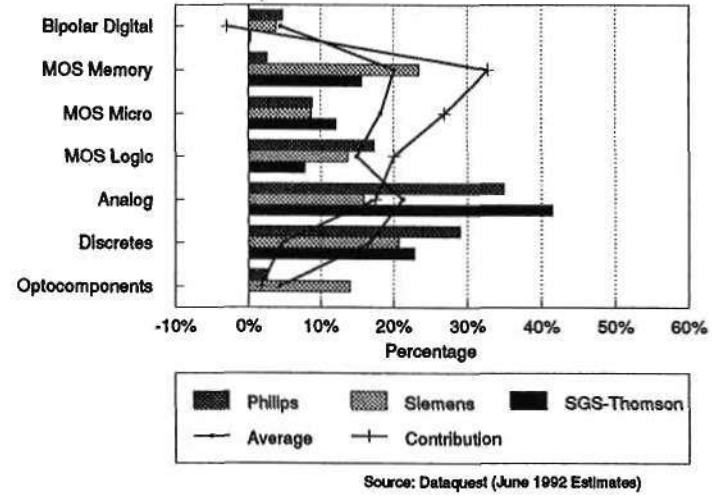
Source: Dataquest (June 1992 Estimates)

TOP THREE EUROPEAN COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



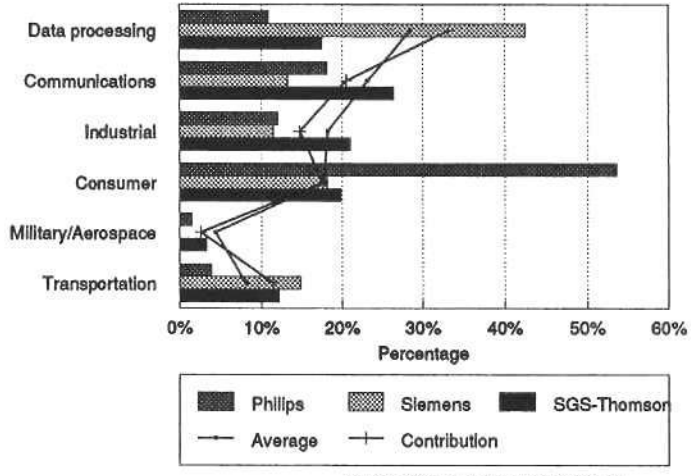
Source: Dataquest (June 1992 Estimates)

TOP THREE EUROPEAN COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



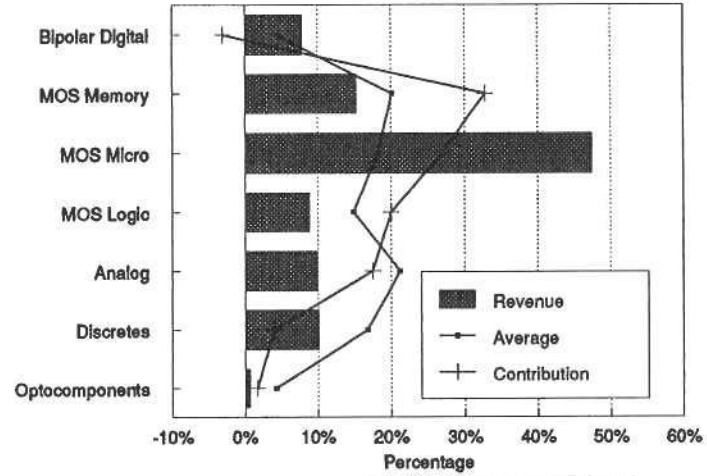
Source: Dataquest (June 1992 Estimates)

TOP THREE EUROPEAN COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



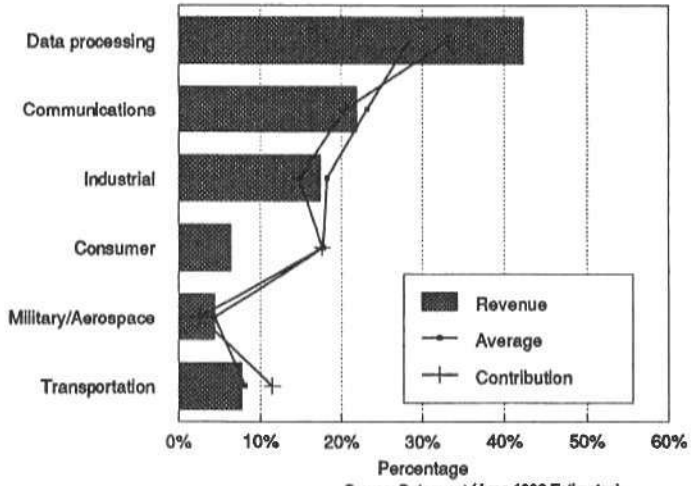
Source: Dataquest (June 1992 Estimates)

TOP THREE US COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



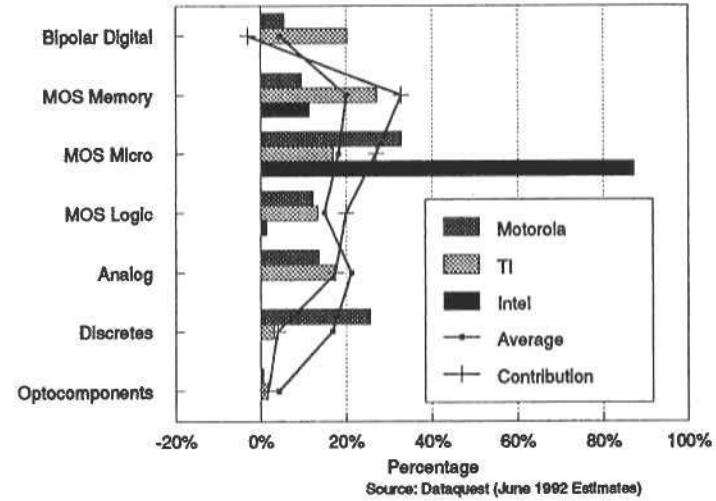
Source: Dataquest (June 1992 Estimates)

TOP THREE US COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



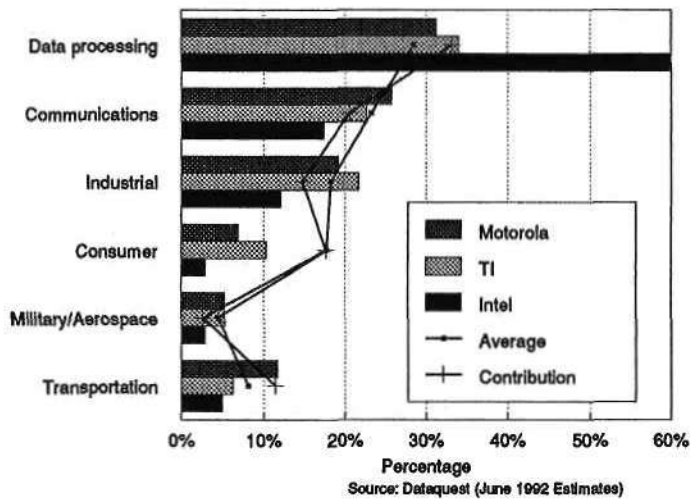
Source: Dataquest (June 1992 Estimates)

TOP THREE US COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



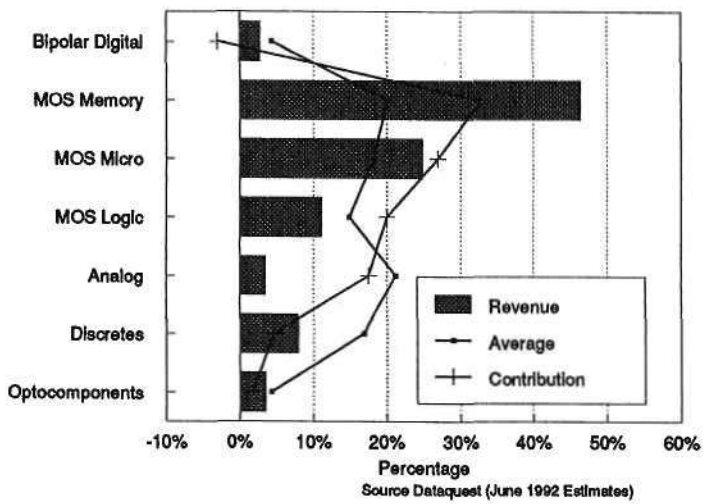
Source: Dataquest (June 1992 Estimates)

TOP THREE US COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



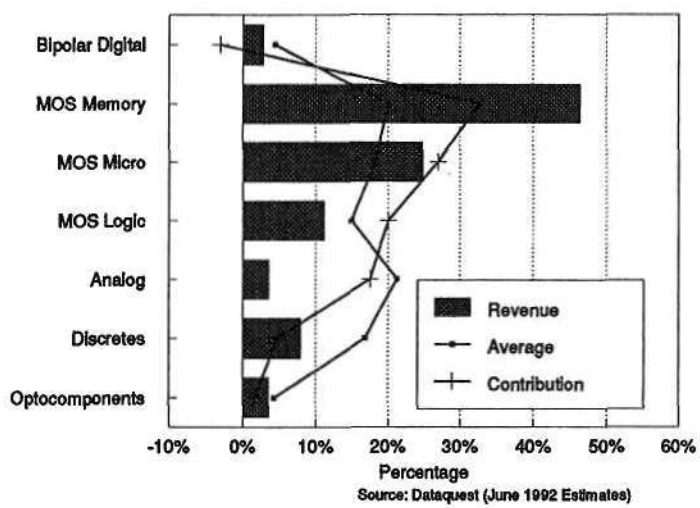
Source: Dataquest (June 1992 Estimates)

TOP THREE JAPANESE COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



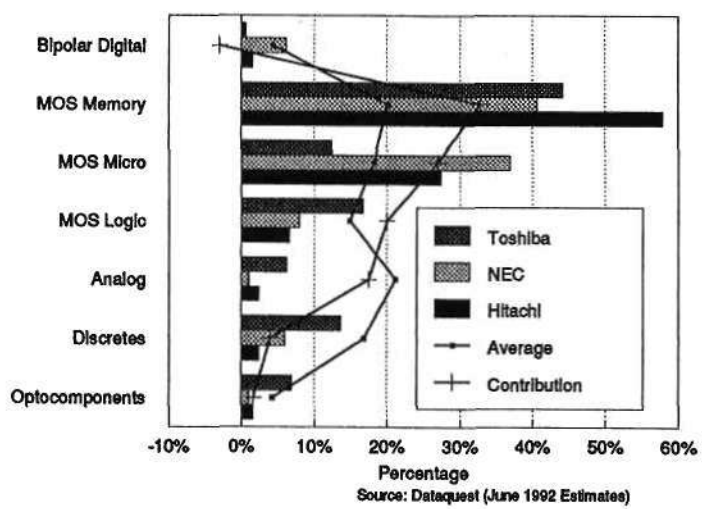
Source Dataquest (June 1992 Estimates)

TOP THREE JAPANESE COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



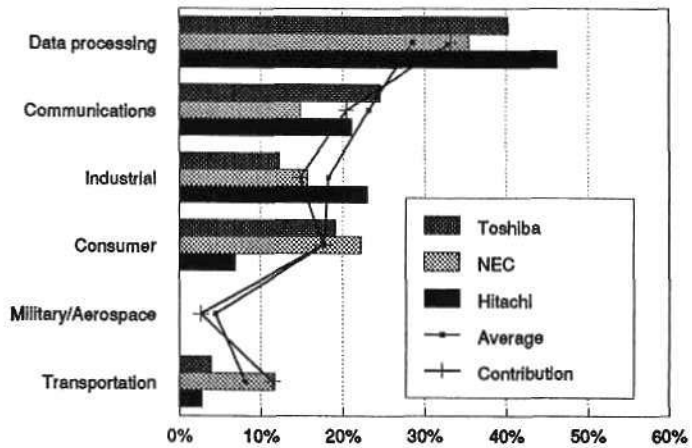
Source: Dataquest (June 1992 Estimates)

TOP THREE JAPANESE COMPANIES ANALYSIS
EUROPEAN PRODUCT SPLIT



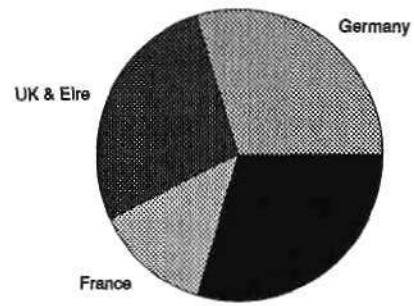
Source: Dataquest (June 1992 Estimates)

TOP THREE JAPANESE COMPANIES ANALYSIS
EUROPEAN APPLICATIONS SPLIT



Source: Dataquest (June 1992 Estimates)

EUROPEAN SEMICONDUCTOR MARKET
REGIONAL SHARE



1991 Regions Share

Source: Dataquest (June 1992 Estimates)

EUROPEAN SEMICONDUCTOR MARKET
CONSUMPTION FORECAST

(Millions of ECU)

Country	1991	1992	AGR 92/91	1996	CAGR 96/91
France	1,228	1,275	3.8%	1,844	8.5%
United Kingdom & Ireland	2,405	2,669	11.0%	4,310	12.4%
Germany	2,770	2,878	3.9%	4,294	9.2%

Source: Dataquest (June 1992 Estimates)

COUNTRIES - GERMANY

- Short-term demand weak
  - Cost of reunification is high
  - Excess consumer inventories
  - Automotive market is soft
- Positive factors are:
  - Telecoms business is strong
  - Industrial production is stable
  - PC manufacture rising
- Longer-term outlook good - due to size
- Attraction for foreign investment - medium

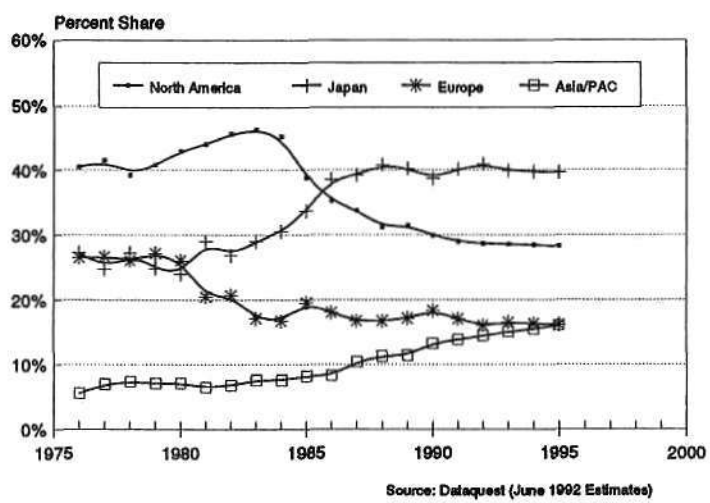
COUNTRIES - UK & EIRE

- High investment by multinationals
  - Strong manufacturing economy
  - Design wins are outside Europe however
- PC manufacture is concentrated here
- Longer-term outlook good
  - Due to foreign investment
- Attraction for foreign investment - good

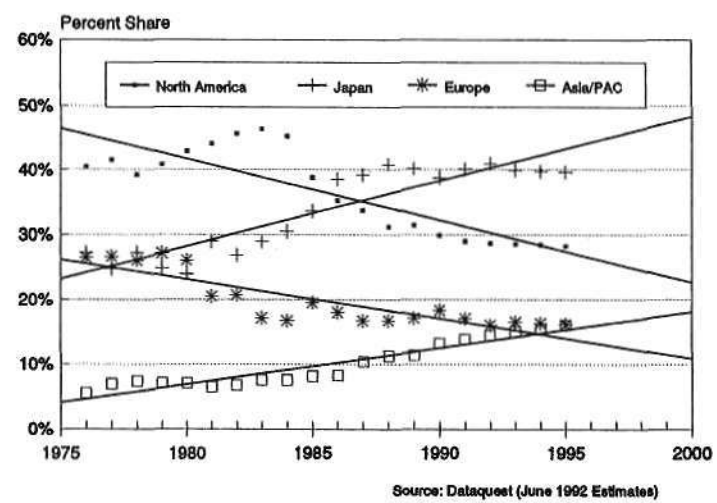
COUNTRIES - FRANCE

- Country close to recession
- Local manufacture moving outside Europe
- Good telecoms business
  - Alcatel No.1 telecoms manufacturer
- Attraction for foreign investment - poor

WORLDWIDE SEMICONDUCTOR FORECAST ACTUAL MARKET SHARE BY WORLD REGION



WORLDWIDE SEMICONDUCTOR FORECAST MARKET SHARE TREND BY WORLD REGION



DELAYED 200 mm FAB PLANS IN JAPAN

COMPANY	PRODUCTS	FAB TYPE
Fujitsu	16Mb DRAM	Production
Hitachi	4Mb/16Mb DRAM	Production
KTI	ASIC	Production
Matsushita	16Mb DRAM	R&D
Matsushita	16Mb/64Mb DRAM	Production
NEC	16Mb DRAM, MPU	Production
NEC	4Mb/16Mb DRAM, EPROM	Production
NKK	4Mb SRAM, ASIC, MPU	Pilot
Oki	16Mb DRAM	Production
Sanyo	16Mb DRAM	Production
Sharp	4Mb DRAM, ROM	Production
Toshiba	16Mb DRAM	Pilot

INVESTMENT

- Slowdown in Japanese foreign investment
- Slowdown in transfer of capital
- Migration from commodity to value-added products
- Spectre of increased trade friction
- Pervasiveness of semiconductors will restore balance

INVESTMENT

- Investment grew from $5.1 billion to $14.4 billion from 1986 to 1991
- Reason: investment boom in Japan
- Result: excess capacity
- Evidence:
  - Memory prices
  - Japanese profit margins
  - Increase in foundry activity
  - Increased fab closures/delays

WORLDWIDE FORECAST OF PRODUCTION, CAPITAL SPENDING AND WAFER FAB EQUIPMENT

(Millions of Dollars)

	1991	1992	AGR	1995	CAGR 95/90
Production	69,231	78,769	14%	110,352	11.9%
Capital Spending	14,372	13,970	-3%	19,090	8.8%
Fab Equipment	6,026	5,568	-8%	8,883	8.7%

Source: Dataquest (June 1992 Estimates)

Dataquest
a company of The Dun & Bradstreet Corporation

Research Newsletter

TOP TELECOMMUNICATIONS MANUFACTURING COMPANIES WORLDWIDE: ANALYSIS OF EUROPEAN STRATEGIES

Consolidation within the industry is further concentrating the worldwide telecommunications market share in the hands of a few companies. In this newsletter we show the top 15 telecommunications manufacturers in terms of 1990 worldwide ranking by revenue, both in local currency and US dollars, along with information on the major acquisitions of the top five companies.

In the main body of the newsletter, Dataquest looks at the top five telecoms equipment manufacturers: what their European strategies are and how they plan to stay ahead of each other. The companies under review are: Alcatel, AT&T, Siemens, Northern Telecom, and Ericsson.

THE TOP FIFTEEN

- The top 10 telecommunications equipment companies had a 68 percent share of the $95 billion worldwide market in 1990. The top 5 companies had 48 percent of this market in 1990 (see Table 1).
- The acquisitions made in late 1990 and 1991 will further concentrate the market share of the top 5 companies, giving these companies an equivalent share of 52 percent of the total market (see Table 2).
- Alcatel has moved into first position.

EXCHANGE RATES

For the purposes of comparison, all revenue is converted into dollars from local currency. The exchange rates are based on 1990 Dataquest conversion rates, which in turn are based on the Wall Street Journal and Financial Times rates. A list of local currencies per US dollar is given in Table 3.

DEFINITIONS

The revenue represents the supply of telecommunications equipment (hardware) only. This includes installation, field support, training and consultancy associated with the implementation of

TABLE 1
Top Telecommunications Companies 1990 Revenue Ranking

Rank	Company	Billions of US Dollars	Local Currency (Billions)
1	Alcatel	13.1	ECU 10.3 (excludes Telettra)
2	AT&T	10.3	$10.3
3	Siemens	8.6	DM 13.9 (excludes GPT)
4	Northern Telecom	6.8	$6.8 (excludes STC)
5	Ericsson	6.7	SKr 40
6	NEC	6.3	¥926
7	Motorola	5.1	$5.1
8	Fujitsu	3.1	¥442
9	Bosch	2.6	DM 4.2
10	GPT	2.2	£1.3
11	Italtel	1.8	L 2,227
12	Philips	1.9	Fl 3.56
13	Nokia	1.5	Fmk 5.8
14	Ascom	1.4	SF 2.0
15	Oki	1.3	¥186

Source: Dataquest (April 1992)

Dataquest Europe Limited
Roussel House, Broadwater Park, Denham, Uxbridge, Middx UB9 5HP, England / 0895 835050 / Telex 266195 / Fax 0895 835260

TABLE 2
Top Telecommunications Companies 1990
Revenue Ranking (including Major Acquisitions)

Rank	Company*	Billions of US Dollars
1	Alcatel	14.1 (including Telettra)
2	AT&T	10.3
3	Siemens	9.5 (including GPT)
4	Northern Telecom	8.4 (including STC)
5	Ericsson	6.7

* These top 5 companies are covered in the detailed profiles which follow.
Source: Dataquest (April 1992)

TABLE 3
Dollar to Local Currency Exchange Rates

Finland	Fmk 3.82
Germany	DM 1.62
Italy	L 1197.2
Japan	¥144.7
Netherlands	Fl 1.82
Sweden	SKr 5.92
Switzerland	SF 1.39
United Kingdom	£0.56
European Community	ECU 0.79

NA = Not Applicable
Source: Dataquest (April 1992)

equipment. Revenue from carrier services (the provision or voice and data networks) are excluded. The financial reporting year of each company varies, and no adjustments have been made for this. The source of information is company annual reports and publications, and Dataquest estimates.

Notes

NEC: In 1990, 23 percent of NEC's sales were outside of Japan.

Motorola: 40 percent of Motorola's 1990 sales were from outside the United States.

Fujitsu: Approximately 10 percent of Fujitsu's total revenue was from Europe in 1990.

Bosch: In 1990, 51 percent of Bosch's sales were outside Germany.

Philips: Revenue includes that from TRT and PKI, which is 80 percent owned by Philips. In 1990, 61 percent of Philip's total sales were into Europe. Philips is planning to sell its Cable and Optical Fiber division to Siemens during 1992. As this is a relatively small division, with turnover of approximately $300 million, it will not affect the overall ranking of companies.

GPT: GEC Plessey Telecommunications (GPT) is owned by GEC (60 percent) and Siemens (40 percent). GPT derived 88 percent of its telecommunications revenue from Europe in 1990.

Italtel: Italtel acquired the majority shareholding (51 percent) in APT Italia in 1990, which helped to increase transmission turnover by 33 percent. Sales within Europe accounted for 97 percent of Italtel's sales.

Nokia: 84 percent of Nokia's sales were within Europe in 1990.

Ascom: Ascom acquired a majority shareholding (51 percent) in Timeplex in 1991. A joint-venture agreement was signed by Ericsson for cooperation in transmission. The joint-venture company will be owned 60 percent by Ascom and 40 percent by Ericsson.

Oki: In 1990, 29 percent of Oki's revenue came from outside Japan.

STRATEGIC COMPANY STUDIES

In this focused analysis, we give a profile of each of the top five telecommunications equipment suppliers in the world:

- Alcatel
- AT&T
- Siemens
- Northern Telecom
- Ericsson

The profile covers corporate financials (including research and development), European strategy (including acquisitions and joint ventures), product strategy (public and private networking) and future plans. Finally, Dataquest gives a perspective of the issues and trends in the European telecoms market and asks: What is the key to survival?

ALCATEL

1990 Revenue:	ECU 13.4 billion
Employees:	122,700
Headquarters:	World Trade Center Strawinskylaan 341 NL-1077 XX Amsterdam, Netherlands
Telephone:	+31 20-573.37.00
Facsimile:	+31 20-664.07.61

Main European Subsidiaries:

Austria (Vienna), Belgium (Antwerp), Denmark (Horsens), Finland (Helsinki), France (Vélizy, Clichy, Paris), Germany (Stuttgart), Italy (Milan), Netherlands (The Hague), Norway (Oslo), Portugal (Cascais), Spain (Madrid), Switzerland (Zurich), United Kingdom (Romford, England)

Pierre Suard, President

Josef Cornu, Executive Vice President

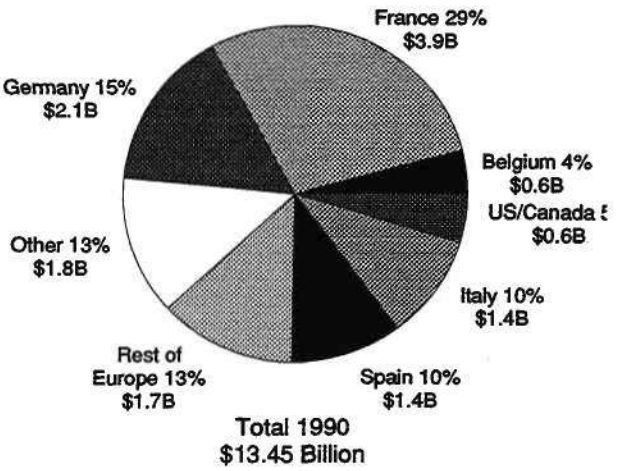
Corporate

In 1986, the telecommunications arm of Compagnie Générale d'Electricité (CGE, the French engineering group now renamed Alcatel-Alsthom) merged with the telecommunications business of ITT, the US conglomerate, to create Alcatel. Incorporated in the Netherlands, the company is run from Paris with its technical center in Brussels, and follows a policy of spreading export orders between units in Spain, France, Germany and elsewhere. This geographic dispersion potentially gives Alcatel a great deal of flexibility. It can fill orders wherever currency, costs and political considerations make filling the orders most attractive.

Alcatel is clearly a highly complex organization and not afraid to be different. Although the French market provides the strongest home base, Alcatel prefers to downplay the French element, as the official company language is English, and accounts are calculated in European Currency Units (ECU), based on a common pool of European currency values.

Alcatel currently ranks as the number-one supplier in the world for telecommunications equipment. Its main markets are France, Germany, Italy and Spain, with Europe as a whole accounting for 82 percent of 1990 sales (see Figure 1). The company is a solid performer. Return on sales has grown steadily from 2.4 percent in 1987 to 5 percent in 1990. Net profit rose by 23.7 percent

FIGURE 1
Alcatel: Sales by Geographical Region



Source: Dataquest (April 1992)

in 1990 to ECU 591.6 million ($698 million) on sales of ECU 13.4 billion. Operating profit in public network systems leapt 57.5 percent to ECU 632.2 million in the same year. Telettra has been excluded in Table 1, as the two separate agreements involving the acquisitions of Telettra SpA (Italy and Telettra España (Spain) were not approved until November 30 and December 12, respectively. The closing of both transactions had not been completed in time for inclusion in Alcatel's 1990 consolidated statements. Telettra's telecommunications equipment revenue was ECU 1.1 billion ($1.3 billion) in 1990. If Alcatel's share of Telettra's revenue was included with Alcatel, the total revenue figure would be ECU 11.1 billion or ($14.1 billion) as illustrated in Table 2.

Rockwell Acquisition

In 1991, Alcatel became successful in its bid to acquire the transmission equipment division of Rockwell International Corporation, the US electronics, aerospace and automotive conglomerate. The acquisition of Rockwell International's Network System Division propels Alcatel into the number-two slot in the US transmission equipment industry, with a 15 percent share of a market worth $5.5 billion, according to Alcatel's estimates. Alcatel is already number two in the US market for telecommunications cables and, indeed, cables is Alcatel's second most important business, accounting for 28 percent of total 1990 revenue (see

Figure 2). In 1990, the Network System Division generated $439 million in sales, and this business will be added to the sales from Alcatel Systems US. For Alcatel, the immediate attraction is access to a US distribution network for its latest range of transmission equipment. Revenue from transmission equipment amounted to ECU 1.4 billion in 1990.

R&D

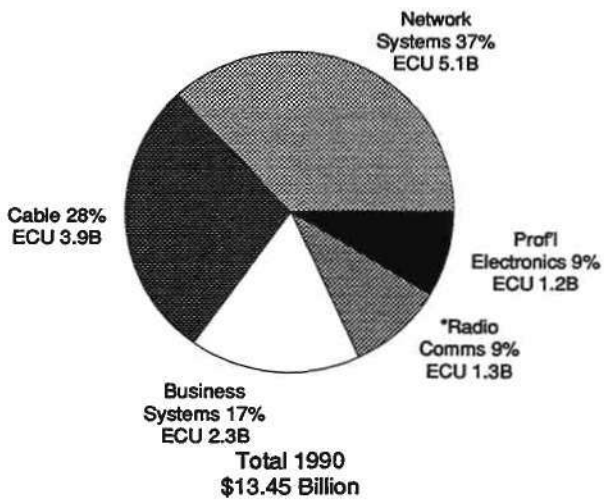
Alcatel's R&D has an annual budget of over 11 percent of sales and a staff of 18,000 scientists and engineers located in 22 countries. A driving force in telecommunications is the increasing amount of software in telecoms equipment, which in turn is reflected in the company's R&D commitments. There are a total of 12 research centers in Europe which invest heavily in next-generation technologies, such as: early broadband systems based on MAN concepts; ATM technology, a high-speed switching mode; optical switching technology; SDH; central office switching, base stations, and mobile terminals for second- and third-generation digital cellular communications networks (based on GSM and PCN standards); and next-generation, high-performance optical transmission components.

European Strategy

Alcatel's particular strength lies in that it is a European company, with a long-established local presence in most of the European countries. These local businesses are virtually self-governing and are successful because they are viewed by the national PTTs as a local supplier rather than a local subsidiary of a remote parent company.

The second special characteristic of Alcatel is its highly acquisitive nature. Since its inception, Alcatel (70 percent owned by CGE and the balance by ITT) has embarked on a strategy of involvement in any of the dynamic growth areas of telecommunications. These key sectors included public infrastructure, considered to have a high level of potential expenditure from national telecoms operators. The company's "refocusing" strategy has also involved a series of aggressive takeovers and alliances, aimed at consolidating the group's activities in areas where it is less powerful. This has led to expansion into new territories in Southern Europe through a wide-ranging alliance with Fiat, the Italian automotive group and into Eastern Europe and the Soviet Union through a series of joint ventures. Further examples include the 1990 purchase of a former east German transmission company, RFT Nachrichtenelektronik; and in December last year Alcatel established a new subsidiary, Alcatel Network Systems (UK), to open up distribution channels in the UK public network market.

FIGURE 2
Alcatel: Sales by Product Line



* Includes space and defense
Source: Alcatel

The Telettra Acquisition

In October 1991, Alcatel concluded the final stages of the merger between its Italian subsidiary, Alcatel FACE, and Telettra, a former member of the Fiat group. The $382 million deal had been delayed six months, pending the European Commission's investigation into the creation of a possible market monopolization between the parent companies, Fiat and CGE. Through the emergence of the new company called Alcatel Italia based in Milan (74 percent owned by Alcatel: 54 percent through Alcatel NV and 20 percent through two subsidiaries), Alcatel's sales in the Southern European telecommunications equipment market were immediately doubled.

The group's transmission equipment sales—an area previously overshadowed by Alcatel's strength in public switching—has in particular been affected. Alcatel gained a 39 percent stake in the Italian transmission market and a 70 percent share in Spain. One of the conditions that the European Commission imposed on the deal was that Telefónica sell its 10 percent stake in Telettra España to Alcatel. Alcatel Italia is expected to see turnover of about L 3 trillion in 1991 (including Telettra's Spanish unit).

Product Strategy

In January 1990, Alcatel simplified its structure to concentrate on its core businesses. The five business divisions are illustrated in Figure 2. The main groups involved in telecommunications are:

Network Systems Group (Switching and Line Transmission Systems)

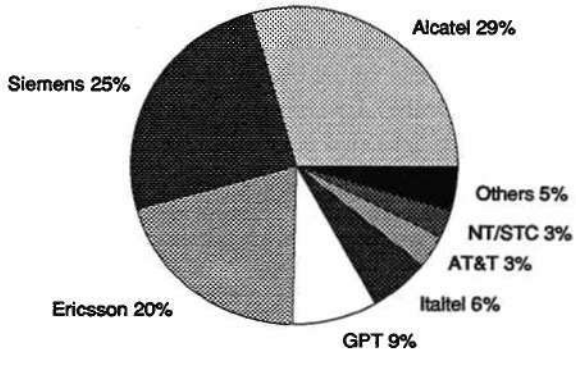
Alcatel is the leading supplier of central office equipment in Europe with a 1990 market share of 29 percent (up from 28 percent in 1989), followed by Ericsson and Siemens (see Figure 3). The total number of Alcatel digital switch terminations delivered worldwide reached 46.7 million at the end of 1990, with additional orders booked for 13.3 million terminations.

Flagship products in the public switching sector are the E10 and System 12 digital switches, where France Telecom is the company's biggest customer. In Germany, Alcatel provides DBP Telekom with a whole range of telecommunications equipment.

Business Systems

Alcatel's range covers systems for just a few lines up to 30,000-line systems. More than 2.7 million PBX and key system lines were produced in 1990, which ranks Alcatel as one of the world's leaders. In 1990, the UK market for small PBXs was penetrated through the acquisition of National Telecom, and subsequently Alcatel has become the leading supplier of premise switching equipment in 1990 with a share of 21 percent.

FIGURE 3
European Central Office Market Supplier Market Share by Revenue



Total 1990 Revenue
$8.0 Billion

Source: Dataquest (April 1992)

Cables

In October 1991, Alcatel acquired the cable business of AEG, part of the Daimler Benz industrial group. AEG Kabel's income from the sales of telecommunications cable is estimated to be DM 850 million or $520 million. On the French front sales were boosted by a share in a $660 million contract for a submarine cable between Marseilles in France and Singapore.

Radiocommunications, Space and Defense

This group exploits synergies among high-frequency microwave transmission and other radiocommunications technologies. The radiocommunications division covers areas such as private mobile radio systems, and digital cellular telephone networks, which is considered a priority business by the corporation.

Eastern Europe

Like other major suppliers, Alcatel is still feeling its way as regards Eastern and Central Europe. It tends to rely on local subsidiaries positioned in countries, which enjoy long-standing historical relationships with particular regions. For example, Austria is used to access Hungary's PBX market; France and Spain provide the portal to the Polish and Yugoslavian switching markets; and Belgium and France are heavily involved in the process of building the switching business in the Commonwealth of Independent States (CIS), the former Soviet Union.

Alcatel's big breakthrough in Eastern Europe came in 1990, when it signed a deal with the CIS, worth an estimated $2.8 billion to supply digital telephone lines over the next 20 years. This translated into 1.5 million system 12 digital telephone lines and 100,000 PABX private lines a year. Other activities in Eastern Europe, which include joint ventures with Poland, Hungary and the former Yugoslavia, brought the company's Eastern European turnover to an estimated $250 million in 1991. Alcatel's French subsidiary, CIT, has formed a joint venture with Data-Tim to manufacture 400,000 lines a year in Romania. Alcatel's Spanish subsidiary took advantage of Spanish government support earlier in 1990 to sell Poland $70 million of new switching equipment.

Future Plans

In Dataquest's view, Alcatel's success lies in some special characteristics, the main being that it is:

- A huge company, which is local to all the main markets
- Continuing to buy out its competition
- Perhaps the most acquisitive telecoms company in the world

AT&T

1990 Revenue:	$37.3 billion
Employees:	22,000 and 50,000 (including NCR)
Headquarters:	550 Madison Avenue New York, NY 10022-3297
Telephone:	+1 212 605-5500
International	AT&T Network Systems International BV
Headquarters:	Hilversum, Netherlands
Telephone:	+31 35 87 3111
Facsimile:	+31 35 87 1748

Main European Subsidiaries:

Belgium (Brussels), Czechoslovakia (Prague), France (Puteauxla Défense), Germany (Bonn), Ireland (Co. Dublin), Italy (Milan), Spain (Tres Cantos), Switzerland (Zurich), United Kingdom (Malmesbury, England).

Robert Allen, Chairman, AT&T

John Heck, President, AT&T-NSI

Corporate

AT&T, the largest US long-distance telephone operator, manufactures telecommunications network equipment through AT&T Network Systems. The company is growing stronger abroad, reflected in 1990 figures, where international sales increased to 15 percent of the total. Through its recent hostile takeover of NCR Corporation, which receives 62 percent of its revenue from overseas, this will increase to about 22 percent. Chairman Robert Allen is aiming for 25 percent by 1995 and 50 percent in the long term.

AT&T brings some formidable strengths to the international arena, including the research capabilities of Bell Laboratories; its position as the leading company in the US long-distance service market; and its pre-eminence in the US equipment market. Although at present its largest source of international revenue is international long-distance calling, AT&T anticipates that this will eventually be superseded by sales of network telecoms equipment. The group sold more than $1.5 billion of equipment overseas in 1990, 50 percent up from the previous year. According to Mr. Allen, the world will spend more on network equipment over the next 10 years than it has done over the last 115 years—since Bell invented the telephone.

European Strategy

Headquartered in the Netherlands, AT&T Network Systems International (NSI) was originally a 50–50 joint venture between AT&T and Philips Telecommunications BV back in 1984, called AT&T Philips Telecommunications BV (APT). Philips reduced its stake to 40 percent in 1988 and in 1989 back a further 25 percent. In September 1990, Philips pulled out its remaining 15 percent stake and the name was changed to AT&T Network Systems International, which became the headquarters for AT&T's international manufacturing business. The ownership of AT&T NSI is as follows:

- AT&T—74 percent
- STET (Italtel)—20 percent (1989)
- Telefónica—6 percent (1990)

AT&T NSI management realized that collaborations and joint ventures were the only viable means of continuing to penetrate new European markets. In Spain, AT&T formed a 51 percent–owned subsidiary called AT&T Network Systems España, by joining forces with Amper in 1988. In the second quarter of 1989, AT&T acquired a 20 percent interest in Italtel SpA, a manufacturer of public and private telecoms systems based in Italy, in exchange for a 20 percent interest in AT&T NSI BV, based in the Netherlands, and $135 million in cash. More recently in September 1990, Telefónica purchased 6 percent of AT&T NSI and as part of the deal, exchanged its 20 percent stake in AT&T Microelectrónica SA, making AT&T the sole shareholder.

AT&T Bell Laboratories

Bell Laboratories is considered to be among the best research laboratories in the world, with researchers averaging a patent a day. Its past list of

accomplishments include: satellite communications, digital switching, lasers, photonic devices, optical fiber, cellular radio, and the plain old telephone handset. The organization is concentrating its efforts on reducing the time it takes to bring products to market and to serve its business units and, ultimately, its clients. AT&T spends $2.4 billion out of its annual budget on research at Bell Labs, which amounts to 7 percent of the company's revenue.

Product Strategy

Central Office

AT&T NSI's flagship product is the 5ESS central office switch. The main sales for this switch are in the Netherlands and Spain. AT&T has basically taken over the public telecoms business, which used to be owned by Philips; it now has a 58 percent share of the Dutch central office market (the other suppliers being Ericsson, and to a much lesser extent Alcatel). In 1990, AT&T concluded negotiations with PTT Telecom Netherlands for the supply of 5ESS switching equipment for the years 1992 to 1996. In Spain, AT&T is successfully growing its business through AT&T Network Systems España, which supplied 245,000 lines to Telefónica in 1990.

In the United Kingdom, AT&T has achieved a low level of sales for specialist applications (that is, an intelligent overlay network to handle freephone and special services applications). The latter application could prove to be important in allowing AT&T to penetrate other European markets. For example, Italtel has its own digital central office switch (the Linea UT) but AT&T is able to lever its 5ESS into Italy for specialist applications like intelligent networking (IN). Early in 1990, AT&T through Italtel landed a contract to supply SIP, the Italian operating company, with an IN. Services to be provided include: green number, virtual private network, televoting, mass calling and personal number. So far, the network equipment activities of AT&T Italtel Network Systems have been restricted to Italy.

Transmission

AT&T's other main business area is in transmission, where it has a wider geographical spread of markets, comprising the Netherlands, Belgium, Spain, the United Kingdom, Switzerland and Italy. Apart from the fairly wide range of cable-based transmission products, the group is starting to develop a significant share in the small but rapidly growing market for digital cross-connect products. Successes include sales to both the French and German markets, through partnerships with local distribution channels (TRT and Siemens respectively).

Eastern Europe

In comparison with some of its fellow US operators, the regional Bell operating companies, AT&T has been less aggressive in capitalizing on the privatization movement in Eastern Europe. This has changed more recently through investments, such as the establishment of an office in Prague, Czechoslovakia. An important element behind this change in approach is the US government's support of exports to newly emerging markets in Central Europe, for instance, the recent removal of export restrictions.

Czechoslovakia

AT&T NSI is in discussion with Czech telecommunications manufacturer, Tesla Staransnice, with a view to establishing a joint-venture company for the marketing and manufacturing of high-tech transmission equipment. At the same time, AT&T is also talking with the cable manufacturer, VUKI, to establish a joint-venture company for the marketing and manufacturing of fiber-optic cables.

Poland

In mid-1991, AT&T NSI landed a substantial "master contract" with the Directorate General of the Polish Post, Telegraph and Telephone administration (PPTT) to extend and digitize the national telecommunications network. The deal is worth $100 million now and could potentially amount to $600 million over the next four years, according to AT&T. The contract includes a 5ESS international gateway exchange in Warsaw, and associated transmission equipment. As part of the contract, AT&T has committed itself to investment in the transfer of technology and the establishment of manufacturing facilities in Poland. This followed on from earlier projects involving the installation of a 60,000 call-per-hour digital international telephone exchange; the installation of a dedicated business telephone network, Komertel, which provides some 2,000 lines to major business, hotels and banks in Warsaw; and the supply and installation of a digital

radio link between the cities of Warsaw, Psary and Katowice. At present, Poland ranks near the tail-end of Europe with only 3.3 million lines—in other words, 9 lines per 100 inhabitants.

Soviet Union

AT&T is also active in the former Soviet Union. In 1990, a Memorandum of Understanding (MoU) was signed between the Soviet Union's Ministry of Post and Telecommunications and AT&T covering a number of potential areas of cooperation, including supply and manufacturing of switching and transmission equipment. Following this MoU, the Armenian telecom authority became AT&T's first Soviet Republic customer by placing an order for an international telephone exchange. A small part of AT&T's plans to develop Russia's communications materialized in February this year, when AT&T formed a joint venture with a Russian company based in St. Petersburg called Dalnya Svyaz. The agreement calls for the provision and marketing of digital transmission equipment to improve long-distance domestic and international telephone links. The new company, AT&T of St Petersburg, will be 68 percent owned by AT&T. In the face of such prominent Western backing, CoCom (Coordinating Committee on Multilateral Export Controls) may be persuaded to lift the prevailing export ban on high-speed fiber-optic systems, which was originally placed to prevent a high-speed Russian military communications link.

Future Plans

In Dataquest's view, AT&T is the only company in the elite group of top five telecommunications equipment suppliers worldwide which wears two hats—that of operator and supplier. It is this dichotomy or lack of clarity concerning the company's core business that may well have handicapped the company in its efforts to penetrate the European market. For example, concern has been voiced by fellow public operators, among them, BT and France Telecom.

AT&T has invested huge sums to gain access to the new growth markets in Europe. Seven years down the road from the deregulation of the US market and the beginning of its major international expansion drive, AT&T must be wondering what in real terms it has gained. Through the initial joint venture with Philips, AT&T has succeeded in leading both the central office and transmission markets in the Netherlands. In Spain, the only access method was through a joint venture with the sole indigenous supplier, Amper, whose technical expertise is not on a par with that of its own. In the third market, Italy, AT&T acquired a minority share in a local supplier in exchange for a slice out of its own company, plus a sizable amount in cash.

Despite these investments, AT&T's presence in the main telecoms markets of France, Germany and the United Kingdom remains almost negligible. It is not surprising, therefore, that AT&T is making a big push in the new expansion areas of Central and Eastern Europe, where the name of the game is the survival of the fittest.

Dataquest believes that AT&T will continue to focus on niche markets and new operators, while building up its presence in the Spanish and Italian markets. With its tremendous financial resources, AT&T is in a position to continue its policy of penetration through acquisition.

SIEMENS

1990 Revenue:	DM 63.2 billion
Employees:	373,000
Headquarters:	Wittelsbacherplatz 2 D-8000 Munich 2 Federal Republic of Germany
Telephone:	+49 89 63601
Facsimile:	+49 89 63651

Main European Subsidiaries:

Austria (Vienna), Belgium (Brussels), Denmark (Copenhagen),Finland (Helsinki, France (Paris), Greece (Athens), Ireland (Dublin), Italy (Milan), Netherlands (The Hague), Norway (Oslo), Portugal (Lisbon), Sweden (Stockholm), Switzerland (Zurich), Spain (Madrid), Turkey (Istanbul), United Kingdom (London, Chessington).

Dr. Karlheinz Kaske, Chairman

Heinrich von Pierer, Deputy Chairman

Corporate

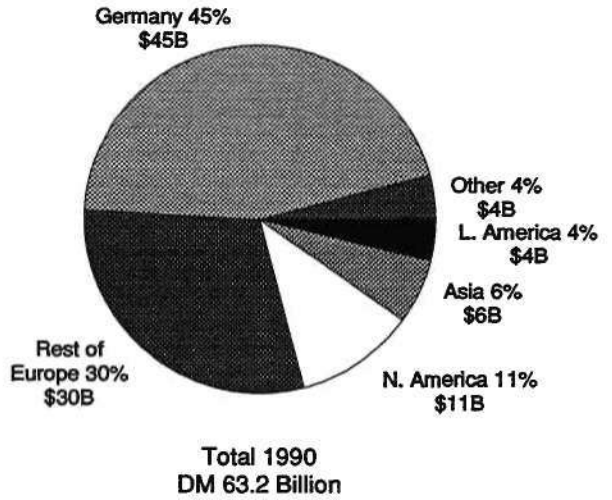
Siemens, the German industrial and electronics giant, has often been referred to as a bank with industrial interests, as it has enormous financial strength in Europe. It is the second-largest manufacturer of telecommunications equipment in Europe (after Alcatel) and number three in the worldwide ranking. Revenue from Europe accounted for 75 percent of total 1990 revenue,

with Germany representing by far the biggest market, followed by Italy (Figure 4). Siemens' telecommunications activities are accounted for by 2 of the company's 14 operating groups—Public Communication Networks and Private Communication Systems. In 1990, these groups returned combined sales of DM 13.9 billion, representing 22 percent of total revenue amounting to DM 63.2 billion (ending September 30). Total sales have increased marginally by 3 percent over the past two successive years. Orders increased by 8 percent in 1989 to 1990 compared with 15 percent increase the previous year. The number of employees breaks down into 230 covering German operations, and 143 for international operations. A total of 6 subsidiaries in Germany and 41 in other countries were consolidated for the first time in the 1989 to 1990 period.

Results continue to be burdened by the integration of Nixdorf and high development costs in semiconductors, a sector in which Siemens now has a joint production venture with IBM (US). To compensate for the estimated annual loss of DM 500 million and DM 400 million respectively in these two areas, Siemens is having to introduce some rationalization measures. Meanwhile, relief has come from the European Commission, which approved ECU 29.3 million of German government aid for two successive years, 1990 and 1991, providing 50 percent of financing for Siemens' basic research into semiconductor technology.

Siemens believes that its net income for 1990 to 1991 may have improved slightly on last year's figure, due to unexpected strong orders in the first eight months generated from the modernization of the infrastructure in the new eastern German states. According to Dr. Karlheinz Kaske, Chairman of Siemens, the total order flow should swell to DM 85 billion for the 1991 to 1992 fiscal year, with sales up to around DM 80 billion.

FIGURE 4
Siemens: Sales by Geographical Region



Source: Siemens

R&D

Towards the end of 1991 the company regrouped into five new "technology laboratories," according to Hans Gunter Danielmeyer, a board member responsible for the company's R&D. The drive behind the reorganization was the growing need to make Siemens' R&D more applications-oriented and responsive to market demands. More than 42,000 people are involved in R&D worldwide, of which some 2,000 are based at the headquarters in Munich. Siemens invests an average of 11 percent of sales on R&D, which amounted to DM 7 billion last year.

European Strategy

Germany counts as Siemens' biggest market with a 45 percent share of total revenue. With the unification of Germany and the enormous cost imposed on DBP Telekom—some DM 55 billion up to 1997—to upgrade the telecoms network in the five eastern states to match the standards of the west, Siemens stands to benefit certainly in the public domain over the next few years. The significant increase in new orders over 1991 already reflects this trend. The danger is that the company will now focus inward.

Nevertheless, Germany's telecommunications minister, Christian Schwarz-Schilling, has determined to liberalize the home market, for both services and equipment. The German government has realized the negative economic impact of maintaining a bureaucratic and noncompetitive telecoms industry in a global business environment. There have been warning signs for Siemens, particularly in the form of a number of public telecoms contracts being awarded to non-German companies. The licensing of private operators will continue to force DBP Telekom to take a market-driven approach to both service offerings and purchasing policy.

Siemens has not been blind to the need to expand its operations outside national boundaries. The company has built a strong presence in public telecommunications both in Europe and around the

world. By the end of 1990, EWSD digital switches had been sold to 107 administrations, including significant shipments to Austria, Belgium, Denmark, Finland, Italy, Portugal and Switzerland. While not a dominant player, Siemens has a presence in every region of the world. The company is also willing to enter into alliances, in order to gain access to local operators.

Acquisitions: Nixdorf and GPT

In recent years, Siemens has strengthened its position in European telecoms with a number of important acquisitions. The two major purchases are:

- **Nixdorf Computer AG:** In April 1990, Siemens acquired a majority interest of 78 percent in Nixdorf located in Paderborn, Germany. In October the company was renamed Siemens Nixdorf Informationssysteme AG (SNI), and now counts as Europe's largest indigenous computer maker. SNI financials will be included in the 1990-91 Annual Report.
- **GEC Plessey Telecommunications (GPT):** Following the joint takeover of Plessey, Siemens took a 40 percent share in GPT Ltd while GEC retained a 60 percent majority interest. (GPT's results are given separately in the top 15 ranking.) Siemens is intending to integrate the activities of Philips' Cable and Optical Fibre into its telecommunications division, if the takeover goes ahead.

As a result of these moves, Siemens' sales for the first half of 1991 were up 12 percent to DM 51 billion, and profits up 15 percent to DM 23 billion. Apart from telecoms, Siemens also has significant activities in the areas of power generation and distribution, industrial and building systems and defense, enabling the company to link its offerings, which in turn provides administrations with a portfolio of public infrastructure products. This is "one-stop shopping" on an enormous scale, and is a ploy which Siemens can and does use.

Product Strategy

Public Communication Networks

Some 14 percent of total revenue was generated by the public communications group, which represents the single largest contributor to the company's total revenue for fiscal year 1990. Siemens has strong products and the company has a very good reputation for its technology. The EWSD public switch is probably the most highly featured digital switch in the market: 28 million lines were ordered or delivered during 1990, an increase of some 50 percent over 1988 to 1989. The company has benefited greatly from the ability to sell large quantities of product at high margins within its home market. It has been, and remains, the major supplier to DB Telekom.

Cellular communications is considered part of the public communications group, which to some extent reflects the company's minor position in European analog cellular activities. By contrast, Siemens intends to make quite an impact in the area of GSM: its strategy is to become a major player at all levels within the market, from semiconductors to systems. Again Germany plays a key role here. Siemens' home territory is expected to be the greatest single market for GSM terminal and infrastructure equipment during the next few years. To achieve its goal, Siemens formed an agreement with PKI, which together with Bosch makes up the DMCS 900 consortium, to cooperate in bids for GSM infrastructure contracts.

Private Communication Systems

According to Siemens, over 30,000 units of Hicom communication systems were sold during 1989 to 1990, making it the mainstay of the company's business in the private networking sector. To service the new eastern states, Siemens created its own distribution company, with principal centers in Berlin, Dresden, Halle, Magdeburg and Rostock. The company also has a production facility in Leipzig producing communications equipment, including Hicom systems. In April 1991, Siemens and GPT merged their UK PABX distribution operations to form a new joint venture called GPT Communications Systems, which will distribute both Siemens' Hicom and its GPT rival, the ISDX. To strengthen its position in the US market, Siemens recently acquired from IBM a California-based company called Rolm Systems, which develops and manufactures communication systems.

The 1990 acquisition of Ferranti (UK) completed Siemens' needs for distribution, sales and service from which to launch the Hicom product range.

Eastern Europe

Siemens' sales in Eastern Europe totalled more than $368 million in fiscal 1990. With the recent incorporation of the eastern German states, Siemens is positioned best among all the major suppliers, not only to capitalize on the tremendous business generated to update the creaking telecommunications infrastructure, but also to leverage this move to sell its technology and expertise further to Eastern and Central Europe. Having said this, many of the company's proposed joint ventures with businesses in the former GDR have been held up due to ownership disputes and the challenge of transforming state-owned entities into private businesses. Siemens is still sticking to its original plan announced in 1990, of investing about $585 million in the new states, but will have to wait a while before it reaps the benefits of this investment.

Joint Ventures/Agreements

Siemens has established telecommunications equipment joint ventures/agreements in most of the Eastern European countries, including the Commonwealth of Independent States (the former Soviet Union), Poland, Czechoslovakia, the former Yugoslavia and Romania. Here are some examples:

- Like Alcatel, Siemens is participating in a joint venture based in Prague, Czechoslovakia together with a local company, Tesla Karlin. Operating under the new name Tescom, production is set to begin in spring 1992 at a level of 100,000 lines a year, rising to 500,000 by 1994. Some DM 50 million have been committed in investment.
- Siemens has formed two "barter-like" agreements with the CIS, in which Siemens has offered its technology and expertise in exchange for a commodity, in this case, oil. The first involved a manufacturing plant in Kiev, and the second, a plant in Ishevsk in the southern Ural steppes. Previously, both had been used for the manufacture of military communications equipment, but they will now construct EWSD digital switching systems as well as continuing development on an indigenous switching system.

Future Plans

As the company achieves greater international success, and as its home market opens up even more, Siemens will be forced to rationalize and become more efficient. Germany is unlikely to be able to continue subsidizing the company's international activities in the longer term. Perhaps one benefit that Siemens can gain from its involvement in GPT is an understanding of how to reduce costs and compete in a public telecoms market with very tight margins. Dataquest views Siemens' overall strengths as its position in the very important German market, and its financial backing, combined with its technology and engineering expertise.

NORTHERN TELECOM

1990 Revenue:	$6.77 billion (1991: $8.18 billion)
Employees (worldwide):	57,000 (including STC)
Headquarters:	3 Robert Speck Parkway Mississauga, Ontario L4Z 3C8 Canada
Telephone:	+1 416 897-9000
Facsimile:	+1 416 275-1143
European Headquarters:	Northern Telecom Europe Ltd, Maidenhead Tel: +44 753 813000
Main European Subsidiaries:	
Germany	Northern Telecom GmbH, Frankfurt Tel: +49 69 66970
France	NT Meridian SA, Paris La Défense Tel: +33 1 49 07 2424

Dr. Paul Stern, President

Desmond Hudson, President, Northern Telecom Europe

Corporate

Northern Telecom (NT), a Canadian company headquartered in Mississauga, Ontario, was originally established as a manufacturer of telephone equipment for Bell Canada, the country's major telephone operator. Since then, it has become the second-largest telecommunications equipment manufacturer in North America (after AT&T). Bell Canada Enterprises Inc. (BCE), the Montreal telecommunications holding company, owns 52.5 percent of NT, as well as Bell Canada, which remains NT's biggest customer. Traditionally, the supplier's main expertise lies in the public area of

switching; but in Europe, where the public sector is difficult to enter, NT is better known for its private network products, in particular its DPN data packet switching systems and Meridian range. However, it is beginning to penetrate the public sector with its family of DMS central office switching systems. (See Figure 5 for a split of Northern Telecom's product line revenue.)

Through its acquisition of STC plc, the UK telecommunications group, in March 1991 for £1.3 billion ($2.2 billion), the company was automatically propelled further up the top league of global telecommunications business. Sales derived from worldwide activities rose 21 percent in 1991 from $6.77 billion to $8.18 billion (see Table 4). The main areas of STC's expertise lie in transmission, optoelectronics, and cable systems. STC's telecommunications revenue for 1990 was approximately $1.6 billion, but as the acquisition was not until 1991, this revenue has been excluded from Dataquest's analysis of the top telecommunications equipment manufacturers worldwide.

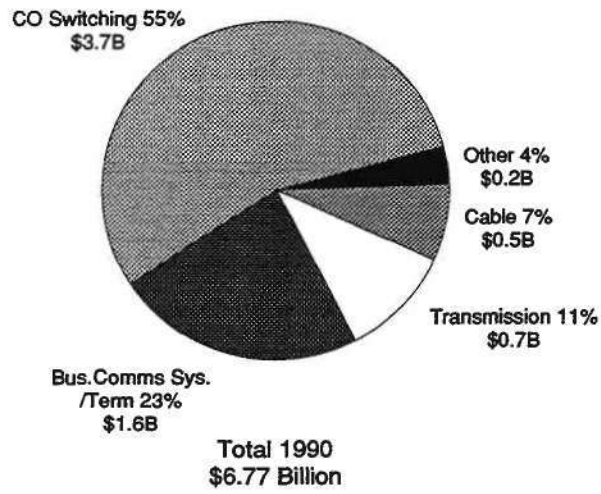
Northern Telecom's favorable financial results were in part attributable to a vigorous cost- cutting program involving a major restructuring in February 1990. This decentralized the company's research, manufacturing and engineering activities into three global product groups, each with its own president reporting to NT's current chief executive officer, Dr. Paul Stern:

- Public networks (central office switching, transmission, and cable)
- Private networks (PBXs, data packet networks, and terminals)
- Cellular and radio products

Northern Telecom Europe Ltd. based in Maidenhead, England has completed the integration of STC's operations with those of Northern Telecom in Europe. With 11,000 employees, NT Europe is responsible for the company's business in Europe, the Middle East, Africa and India, and operates 14 European manufacturing plants.

FIGURE 5

Northern Telecom: Sales by Product Line



Source: Northern Telecom

R&D

NT's spending on R&D in 1991 increased a significant 23 percent, in line with the increase in revenue, to $948 million from $774 million in 1990—the equivalent of 11.6 percent of 1991 revenue. Bell Canada and Northern Telecom share ownership of Bell-Northern Research (BNR), which is the biggest private research facility in Canada. In 1990, BNR opened an optoelectronic laboratory in Ontario. The main European laboratory was established at Maidenhead in 1984, and is

TABLE 4
Northern Telecom: 1990 Revenue by Geographical Location*
(Billions of Dollars)

Region	1991	1990	Percent of Total	1989	Percent of Total	1988	Percent of Total
United States	N/A	3.94	58%	3.62	59%	3.35	62%
Canada	N/A	2.42	36%	2.17	36%	1.85	34%
International	N/A	0.41	6%	0.317	5%	0.21	4%
Total	8.18	6.77		6.11		5.41	

* Based on the location of the selling organization rather than the location of the customer
N/A = Not Available
Source: Dataquest (April 1992)

primarily involved in public switching. In particular, it is known for its customized work on the DMS switch, supplied to both BT and Mercury. BNR-Maidenhead now forms the core of an expanded group called BNR-Europe, which includes a major STC engineering laboratory (STL) now renamed BNR-Harlow, specializing in transmission. Another STC plant in Paignton is being turned into a European center for NT's optoelectronic design work. A French facility was opened last year in Marne la Vallée, focusing on the development of new business communications systems, an area of rapid international growth for the company.

European Strategy

Apart from the United Kingdom, NT is targetting two other European countries, Germany and France. The company aims to establish long-term relationships with PTOs for future public and private switching orders, BT being the most recent and best example. A much smaller, but rapidly growing market, Turkey, represents a good testing ground for the company and in many respects, has turned into a role model for other NT joint ventures. NETAS, jointly owned by NT (31 percent) and the Turkish PTT, was established back in 1967 for the purpose of manufacturing exchange and telephone equipment in Istanbul for the national network. NETAS boasts the largest private R&D laboratory in Turkey, manned by 300 employees. In 1991, according to a recent NT press release, the company manufactured one million lines of digital switching equipment.

The STC Acquisition

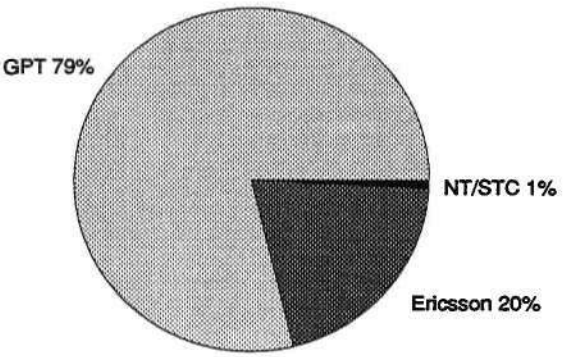
The acquisition of the UK company STC is a major milestone in Northern Telecom's expansion plans outside North America. It has given the company access to a UK equipment market valued at close to $6 billion (Figure 6). The logic behind the acquisition was:

- STC needed to be supported by a larger organization in order to give it critical mass and ensure a future flow of world-class products.
- NT saw STC as a springboard into Europe.

Most of STC's business was very UK-oriented, with BT accounting for the majority of sales. As a result of the acquisition, BT has now become NT's biggest customer in Europe, and second worldwide only to Bell Canada. Much of STC's business was viewed as nonstrategic and various divestitures were quickly made, accounting for over $400 million alone in the second quarter of 1991. For instance, in late 1991, there was a management buyout of STC's business systems unit. In the first year of ownership, according to Des Hudson, president of Northern Telecom Europe, more than $300 million was invested in STC's telecommunications business and similar investment figures are expected over the next few years. NT initiated a complete overhaul of STC's two main factories in Northern Ireland and South Wales, which both required complete renovation. Mr. Hudson feels that one of STC's problem areas was the lack of investment in manufacturing technology and new product lines, particularly over the last decade—an issue which lies at the root of the United Kingdom's manufacturing malaise.

FIGURE 6

United Kingdom Central Office Market Digital Local Lines, Supplier Market Share



Total 1990 Shipments
3.4 Million Lines

Source: Dataquest (April 1992)

Product Strategy

Europe represents the one important public telephone equipment market that NT must develop to offset slower growth in the US market. "Our growth in the next five years will come out of international markets," says Des Hudson. "The equipment market will be 50 percent larger in Europe than in the United States, particularly in public switching systems." It remains NT's long-

term strategy to continue developing as an equipment supplier rather than a service operation.

Public Networks

NT's flagship product is its DMS fully digital central office switching systems, with which it has been very successful in North America. In 1990, NT introduced the DMS SuperNode, the largest-capacity digital switching system available in the world. Last May, the company made a major breakthrough when it landed a contract with DBP Telekom to supply the DMS switching system as part of a new DM 75 million ($44 million) "Intelligent Network" pilot service to its customers in eight German cities: Frankfurt, Düsseldorf, Hamburg, Berlin, Hannover, Munich, Stuttgart and Nürnburg. Until this date, that particular German sector had traditionally been supplied by two German companies, Siemens and Standard Elektrik Lorenz (SEL).

NT's major thrust is with its "FiberWorld" products, incorporating synchronous technology. Last year, NT formed a partnership with Philips PKI of Germany where Philips is providing the high-speed synchronous optical fiber transmission technology to complement NT's switching systems, as well as lower-speed SDH systems. This is a key relationship, which will allow NT to offer systems for Europe's first SDH trials this year. Another integral operation that forms part of the public network group, STC Submarine Systemsthe only real international business that NT inherited from the acquisition—is a big supplier of undersea telephone systems.

Private Networks

NT is a major global supplier of data packet switching systems, with more than 90 DPN-100 switching systems installed around the world in public and private networks. In 1991, NT landed several major contracts including one in Spain worth $6.8 million for 50 DPN-100s, which is part of a four-year project to build a new, integrated official communications network (RICO) sponsored by the Spanish government with an estimated budget of Pta 43,000 ($430 million). NT is also building a new data communications network for the Central Bank of the Republic of Turkey (CBRT), based on its previous success with TURPAK, Turkey's national public packet-switched network.

The Meridian line of business communication systems is one of the most widely used, fully digital PBXs in the world; NT claims nearly 50,000 Meridian 1 and SL-1 systems are installed in more than 60 countries, covering an estimated 15 million lines. Last year, several major deals were secured, the biggest being with BT, which became the distributor in the United Kingdom for NT's Meridian 1 business communications systems. In Germany, the Netherlands and France, sales of PBXs have picked up significantly, for example the contract arranged with BASF AG.

Cellular and Radio Products

NT was a late entrant to the cellular business and is working hard to catch up. For example, it is working with two major GSM suppliers, Motorola and Philips, to adapt its switches to GSM technology, and with Motorola and Shaye Communications to provide digital cordless extensions to its PABXs. On the broader international front, NT (Canada) has just announced plans to form a joint venture with Motorola (US) to market cellular telephone network systems in North and South America, including the Caribbean region. The move is aimed at stepping up competition against AT&T and Ericsson. The new operation, called Motorola–Nortel Communications, will be based in Chicago.

Eastern Europe

NT is leveraging its long-term presence in Turkey through NETAS to gain access to the remote markets of the former Soviet states. In 1991, NETAS won a couple of contracts in the Commonwealth of Independent States to supply central office switching systems. By way of example, the Azerbaijan Ministry of Telecommunications ordered $21 million worth of equipment, 40,000 lines and a further 50,000 long-distance lines using NT's DMS switching system as well as NETAS' DRX digital switch.

NT is also busy making inroads into Eastern European countries, such as Poland and Hungary. The company embarked on a recent joint venture with Elwro, one of Poland's largest computer manufacturers, worth $10.5 million. The new company is to be called Northern Telecom Elwro and will manufacture NT's DMS-10 switching systems and telephone receivers. NT has deals with EuroTel Praha Ltd and EuroTel Bratislava Ltd. to supply a DPN-100 packet-switching system for Czechoslovakia's first public packet switched network. This is believed to be the first of its kind in Central

Europe and will prove particularly attractive to businesses wishing to invest in that area.

Future Plans

It has not been easy for a non-local supplier such as NT to enter the European sector. The company has been quietly building relationships and it comes as a surprise to most people in the industry that NT has done so well. The acquisition of STC has given the company access to markets hitherto closed to it, as well as to important partnerships across Europe, in particular with BT. In the coming decade, further acquisitions will be necessary to fuel NT's continued growth in Europe as the company is still heavily biased towards the United Kingdom. Germany is likely to be the next country targeted for penetration. NT plans to acquire another European company by the end of 1992 and will need this second purchase to meet its goal of increasing sales by 35 percent.

ERICSSON

1990 Revenue:	SKr 45.7 billion
Employees:	70,000
Headquarters:	Telefonaktiebolaget LM Ericsson S-126 25 Stockholm, Sweden
Telephone:	+46 8 719 0000
Facsimile:	+46 8 18 40 85

Main European Subsidiaries:

Belgium (Brussels), Denmark (Brondby), Finland (Helsinki),France (Guyancourt), Germany (Düsseldorf), Greece (Athens), Ireland (Dublin), Italy (Rome), Luxembourg, Netherlands (Rijen), Norway (Billingstadsletta, Oslo), Portugal (Lisbon), Spain (Madrid), Switzerland (Zurich), Turkey (Istanbul), United Kingdom (Horsham, England)

Bjorn Svedberg, Chairman

Lars Ramqvist, President

Corporate

Although not in the same league as some of its competitors, in terms of overall company revenue, Ericsson's focus on telecommunications has ensured it a firm place in the worldwide ranking of the top 10 telecommunications suppliers. The majority of Ericsson's income is derived from its core business, telecommunications, which accounts for over 80 percent of revenue. Ericsson's consolidated net sales for the first nine months of 1991 amounted to SKr 32.04 billion, down 2 percent for the corresponding period in 1990; and order bookings totalled SKr 30.89 billion, down 20 percent from the previous year. Ericsson attributes the decline in net sales to the divestment of the Italian FIAR Group, part of the Defense Systems division, as well as a general decline in investment volume in key markets. Ericsson anticipates that as a result of lower orders and the depressed business climate, the financial results for 1991 will be considerably lower than for 1990. The drop in orders has been greatest in the public network area, in markets such as the United Kingdom and Spain.

Nearly two-thirds of Ericsson's operations are in Europe, and will continue to represent its principal market over the next few years. Italy represents its largest single European market, although the country in which the company has recently experienced rapid growth has been Spain. Sweden accounted for only 12 percent of total sales in 1990, compared with 16 percent a year earlier. At the end of 1990, Ericsson reported subsidiaries or associated companies in 57 countries worldwide, with 59 percent of its total revenue generated from Europe.

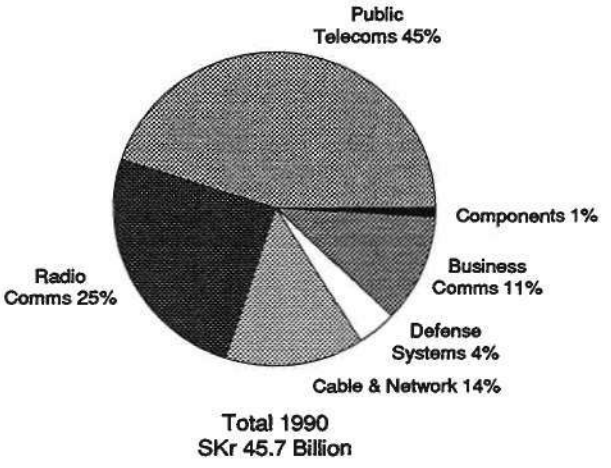
Of the company's six divisions, Public Telecommunications is by far the largest revenue producer, accounting for 45 percent of the total. Revenue from Ericsson's Radio Communications division has also played a key role in the company's growth, mushrooming from SKr 990 million or some 5 percent of the company's total in 1982, to SKr 11.69 billion, over 25 percent of total turnover in 1990 (see Figure 7). The cost of maintaining a leading position in this high-growth market has resulted in a major drain on the company's coffers, especially in the case of developments in switching and GSM/PCN equipment.

R&D

The company maintains a large engineering budget—more than SKr 10 billion ($1.6 billion) was allocated by the company to its technological investment program in 1991; a slightly lower amount is being invested this year. There are 40 R&D locations worldwide, staffed by 8,700 people. Less than 30 percent are at present employed outside of Sweden, mostly in other parts of Europe, but the company expects to increase this percentage to 35 by 1995, and 50 by 2000. Expenditure on

FIGURE 7

Ericsson: Product Line Revenue



Source: Dataquest (April 1992)

R&D during 1990 amounted to SKr 4.9 billion, the equivalent of 11 percent of sales. In addition, the company benefits from two major joint development efforts: ELLEMTEL, a 50–50 R&D joint venture with Televerket, the Swedish PTT; and RACE, an EC-funded program to encourage suppliers to develop broadband applications.

Despite hiring 70 percent of Sweden's electrical engineering and physics graduates every year, Ericsson faces a limited source of engineering labor on its home turf. This factor, combined with political pressures from other countries, which demand a local presence as a prerequisite for market entry, is forcing Ericsson to expand its R&D activities outside of its home market. For example, a new plant being built in Aachen, Germany could potentially enhance its relationship with DBP Telekom. Ericsson's main research centers cover the fields of fiber optics, high-speed electronics, computer sciences and radio technologies.

European Strategy

Most of Ericsson's peers in the elite top 10 worldwide ranking of telecommunications equipment suppliers come from the background of a large, technically advanced home market. They have leveraged this solid base into expanding their operations worldwide. By contrast, Ericsson comes from a small home market which is large in terms of area but sparse in terms of population—there are a mere 8.4 million inhabitants in Sweden.

The company initially developed its products in the Scandinavian countries, and then focused its efforts on individual European markets, such as the United Kingdom, Italy and Spain and more recently, Germany. In October 1990, Ericsson acquired a 33.5 percent share in the Austrian company, Schrack Elektronik, with just under 50 percent going to a group of Austrian investors, headed by the largest national bank. Ericsson's PBXs have been sold by Schrack since the late 1970s. It may also consider the possibility of Schrack marketing its public switching equipment in the future, although the Austrian PTT mainly uses Northern Telecom's digital central office switches. Ericsson believes that Austria's traditionally strong relations with Hungary, Czechoslovakia and Poland will boost sales of its telecoms equipment.

In October 1991, a joint-venture agreement was signed with the Swiss company, Ascom, for cooperation in transmission systems. The joint-venture company will be owned 60 percent by Ascom and 40 percent by Ericsson.

Over the last couple of years, Ericsson has suffered a significant blow to its revenue as a result of the general recession. According to Lars Ramqvist, President: "We are forced to spend more than our competition because unlike them we have no strong home market or state support to help us through a recession." It is not surprising that the company has traditionally been focused on international business and become successful at marketing to a wide variety of local environments, against local and regional competition.

Product Strategy

Public Telecommunications

The company's main product line includes the range of AXE public switching systems, and the digital MD110 subscriber exchange. The AXE system for both fixed and mobile telephone networks is now in service or on order in 81 countries. The United Kingdom continues to be the largest single AXE market, with a total of 4.2 million lines installed or on order. The company enjoys a long-term relationship with BT, resulting in an installed base of 3.2 million lines since 1985, and new orders to 1992.

Radio Communications

Ericsson is the number-one player in the world market for cellular infrastructure, its closest

competitors being two American companies, Motorola and AT&T, followed by NEC of Japan; 40 percent of all current cellular subscribers are registered on networks built using Ericsson equipment. The NMT-450 systems in the four Nordic countries of Denmark, Finland, Norway and Sweden were among the first to be launched in the world, and have continued to lead the way in terms of subscriber penetration. This has now been upgraded to NMT-900 system which runs at 900 MHz. Ericsson has not restricted its expertise to this one system. In 1990, TACS systems were launched in Italy and Malta using Ericsson equipment.

Of all the European companies, Ericsson would seem the least likely to require partners for the purpose of developing a GSM portfolio. However, other factors at play, such as financial and political considerations, are equally important to technical capability. With an influx of powerful new players to the market, each selling basically the same product, Ericsson will become increasingly vulnerable to political bias and the weight of long-standing PTO/supplier relationships.

Rather than creating an official consortium, Ericsson chose to extend its relationship with Matra of France to include the joint development of GSM equipment. The two companies own a third, MET (Ericsson, 26 percent), which acts as the second supplier of central office switches to France Telecom. Matra also has a joint-development relationship with Telettra, which indirectly serves as a link between Ericsson and Telettra. Both Matra and Ericsson have formed an alliance with the Racal subsidiary Orbitel to manufacture base stations. In all these dealings, Ericsson remains the dominant partner, providing the switching expertise.

The company's GSM systems are currently part of various pilot services, such as the D2 network in Germany. In early 1991, it seemed that Ericsson was having trouble with its base station developments, and there was some concern as to whether the company could meet its contractual commitment to Mannesmann. These doubts were dispelled later that year when Ericsson purchased 50 percent of Orbitel, a UK company manufacturing radio communications equipment, including base stations. Recently, 25 percent of Orbitel's work force were made redundant, chiefly in the GSM infrastructure division. This company will now manufacture base stations solely based on Ericsson technology, but compete with the latter in the manufacture of GSM handsets.

Eastern Europe

The Eastern European countries with the highest growth potential are Hungary, Poland and Czechoslovakia, and Ericsson is competing among the rest for the prolific number of contracts that are currently being meted out. The company is in the process of building up its resources in Hungary, where it has been involved since 1988, through the establishment of a new subsidiary, Ericsson Technica. This follows in the wake of a five-year general purchasing agreement with the Hungarian Telecom Company, landed in 1990, where Ericsson was named the leading official supplier to the PTT. As part of a massive expansion program undertaken by the Hungarian PTT, the company will deliver 1.5 million new telephone lines planned for installation over the next five years. Ericsson has also recently, and very rapidly, installed a cellular mobile system serving Budapest and its suburbs. More recently in 1991, Ericsson was awarded a contract in Hungary for AXE switching equipment to serve more than 100,000 subscriber lines.

In Poland, Ericsson's Spanish subsidiary is supplying the new, independent telephone operators with equipment, which is partially funded by the European Commission to immediately alleviate the telecommunications problem in Eastern Europe.

Future Plans

Compared with other major suppliers, Ericsson is a relatively small but highly focused company, which pursues an integrated decentralization culture, giving local subsidiaries the authority and power to act quickly. This flexibility is the key to Ericsson's success and enables it to respond to changes and trends in the marketplace, without the burden of an overly bureaucratic structure. The quality of its product offering and its ability to price aggressively have enabled it to succeed in developing new markets around the world, but this has entailed heavy spending on R&D. The major challenge lies in whether a company its size can continue to do it all alone.

Having attempted to break into more markets than most companies, Ericsson is very aware of the benefits of political assistance. It is keen to capitalize on this strength as well as its reputation for being a missionary in new markets; for example in mobile communications, Ericsson is clearly a world leader. However, as a standalone company, Ericsson lacks the financial backing of some of its

competitors, and this factor makes it more susceptible to economic shifts in the market.

Dataquest believes that the company has three special characteristics:

- Ability to be a technological leader
- Clear focus on core business
- Flexibility

Ericsson has to ensure that these strengths are used to maximum effect to overcome short-term financial setbacks.

DATAQUEST PERSPECTIVE

The downturn in the world economy in 1990 and 1991 has had an impact on the major telecommunications equipment suppliers. This has been deeper and more protracted than expected. Purchasing decisions on telecommunications equipment have been postponed and competitive pressure has intensified, resulting in overall lower sales for most suppliers compared with the corresponding period last year, and a marked drop in new orders.

Suppliers have also been forced to invest heavily in new technologies to maintain their leading positions both in the public and private network sectors. Alliances have been formed in the areas of R&D to offset some of the common expenditures involved. In many cases, consolidation has been the main access route to underdeveloped areas within the company as well as new market penetration: for example, Siemens/GEC (Plessey); Alcatel/Telettra; and Northern Telecom/STC. Dataquest believes that this industry restructuring will continue.

Issues and Trends

The major suppliers derive the majority of their revenue from the sale of systems for public network infrastructure. These markets show trends as identified below.

Central Office

Dataquest sees the European central office market as having peaked in 1990 and 1991, at an annual value of some $8 billion, but now starting to decline by approximately 4 percent per annum. Major new product offerings and services will continue to take a long time to launch and penetrate the market; for example, ISDN, intelligent networks, Centrex, and broadband switching. Product rationalization is a much longer-term process than supplier rationalization, and suppliers or supplier groupings will continue to offer multiple product lines. While vast sums of money will still be invested in such technologies, the basic market will continue to comprise mainly plain old telephone service (POTS) products. Potential opportunities for central office suppliers, arising out of further deregulation and liberalization, will be very limited, despite the emergence of niche markets. The market is dominated by Siemens, Alcatel and Ericsson.

Transmission

Dataquest views the cable transmission market as having more than doubled its size since the mid-1980s to $2.4 billion by 1990. Dataquest forecasts market growth at an average of 7 percent per year, valued at $3.2 billion per year by 1995. The major technology issue impacting the market over the next five years will be the commercial availability of transmission systems based on SDH technology. These are currently being trialled throughout Europe, and will become commercially available through 1992, followed by rapid network deployment. The growing demand for transmission systems will be fuelled, in particular, by data requirements. For example, the LAN market is booming with continued demand for high-capacity connectivity between LAN sites, enhanced by the viability of sophisticated applications such as video and image.

Germany currently represents by far the largest market in Europe, and will continue to grow at more than 9 percent per year due to investment in the infrastructure of the eastern states. The major companies profiting from this expansion activity in Germany will be Alcatel and Siemens; these already dominate the European market, accounting for over 50 percent. No other company has more than 5 percent of the market.

Eastern Europe

Despite the flurry of activity within the Eastern European countries, this will not translate into much short-term business for the world's major equipment suppliers and will probably not change the source of their telecoms business over the next three years. Any returns from the significant investments made in Eastern Europe will have to be viewed in the long term.

The Key to Survival

In Dataquest's view the key elements contributing to the major suppliers' success in the European marketplace are:

- Wide base of established European operations
- Good solid relationship with PTOs
- Financial strength to invest in new technologies
- Comprehensive product range

The major national markets in Europe are still actively dominated by the indigenous suppliers. This is largely driven by national protectionism, but is also a result of the complex nature of the relationship between a national network operator and the major systems suppliers to those operators. It is an extension of a natural human tendency to want to deal with your own kind, on your own shores, by means of a common language based on a shared culture, rather than with an outside element. Where foreign companies plan to make any impact on these markets, it has to be done through building a very substantial local presence, and almost always involves working closely with existing national companies. This applies equally to European companies selling into other European countries and to non-European companies trying to penetrate European markets.

The European telecommunications market is therefore characterized by major suppliers with a wide range of subsidiaries or joint ventures, and a multitude of licensing arrangements. Both Alcatel and Ericsson are prime examples. With the passing of time, the nature of such relationships often changes, and collaborations tend towards outright acquisition, as Siemens and Alcatel have done in the United Kingdom.

(This newsletter was previously published as a Telecommunications Europe *Dataquest Perspective.*)

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Research Newsletter

COMPUTER SYSTEMS: DOWNSIZING AND THE RECESSION TAKE THEIR TOLL

Preliminary estimates indicate that the computer systems market in Europe, as defined by Dataquest, declined in end-user, if-sold revenue by around 6 percent during 1991. This was the result of a number of issues: some of which were external to the industry, such as political factors and the economic recession; and some of which were specific to the industry, most notably downsizing and the move to open systems. The move towards open systems is now taking its toll on margins, which have certainly decreased during the past year.

The major areas of weakness have been in the mainframe segment and in the traditional proprietary area. The decline in these areas was already evident in 1990 over 1989, and the trend has continued. Price discounting of systems across the board has also contributed to the vendors' revenue problems. The two areas of strength remain the workstation market and the overall market for UNIX systems.

Several major alliances were formed during the year, the most notable being that between IBM and Apple, and the formation of the ACE Consortium. In addition, a number of the traditional midrange vendors, notably Wang and MAI Basic Four, have moved away from hardware manufacture into value-added businesses.

MAINFRAME MARKET

Preliminary indications are that the mainframe market declined by at least 7 percent in end-user revenue terms during 1991, to $10.1 billion. The availability of IBM's high-end ES/9000 range sustained the company's unit shipments, but heavy discounting by all major mainframe vendors has taken its toll on margins. Overall, it appears that many users are postponing purchase decisions for mainframe replacements, owing to the recessionary economic climate. Consequently, "downsizing" to more price-performant systems, which is the very act which would be of long-term economic benefit in any IT policy, is being held in check by the short-term costs of migration.

Of particular significance in this market has been the announcement of the availability of UNIX on a number of vendors' systems, notably AIX on IBM's ES/9000 range, and UNIX V.4 by Fujitsu on its UXP/M range. While, in the short term, this is likely to have an adverse impact on margins and hence revenue, the endorsement of mainframe UNIX by IBM (albeit many years after Amdahl) may well inject some life into the mainframe market. Users who have been hesitant about new or replacement purchases of proprietary mainframes, or about replacing a mainframe with a smaller UNIX-based system which offers better price/performance, may feel more secure about the purchase of an "open" mainframe. As soon as economic conditions improve, however, and users continue to downsize to client/server systems and other lower-cost and more price-performant ones, it will be difficult for mainframe vendors to attract users back, even to open mainframes.

MIDRANGE MARKET

In the midrange market (encompassing Dataquest's business unit, large department, small department and work group segments) the proprietary vendors have certainly been hit, with the exception of the Hewlett-Packard (HP) 3000 series, and IBM's AS/400 range. The continued success of these proprietary systems, against the trend in the market, is attributable to different strategies in the

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case of each company. HP's 3000 series, augmented in July 1991 by new RISC-based, entry-level midrange and server systems, offers a very broad and highly price-performant range, and existing customers are offered excellent upgrade paths. Furthermore, the company has outlined a future migration path to the 9000 series and customers have no concern over supporting obsolescent hardware or software. IBM's AS/400 range was entirely renewed in 1991, and the continued success of this line seems to be based around traditional customer loyalty.

Overall, final figures for the midrange area are expected to show a decline of around 6 percent in units or 10 percent in revenue, to a market size of $14.4 billion, with the UNIX portion growing by around 18 percent. UNIX systems represented some 55 percent of units shipped in these segments in 1991, up from 45 percent in 1990.

Digital Equipment has certainly lost share in this segment, although it was responsible, late in October, for the introduction of some particularly price-performant hardware, namely the VAX 6000 model 600 and VAX 4000 model 500 systems, both of which run VMS. The former was positioned as a mainframe alternative, and is almost certainly aimed at Digital's installed base of VMS users in an attempt to stop them defecting to UNIX-based systems from other vendors, which have been responsible for Digital's difficulties in the midrange. These hardware announcements were combined with Digital's new, integrated Network Application Support (NAS) software, which will enable the company's users to move applications from system to system, and to implement standards all the way from PCs (running DOS, MS-Windows, or OS/2) and Apple Macintosh systems, through ULTRIX, UNIX and VMS workstations, to high-end VAX and multivendor UNIX systems. This combined announcement should place Digital's proprietary versus open strategy in a clearer perspective and stop further erosion of market share.

The result of the movement towards UNIX systems was a considerable amount of turmoil in the distribution channels, with many of the major players reorganizing their channels and a number of indirect operations either going out of business or running into severe financial difficulties. For those companies long entrenched in proprietary systems business, such as Digital and IBM, the internal sales rivalries between open and proprietary groups still seem to be unresolved.

This segment continues to come under pressure from the traditional workstation segment and from the multiuser personal computer (MUPC) market. Preliminary indications are that the latter grew by 19 percent in unit terms in 1991.

WORKSTATION MARKET

This segment of the market was certainly the healthiest of 1991, with preliminary estimates showing a unit growth of some 35 percent, while revenue grew by around 12 percent to reach some $3.6 billion. Revenue growth has been kept down by fierce price-cutting wars, heavy "special" end-user discounts and numerous new product introductions. The most notable of these was Hewlett-Packard's PA-RISC 700 series, which set the lead for price/performance in the midrange workstation market at the time it was introduced.

Discounting by Digital, especially at entry level, has had a considerable impact on workstation revenue. In addition, the company's sales were probably impacted by customers delaying purchase decisions in advance of the announcement in December of the Personal DECstation 5000 models and the VAXstation 4000 VLC.

Sun Microsystems continued to lead the unit wars, although its revenue splits indicate a shift towards low-end models. The restructuring of Sun's business, with an increasing concentration on software and services may indicate the maturing of the workstation market.

IBM continued to make market share gains on 1990, although it was also forced to cut the price of its low-end 320H model. The introduction of an entry-level model in the near future will further impact the already overcrowded low end of the workstation market, making issues of distribution increasingly critical.

DATAQUEST PERSPECTIVE

The outlook remains poor for all the major systems vendors—with the possible exception of Hewlett-Packard—and the only signs of buoyancy are in the workstations and open systems sectors. Many vendors are stuck in a quagmire, bogged down trying to reconcile their existing customers with the new trends towards open systems. It is those companies whose installed base does not compete with their new systems who are in the best position to take advantage of the market trends; in Europe this list includes ICL and HP.

In order to succeed in a downsizing market, vendors need a good migration path to open

systems, and they must also be able to offer the same functionality and an equivalent list of applications on their open systems as are available on the proprietary alternatives.

Many of the workstation vendors are still one-product companies, and while this has been an advantage in the past, it will be a disadvantage in the future. In particular, workstation profitability is declining, and many more companies that were founded on the basis of continual high growth in this field will have to make the very painful adjustments needed to operate in a lower-growth market. In addition, as downsizing spreads, customers need more than just workstations, and one-product companies are likely to lose out to those offering a full range of systems from the mainframe to the desktop.

(This newsletter was first published in an issue of *Dataquest Perspective*, Computer Systems Europe.)

Jane Doorly
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Research Newsletter

GEC PLESSEY SEMICONDUCTORS CONSOLIDATES HYBRID AND MICROWAVE STRENGTHS FOR WIDER APPLICATION MARKETS

SUMMARY

In 1990, GEC of the United Kingdom and Siemens of Germany took over the UK Plessey company. The various divisions of Plessey were shared between the two companies, and one of those divisions, semiconductors, was merged with GEC's semiconductor operation MEDL, to form GEC Plessey Semiconductors (GPS).

The new company has since restructured to meet the demands of the end-user market. The company's silicon-on-sapphire technology combined with its hybrid activities at the Lincoln, England site has allowed GPS to develop multichip modules (MCM) using silicon-on-silicon technology. This presents an important breakthrough in component packaging for electronic systems, and will bring major benefits in size and performance for products that adopt the technology. This bulletin focuses on the activities of the Hybrid Division of the new organization based in Lincoln.

INTRODUCTION

MEDL's microwave division has been located at Lincoln for more than 20 years. Plessey's hybrid operations from its Swindon, England facility were centralized at Lincoln in 1990 after the acquisition of Plessey Semiconductor by the UK conglomerate. GPS also has a hybrid operation in Farmingdale, New York specializing in Mil 1553 databus circuits.

Dataquest estimates that the microwave and hybrid business of GPS represents 10.7 percent of the company's 1991 worldwide semiconductor revenue. Following the slump in worldwide military and aerospace markets since the end of the "cold war" GPS has reformed its hybrid group (at Lincoln) to fit into its broad base of product offerings. The division was formerly part of the GEC subsidiary MEDL and has traditionally been active in the European and US military IC market. It is now gaining further growth through diversified application markets from the experience of the wider marketing and sales channels of GPS. It is partly due to this that GPS' hybrid microwave sales have grown to $43 million in 1991. GPS is strong in military applications and is the leading 1991 semiconductor supplier for military applications in Europe, and sixth worldwide.

The company's microwave and hybrid division has also launched new strategic products into the high-growth markets of automotive, communications and consumer electronics. Although the military business generally remains strong in Sweden and the United States, overall growth in the military segment has remained stagnant as a result of general market conditions. To counter this, the company has produced new products from its wide base of technology available from the microwave, hybrid and silicon-on-sapphire divisions.

GPS (Lincoln) has further expanded its business portfolio with a range of products for newly opened application markets:

- Communications: SAW (surface acoustic wave) filters and SAW oscillators for PCNs and GSM
- Consumer: satellite TV products, DBS (TV transmission) polarisers and LNBs (low-noise blocks for DBS)
- Automotive: navigation systems, microwave car alarms, cruise control and AVI (automatic vehicle identification).

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MULTICHIP MODULES

From the Lincoln site, GPS has launched a series of merchant market modules for portable computers and pocket telephones. These utilize the silicon-on-silicon multichip module technology developed at Caswell Laboratories, and now in production at Lincoln.

This technology makes it possible to lay down on a silicon substrate a series of naked die which incorporate an entire electronic system. Since the silicon in an MCM does not have to be packaged and then inserted into a circuit board, it produces a system that operates much faster, interconnects at higher-density, and is more compact and lighter than board-based systems.

APPLICATIONS

The first standard products to use MCMs include memory module satellites incorporating eight 64K silicon-on-sapphire SRAM die and a 1750A military processor in one multichip module. Major design wins in the satellite business have complemented GPS' consumer IC business in TV chip sets and teletext chips.

Other product modules will incorporate all the electronics circuitry for RISC workstations or high-end PCs, where our estimates show a trend towards complete market domination (90 percent) of RISC-based workstations. GPS initially plans to buy in the RISC microprocessors and add the peripheral circuitry; alternatively, the company may license the manufacture of a RISC microprocessor.

The next standard MCM product in the pipeline will be modules incorporating the electronics circuitry of a pocket telephone, possibly GSM, where the small size and high performance offered by the modules bring major benefits.

GPS has substantial application-specific IC revenue which would benefit from having a RISC processor as a core cell. The processor and memory module would be very suitable for use in workstation computers. GPS has the leading position in Europe for MCM technology. Outside Europe the leading MCM company is the US start-up company n-Chip.

In the automotive area, GPS' unique qualification and expertise in microwave technology for car alarm and navigation systems in both the US and European markets will provide a foundation for its share in the rapidly growing automotive semiconductor markets. With increasing noise nuisance caused by false car alarms in European Community (EC) countries and consequent EC regulations restricting noise, the European Commission has set a maximum 30-second timing for car alarms, together with a tighter regulation for triggering alarms on cars based on a threshold of disturbance/interference tolerance to further reduce false alarms. One key technology for meeting this limitation is microwave, because of its resistance to noise (most conventional infrared systems are noise- and wind-sensitive). A further design win in hybrid systems for auto-tolling systems in the United States has enhanced growth in the automotive business. GPS is thought to be the only company in the world with a fully active transponder for auto-tolling.

DATAQUEST PERSPECTIVE

With strong influence in the European electronic data processing, telecoms, consumer, and automotive segments, focus for short-term growth should be in high-growth application areas. Dataquest forecasts the telecoms and automotive application markets to be among the most flourishing segments over the next five years (see ESAM Vol. 1, sections 3. Electronic Equipment Forecast and 4. Semiconductor Consumption Analysis).

GPS has demonstrated a prolific presence in these segments with products available for areas like personal communications where silicon ICs combining CMOS with high-speed bipolar technology may be aimed at the pager and cellphone market. Furthermore, GPS hopes to bolster its consumer base through new developments in gate arrays, resulting in a 110,000 gate device, which has enabled production of chip sets for satellite TV. PC peripherals and nonvolatile memories are also believed to be on GPS' agenda. For manufacturing processes, GPS is likely to adhere to the technology route map conceived by its Caswell research center, which will guide the company to 0.5-µm capacity by 1993. Another positive point is the potential of the technological synergy between the NMOS EEPROMs licensed from Simtek, and MEDL's silicon-on-sapphire technology used for the manufacture of radiation-resistant, remotely reprogrammable ICs for use in space.

Mike Williams

Stop Press: Advanced Research Machines's ARM processor has now been licensed.

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Research Newsletter

WORKSTATIONS: CONTINUED GROWTH

SUMMARY

This newsletter presents the results of Dataquest's 1991 survey of workstation manufacturing in Western Europe. The survey showed that during 1990 total workstation production in Europe was 77,875 units. In 1991, we estimate production at approximately 141,000 units, an 81 percent unit growth over 1990, driving a semiconductor consumption estimated to be worth $58 million.

Workstation manufacturers are moving rapidly to provide production capacity in Europe; the 81 percent growth in unit production for 1991 over 1990 exceeds the *end-user* market growth estimated at 50 percent for the same period.

The future growth for workstation demand also looks bright. Price/performance is increasingly challenging the traditional business personal computer markets. Dataquest forecasts, during the period 1991 to 1995, a compound annual growth rate (CAGR) for the end-user market of 33 percent in units in Europe; this compares to a unit production growth of 36 percent for the same period.

WORKSTATION DEFINITION

Dataquest defines a "workstation" as a personal multitasking, single-user computer. For the most part these are technical workstations running UNIX (or UNIX-like) operating systems with integrated networking and high-performance graphics.

For the purpose of this newsletter, we exclude personal computers (that is, those 80x86 microprocessor-based machines which normally run MS-DOS or OS/2-type operating systems). A previous newsletter (ESAM newsletter 1991-14, "PC Production in Europe: 1990 and Forecast") covers PCs.

Our semiconductor content and consumption estimates refer to the motherboard semiconductor content only; they do not include the power supply or other workstation peripherals such as graphics cards or added memory. Additionally, they do not include semiconductors in workstation peripheral units such as disk drives or monitors.

INTRODUCTION

Sun was the biggest manufacturer of workstations in Europe in 1991. It is also the leading vendor, with its RISC workstations achieving an estimated 30 percent market share (37,695 units) of total workstation shipments (116,725 units) in 1990. For 1991, Dataquest forecasts total European workstation unit shipments to be 175,568 representing a 50 percent annual growth rate (AGR) over the previous year.

Sun manufactured 8,500 units in 1990 and shows a sixfold increase to 51,000 units for 1991, displacing Digital from first position as Europe's largest European manufacturer of workstations. We estimate that Digital will make 29,700 units in 1991, closely followed by Hewlett-Packard/Apollo with 26,300 units. Altogether, the top three manufacturers account for 76 percent of total unit production. IBM is also markedly ramping up production, with some 20,000 units expected for 1991.

Table 1, placed at the end of this newsletter for space reasons, shows a detailed breakdown of manufacturing activity across Europe by manufacturer.

WORKSTATION PRODUCTION

Dataquest's estimates for workstation production by processor type and market shipments are shown in Table 2, also at the end of the newsletter. We expect the shift towards RISC-based workstations to intensify, rising to an estimated 78.5 percent share of production in 1991, compared with 65.3 percent during 1990. For 1991, the four

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major RISC architectures, HP/Apollo's Precision Architecture, IBM's RS/6000, MIPS' R-series and Sun's SPARC make up 89.5 percent of all RISC workstations manufactured. CISC workstation production continues to be dominated by the Motorola 68000 series processors.

Also shown in Table 2 is total production and update of our forecast for semiconductor consumption from 1991 to 1995, and Table 3 shows manufacturing activity in Europe by company location.

The End-User Market

Dataquest estimates that total revenue for workstations sold in Europe during 1990 was $3,071 million across 116,725 units. Collectively the top three workstation manufacturers supplied 75 percent of the market: ranked first is Sun with 30 percent of the unit market; second is Hewlett-Packard with 23 percent; and third is Digital with 22 percent. Total unit market growth in 1990 represented 38 percent over 1989. From 1991, Dataquest forecasts the market to grow at a CAGR of 33 percent until 1995 (see Table 2).

Dataquest's Computer Group estimates that sales of RISC workstation units by processor platform amounted to 47 percent of overall European sales. The SPARC platform accounted for 59 percent of the European RISC workstation market in 1990, followed by MIPS (13 percent), IBM (14 percent), Clipper (10 percent), HP PA/PRISM (2 percent), 88000 series (1 percent) and others (1 percent). However, the CISC market is dominated by Motorola's 68000-based workstations (49 percent in total including HP/Apollo), followed by Digital's VAXstations (35 percent), and others—including PC-compatibles—(16 percent).

The price wars recently experienced in the PC market are beginning to ripple through to the low end of the workstation market. For example, IBM's long-awaited and soon-to-be-launched, entry-level RS6000, is to be priced at around $5,000 early in 1992, bringing it close in price to high-end 80486-based PCs. Hewlett-Packard, with its Precision Architecture series, is expected to announce its entry-level 700-series at less than $10,000 in early 1992, thus responding to Sun's domination of, and Digital's recent attack on, the entry-level desktop market.

Although some manufacturers in the workstation business have cut prices by up to 30 percent (Dataquest's Computer Group estimates that overall, the DECstation family's average-weighted

TABLE 3
Estimated Workstation Production in Europe by Location

Manufacturer	Subcontractor	Town	Country	Country of Origin	Board Assembly	Board Test	Workstation Assembly	Local Semi. Procurement
Acorn	AB Electronics	Cardiff	Wales	Wales	✓	✓	✓	✓
Cetia	Cetia	Toulon	France	France	✓	✓	✓	
Digital	Digital	Ayr	Scotland	United States	✓	✓	✓	(Spares only)
HP/Apollo	HP/Apollo	Böblingen	Germany	United States	✓	✓	✓	✓
IBM	IBM	Santa Paloma	Italy	United States	✓	✓	✓	(Mainly captive)
Intergraph	Intergraph	Nijmegen	Netherlands	United States	✓	✓		
Siemens Nixdorf	Siemens Nixdorf	Augsburg & Paderborn	Germany	Germany	✓	✓	✓	✓
Silicon Graphics	Silicon Graphics	Neuchatel	Switzerland	United States	✓	✓	✓	
Sun Microsystems	Sun Microsystems	Linlithgow	Scotland	Scotland	✓	✓	✓	✓

Source: Dataquest (December 1991)

ASPs have declined 22 percent in 1991 over 1990). Others, like Sun, have maintained price levels but have enhanced product performance by increasing RAM configuration to match, or outperform, competition.

Semiconductor Consumption Market

From a semiconductor marketing perspective, not all manufacturers procure locally. Many are US-based companies that import motherboards and sub-assemblies for local assembly and testing. However, the trend is for many of these companies to increase local procurement. With these adjustments taken into account, the actual proportion of the end-user market "effectively" produced in Europe increased from 39.5 percent (20,950 units) in 1989 to 47 percent (36,565 units) in 1990. We estimate that motherboard semiconductor consumption totalled $26.5 million in 1990, and this is forecast to more than double to $58.1 million for 1991.

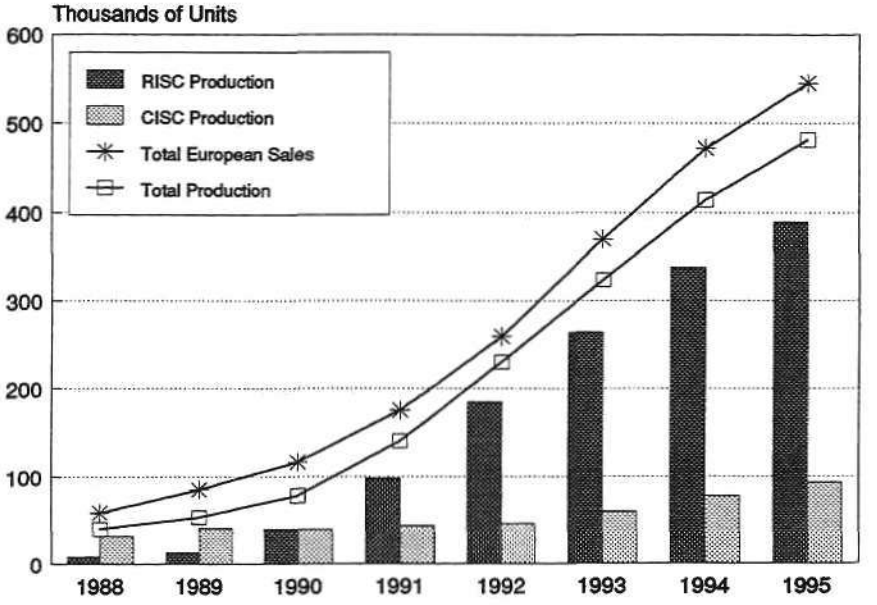
The bulk of Europe's workstation manufacture (58.7 percent) occurs in the United Kingdom, generated mainly by Sun (Linlithgow, Scotland) and Digital (Ayr, Scotland), with the former having increased production by 500 percent. However, most of the volume manufacturers are based in the United States where they also carry out design and development. Semiconductor purchases for workstation applications are therefore dominated by "strategic" commodity products such as memories (DRAM) and microprocessors (MPU), where regional price differentials often result in significant cost savings.

Furthermore, in response to our survey, most manufacturers indicated that they plan to continue increasing both local production and procurement. We forecast the semiconductor demand for workstation motherboards to reach $200 million by 1995, equivalent to a 36.2 percent CAGR between 1991 and 1995.

Production of RISC-based machines (see Figure 1) surpassed that of the CISC-based ones last year, and the trend towards RISC is expected to continue for the foreseeable future. For 1991, 69.6 percent of total European production is RISC-based computers. By 1995, we expect CISC-based workstations to account for less than 20 percent of total European production.

While the majority of the manufacturers surveyed indicated local semiconductor sourcing as standard practice, many assemble boards and purchase components for motherboard manufacturing only. Peripheral boards, keyboards, disk drives and other peripherals are normally subcontracted out to other companies, or imported from specialist suppliers (see Table 4).

FIGURE 1
European Workstation Market and Production



Source: Dataquest (December 1991)

TABLE 4
Major Workstation Subsystem and Peripheral Suppliers

Keyboards	Monitors	Disk Drives
Honeywell	Barco	Conner
IBM	Conrac	Fujitsu
(Scotland)	Eize (Japan)	IBM
Keytronic	Hitachi	Maxtor
(United States)	IBM (Scotland)	Panasonic
NMB	JVC (Korea)	Seagate
(Thailand)	NEC (Japan)	Sony
	Philips (Italy)	Toshiba
	Sony	
	Tatung (England)	
	Zenith (United States and Mexico)	

Source: Dataquest (December 1991)

Regional Production

Workstation unit production by region is shown in Figure 2. The United Kingdom and Eire show the highest concentration of workstation production representing 47.3 percent of the total European production in 1990, expected to rise to 59 percent for 1991. The main producer in the United Kingdom is Sun Microsystems, whose production next year is expected to account for 66 percent of production share in that region. Italy will also enjoy a strengthened position with the production of IBM workstations at Santa Paloma.

CONCLUSIONS

In 1990, North American manufacturers accounted for 91.5 percent of European production. In 1991, our estimates show that 93.4 precent of all European production will come from North American vendors. The workstation end-user market is also very heavily dominated by the US vendors; clone manufacturers have not yet gained any significant market share to justify local manufacture.

During 1991, less than 60 percent of workstations manufactured in Europe contained locally procured semiconductors. The survey showed a strong effort to European manufacturing corresponding to a 120 percent increase in semiconductor sales for this application between 1990 and 1991. The fastest-growing region in Europe for workstation production is the United Kingdom. This is largely from production by both Digital and Sun Microsystems.

RISC-based workstations represented 50.2 percent of 1990 production, expected to rise to 69.6 percent of 1991 production. The shift towards RISC production is driven by the market demand for RISC-based machines.

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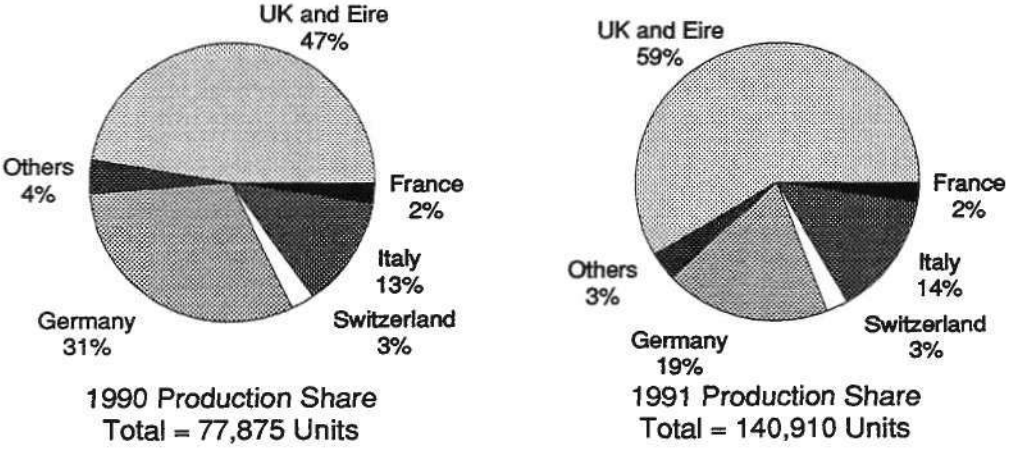
FIGURE 2
Workstation Production in Europe by Country



Source: Dataquest (December 1991)

TABLE 1
Estimated Workstation Production in Europe by Manufacturer

Manufacturer	1988 CISC Total	1988 RISC Total	1988 Total	1989 CISC Total	1989 RISC Total	1989 Total	1990 CISC Total	1990 RISC Total	1990 Total
Acorn	-	-	-	-	1,250	1,250	-	2,200	2,200
Cetia	970	-	970	1,800		1,800	1,665	200	1,865
Digital	18,750	-	18,750	20,500	400	20,900	13,100	13,100	26,200
HP/Apollo	12,058	-	12,058	17,900	-	17,900	23,500	-	23,500
IBM		2,500	2,500	-	5,000	5,000	-	10,000	10,000
Intergraph	-	4,500	4,500	-	4,950	4,950	-	3,060	3,060
Siemens Nixdorf	-	-	-	-	-	-	500	-	500
Silicon Graphics	-	935	935	-	1,200	1,200	-	2,050	2,050
Sun Microsystems	-	-	-	-	-	-	-	8,500	8,500
Total Production	31,778	7,935	39,713	40,200	12,800	53,000	38,765	39,110	77,875
Percent Effective Production	41.0%	0.0%	32.8%	49.0%	9.8%	39.5%	66.2%	27.9%	47.0%
Effective Production	13,028	-	13,028	19,700	1,250	20,950	25,665	10,900	36,565

Manufacturer	1991 CISC Total	1991 RISC Total	1991 Total	1992 CISC Total	1992 RISC Total	1992 Total	AGR 89–90	AGR 90–91	AGR 91–92
Acorn	-	3,250	3,250	-	5,500	5,500	76.0%	47.7%	69.2%
Cetia	1,750	250	2,000	1,800	500	2,300	3.6%	7.2%	15.0%
Digital	14,850	14,850	29,700	15,050	15,050	30,100	25.4%	13.4%	1.3%
HP/Apollo	25,800	500	26,300	28,500	1,000	29,500	31.3%	11.9%	12.2%
IBM	-	20,000	20,000	-	30,000	30,000	100.0%	100.0%	50.0%
Intergraph	-	4,560	4,560	-	5,500	5,500	-38.2%	49.0%	20.6%
Siemens Nixdorf	500	-	500	-	1,000	1,000	0.0%	100.0%	-
Silicon Graphics	-	3,600	3,600	-	6,400	6,400	70.8%	75.6%	77.8%
Sun Microsystems	-	51,000	51,000	-	120,000	120,000	500.0%	135.3%	-
Total Production	42,900	98,010	140,910	45,350	184,950	230,300	46.9%	80.9%	63.4%
Percent Effective Production	65.4%	56.1%	58.9%	66.8%	69.2%	68.7%	-	-	-
Effective Production	28,050	55,000	83,050	30,300	128,000	158,300	74.5%	127.1%	90.6%

AGR = Annual Growth Rate
Source: Dataquest (December 1991)

TABLE 2
Estimated European Workstation Production by Processor Type

Microprocessor Type	1988	1989	1990	1991	1992	1993	1994	1995	AGR 90–91	CAGR 91–95
Market Shipments	58,090	84,745	116,725	175,568	259,016	369,888	471,917	545,134	50.4%	32.7%
CISC										
68000 series	31,778	40,200	38,265	42,400	NA	NA	NA	NA	10.8%	21.5%
80x86 series	-	-	-	-	NA	NA	NA	NA	NA	NA
Other CISC	-	-	500	500	NA	NA	NA	NA	NA	NA
Total CISC	31,778	40,200	38,765	42,900	45,350	59,134	77,078	92,493	10.7%	21.2%
RISC										
MIPS R2000/3000/4000	935	1,600	15,150	18,450	22,450	32,060	40,903	47,249	21.8%	26.5%
Intel i860	-	-	-	-	NA	NA	NA	NA	NA	NA
Acorn ARM	-	1,250	2,200	3,250	NA	NA	NA	NA	47.7%	37.4%
Sun SPARC	-	-	8,500	51,500	NA	NA	NA	NA	505.9%	49.1%
Motorola 88000	-	-	200	250	NA	NA	NA	NA	25.0%	43.2%
AMD 29000	-	-	-	-	NA	NA	NA	NA	NA	NA
HP/PA	-	-	-	500	NA	NA	NA	NA	NA	NA
IBM RS/6000	2,500	5,000	10,000	20,000	NA	NA	NA	NA	100.0%	33.3%
Inmos Transputer	-	-	-	-	NA	NA	NA	NA	NA	NA
Intergraph Clipper	4,500	4,950	3,060	4,060	NA	NA	NA	NA	32.7%	24.9%
Other RISC	-	-	-	-	NA	NA	NA	NA	NA	NA
Total RISC	7,935	12,800	39,110	98,010	184,950	264,118	336,972	389,252	150.6%	41.2%
Total Unit Production	39,713	53,000	77,875	140,910	230,300	323,252	414,050	481,746	80.9%	36.0%
Effective Unit Production	13,028	20,950	36,565	83,050	158,300	226,060	288,416	333,164	127.1%	41.5%
Semiconductor Content per Unit ($)	$780	$740	$725	$700	$675	$650	$625	$600	-3.4%	-3.8%
European Semiconductor Consumption ($M)	$10.16	$15.50	$26.51	$58.14	$106.85	$146.94	$180.26	$199.90	119.3%	36.2%
I/O Ratio	3.51%	3.31%	2.76%	3.13%	3.77%	4.03%	4.30%	4.59%		
Average Selling Price	$22,224	$22,373	$26,310	$22,384	$17,914	$16,127	$14,522	$13,072	-14.9%	-12.6%

NA = Not Applicable
AGR = Annual growth rate
CAGR = Compound AGR
Source: Dataquest (December 1991)

COMPANY NOTES

Acorn

A subsidiary of the Olivetti group and currently subcontracting all motherboard manufacture in the United Kingdom. Acorn is also a major manufacturer of personal computers.

Cetia

Cetia (Compagnie Europeenne des Techniques de l'Ingenierie Assisté) is a subsidiary of Thomson-CSF SA. It markets integrated solutions for real-time computing, software engineering and interactive scientific applications. Cetia manufactures UNIX workstations and VME board computers based on Motorola 680x0 and 88x00 RISC microprocessors. The company has its main design center for workstation products at Toulon in France.

Digital Equipment Corporation

This company has its workstation computer manufacturing facilities in Ayr in Scotland where it also has design centers.

Hewlett-Packard/Apollo

Hewlett-Packard acquired Apollo in 1989 to complement its own workstation business (hence Hewlett-Packard/Apollo). Apollo had a factory in Scotland which has since been closed down and all manufacturing, including R&D, has now been transferred to HP's factory at Böblingen, Germany.

IBM

IBM has several computer and peripheral manufacturing plants in Europe. All of its workstations are manufactured at Santa Paloma in Italy with a few minor parts of its RS/6000 series also being procured mainly in Europe (mostly from other IBM manufacturing sites). All IBM workstation motherboards come from its Vimercate plant in Italy. Workstation monitors and keyboards are built at the Greenock factory, Scotland.

ICL

ICL became 80 percent owned by Fujitsu in 1990. In May 1991, ICL announced the agreed acquisition of Nokia's computer division, Nokia Data. All workstation manufacturing in Europe is currently at Ashton-under-Lyne, England and the remainder of its European shipment comes from Acer in Taiwan which acquired the UNIX systems manufacturer, Altos, in July. ICL has an agreement with Sun (UK) to manufacture all of its motherboard production. Sun's figures are shown separately. For the purposes of this report, we have excluded ICL's production.

Intergraph

Intergraph has an assembly plant for workstations in Nijmegen (Netherlands). This facility previously assembled its mainframe computers for the European market, but this program has now been terminated. Intergraph plans to commence computer monitor assembly in Europe specifically for its workstation range in 1992 at Nijmegen. Research and development of all hardware is at Huntsville, United States.

Siemens-Nixdorf Information Systems

SNI was formed by the merger of Siemens' computer division and Nixdorf in January, 1990. Siemens acquired IN2/Leanord which had formerly acquired Leanord (France) in early 1989.

Silicon Graphics

Manufactures workstation computers at the Neuchatel facility in Switzerland, which performs board test and final product assembly. Silicon Graphics is constructing a new facility to expand its European plant capacity by a further 7,500 m^2. This is scheduled for completion by August.

Sun Microsystems

Sun Microsystems has recently constructed a factory in Linlithgow, Scotland. It has been built in three phases and final completion is scheduled by 1993. All board-level manufacturing is subcontracted out to ICL's Kidsgrove (UK) facility.